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MESSAGE FROM THE

CHAIRMAN

Dear Readers,

2023 promises to be another eventful year for Oman's energy industry as it pivots away from hydrocarbons towards a new true north: a sustainable, low carbon energy future powered predominantly by green fuels. The energy transition, formally launched last year, continues to gather pace in Oman and across the wider region, unleashing a paradigm shift in the way how we produce, consume, transport and store energy. These are incredibly exciting times for energy producers and exporters like Oman, and indeed importing blocs as well, as both sides work collaboratively to chart a pathway, fraught with uncertainty and risk, to a carbon-neutral future for all of mankind.

From the outset of Oman's transition, Birba Energy - the parent company of Energy Oman - has worked in concert with government and private sector stakeholders in keeping this vital strategic goal front and centre of the national agenda. It has done so by, among other initiatives, hosting international-level annual summits focused on green hydrogen as a viable pathway to a sustainable, low-carbon future. Later this year, a third edition of this compelling and impactful summit will take place in Muscat to help attract investors, developers and technology providers to this promising new industry.

But as nations navigate uncharted waters in their energy transition journeys, collaboration becomes indispensable. To this end, Birba has charted a new course for itself: Organizing forums in key markets across the wider Middle East and North Africa (MENA) with the underlying goal to promote networking, collaboration and information sharing across national borders. Later in May 2023, Birba will partner with Qatari stakeholders in the delivery of a first-ever forum on Carbon Capture, Storage & Utilisation (CCUS) in Doha. Marrakesh in Morocco is next in our sights as we grow of calendar of green-energy focused events.

This edition of Energy Oman brings you up to date with our upcoming initiatives, as well as developments across the green energy space.

Abdullah Al Harthy



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SOUNDING BOARD

Members of the Editorial Advisory Board of Energy Oman share their perspectives on the outlook for the Sultanate's energy sector as the Sultanate, among other oil-producing states, continue to navigate the challenges posed by the coronavirus pandemic and the lingering effects of the global economic slump.

BUOYANT ENERGY PRICES TO SUSTAIN HYDROCARBON ACTIVITIES

The energy industry at large has been going through some stabilization post the turbulence of Covid worldwide lately. This is clearly manifested in the robust prices of crude oil prices, as well as in refining and petrochemical product prices. Gas prices have been going through the roof during the past few months, largely due to market instability caused by the Russian-Ukraine war in Europe.

In Oman, production has been sustained to levels seen prior to Covid and even earlier. This is exemplified by Oman's latest additions to its production portfolio post-2020, from the likes of OQ's newly producing Bisat Oilfield in Block 60, and Masirah Oil Limited's Yumna field in Block 50.

Moreover Oman's resilience in finding new oil and gas fields continues with increasing levels of exploration activities by both local and international players in the country. The latest gas startup in Block 10 operated by Shell with OQ and TotalEnergies as partners pays testimony to successful exploration maturation translating into quick production.

There is no doubt that oil and gas will remain very strong and in high demand for the foreseeable future, and Oman will supply its share of the hydrocarbon supply worldwide.



BY DR ANWAR AL KHARUSI

VICE PRESIDENT - UPSTREAM
BUSINESS DEVELOPMENT
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DR AISHA AL SARIHI
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NATIONAL INSTITUTE OF SINGAPORE

THE RACE TO NET-ZERO

The world has already warmed by around 1.1 °C compared to pre-industrial times, and likely getting close to the 1.5°C of heating within the next two decades, according to the latest United Nations' Intergovernmental Panel on Climate Change (IPCC) Report. Every corner of our planet has already experienced the impacts of climate change from extreme heatwaves and floods to devastating droughts. Countries around the world recognise the urgency to combat climate change. To date, over 130 countries, covering 83% of global emissions, have committed to achieving net-zero by or around mid-century. This is a right step in the right direction.

Yet, achieving net-zero targets is not without challenges. The road to net-zero will require collective efforts to develop and scale up the implementation of all possible solutions that can reduce greenhouse gas emissions by half by 2030 and reach net-zero around mid-century. Renewable energy, hydrogen, bioenergy, carbon capture and storage and energy efficiency as well as nature-based solutions will all play a role in countries' race to net-zero. Countries' approach to net-zero and to what extent the aforementioned solutions will play a role in their net-zero pathway may vary considerably given differences in endowment of natural resources (such as hydrocarbon vs solar and wind) and variances in socio-economic contexts as well as financial and technological capacities.

Nevertheless, there is a significant gap between where countries stand today in their clean energy and where they need to be in 2050. For instance, in a net-zero emissions pathway, the share of renewables in total electricity generation globally should increase from current 29% to over 60% in 2030 and to nearly 90% in 2050. Similarly, clean hydrogen production should increase six times from current levels of 0.87 Mt to 530 Mt in 2050. Achieving these targets will require incremental increase in clean energy investments, approximately \$2 to 4 trillion per annum between 2022 and 2030, roughly triple today's levels of \$755 billion. No one country can address these gaps alone. Collective efforts to address these challenges is of an equal importance as acknowledgment of climate change emergency and setting net-zero targets.



ENG. SAIF AL SALMANI
TECHNICAL DIRECTOR –
CC ENERGY DEVELOPMENT (CCED)

WHY ESCOS ARE A WIN-WIN FOR ENHANCING ENERGY EFFICIENCY IN BUILDINGS

While Oman is outpacing the rest of the world in the delivery of a green hydrogen-based clean energy industry, it is lagging behind others in one notable area: Enhancing energy efficiency in the Residential Buildings & Construction industry.

It is a well-established fact that the residential and buildings sector accounts for the lion's share of electricity demand during the hot summer months of the year when air-conditioning becomes indispensable to our daily existence. While new property developments can incorporate energy efficiency features in their design, choice of materials and installation of control systems, existing buildings require a different set of actions and measures to help progressively reduce energy consumption over a

period of time.

This is where ESCOs come in! Short for Energy Services Companies, these are specialist businesses with the skills and wherewithal to help developers, real estate investors and building owners gradually pare their electricity demand through relatively minor tweaks in patterns of their energy consumption. Through modest investments in, for example, the retrofitting of energy-intensive fittings and cooling appliances, roof and wall insulation, use of cladding systems, and so on, significant savings can accrue to the building owner. Over time, these savings will offset any capital investments made towards making buildings more energy efficient.

While a number of ESCOs are in operation in Oman, the large-scale uptake of their business model is still lagging, unfortunately.

ESCOs come in with the requisite funding and expertise to help a building owner reduce his energy bills over time. The latter, for his part, incurs no upfront costs during the period of the arrangement with the ESCO, who recoups his costs (as well as his margins) from the energy savings delivered to the building owner. As timeframes typically span multiple years, ESCOs have enough of a payback period to recover their costs. It's a win-win model that also benefits the wider energy sector and the national economy as well.



DR ZAKIYA AL AZRI
CORPORATE RESEARCH &
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PETROLEUM DEVELOPMENT
OMAN

WHY IT'S IMPERATIVE TO DOUBLE DOWN ON THE GLOBAL ENERGY TRANSITION

The tide of increasingly grim news casting doubt on our collective ability to achieve our Paris commitments while, on the one hand, disconcerting, should on the other, galvanize is to do much more to stay on course.

It's true that back-to-back global crises, such as the ongoing conflict in Ukraine, rising inflation and the economic slowdown, and the coronavirus pandemic just earlier, have somewhat derailed the energy transition drive. Multiple agencies, notably the International Renewable Energy Agency (IRENA), have warned that we are far too off-track to achieve the goal of limiting global warming to 1.5 degrees Celsius by 2050. But defeatism is not an option if we have to safeguard Planet Earth for our children.

The challenges, no doubt, are daunting! According to IRENA, we would need renewables deployment to surpass 10,000 gigawatts by 2030 – up from around 3,000

GW presently – if we have to pivot back to the 1.5 degree Celsius pathway. Coverage should extend beyond the United States, Europe and China, which currently dominate the renewables space. Further, the share of renewables in the electricity generation mix should reach around 91 per cent of the total by 2050, up from 28 per cent presently.

Oman has chalked out a well-defined pathway to Net Zero by 2050 that should serve as a paradigm for other countries to emulate as well. Of course, it would be unfair to impose similar targets on poorer nations, particularly those in Africa, which just do not have the resources to focus on climate change concerns when they are weighed down with more pressing challenges. Richer economies need to rally together to help developing countries with resources and meaningful incentives to aid their energy transition as well.



DR. SALIM AL HUTHAILI
CEO OF SOLAR WADI

CREATING GREEN JOBS IN THE ENERGY SECTOR

As Oman's energy transition gains momentum in the coming years, jobs will be created across a broader spectrum of sectors, spanning energy efficiency services, low-carbon mobility and transportation, clean fuel production, emissions reduction, carbon capture and utilization, green finance, carbon markets, and so on.

This employment generation potential will also be ignited by the onshoring of manufacturing of solar panels, wind turbines, electrolyzers and other hardware necessary to support this new economy.

Given this vast potential, it becomes imperative for policymakers particularly in vocational training and higher education to allocate the required resources to drive curriculum development, attract new training services providers into the country, and generally galvanize the growth of the skills development and training sectors relevant to these emerging industries.

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Following the overwhelming response from the previous two editions, with over 2500 attendees in the second edition alone, the third edition of the Green Hydrogen Summit Oman 2023 (GHSO23) will be held from 12th to 14th of December 2023 at the Oman Convention and Exhibition Centre, Muscat, the Sultanate of Oman.

After the tremendous success of the GHSO 2022, GHSO 2023 will be twice as big to accommodate the increasing global demand for the green hydrogen industry.



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OMANI HYDROGEN FOR GERMANY AND THE EU: NOT JUST A MATTER OF ENERGY POLICY

Strengthening the national hydrogen economy of Oman also serves global efforts to fight climate change, promote regional stability, and establish key diplomatic partners for Germany.

DR DAWUD ANSARI
RESEARCHER,
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UND POLITIK (SWP)



His Majesty Sultan Haitham bin Tarik with President Dr. Frank-Walter Steinmeier of the Federal Republic of Germany during the Omani monarch's visit to Germany in July 2022

[This article, originally published by German think-tank Stiftung Wissenschaft und Politik (SWP), has been slightly edited for length and style]

Germany and the EU plan to import hydrogen and its derivatives from the Arab Gulf states. Although Germany has signed a joint declaration of intent with the Sultanate of Oman to this end, its efforts focus primarily on Oman's larger neighbours. However, it would be a mistake to overlook Oman's potential role within German and European energy policy, geostrategy, and climate diplomacy. Oman's ambitious hydrogen plans can provide Germany and the EU with affordable clean energy; and enhanced (trade) relations with the Sultanate align with a value-based approach to trade, support global climate action, and stabilise regional power balances – thus preventing the potential of dangerous conflict.

The Arab Gulf states – Saudi Arabia, Kuwait, Bahrain, Qatar, the United Arab Emirates (UAE), and Oman – have entered the spot-light of German and European energy policy in 2022. While Germany and the EU still urgently need liquefied natural gas (LNG) in the short-term, hydrogen imports will allow for the long-term decarbonisation of their industry and aviation. The Gulf states boast excellent conditions for the production of hydrogen from renewable energies thus placing them at the lower end of the global supply curve. The Gulf states can provide these resources at a lower cost and diversify the EU's import sources, but just as important, turning to these states will also help to support the necessarily rapid development of the hydrogen market. The Gulf states offer strong financing capacities, pre-existing (export) infrastructure, short construction times, and advanced know-how in the hydrogen sector, thus allowing them to implement pilot projects quickly and reliably. For these reasons, they are also able to get exports to Europe faster than other regions.

Within this context, the Gulf states have adopted ambitious hydrogen plans and they are keen on teaming up with partners to develop technology, investment, and trade in this sector. Here, Germany has signed declarations of intent with Saudi Arabia, the UAE, Qatar, and Oman. However, throughout 2022, the German government failed to visit Oman during its trips to the region. Also, other institutions and companies seem to neglect Oman as they direct most of their attention to Saudi Arabia and the UAE. After all, when compared to Oman, these countries tend to have stronger representation in Europe and produce more oil and gas.

Nonetheless, it would be a strategic mistake to overlook Oman. The Sultanate is deeply committed to its plans – partially because its economic situation urgently requires the government to develop new sectors. Moreover, Germany's hydrogen ambitions should consider geostrategic implications and climate diplomacy in the case of Oman. Indeed, so far, it represents an example of weakness in Germany's management of the hydrogen sector that needs to be resolved.



HE Salim bin Nasser Al Aufi,
[left] Oman's Minister of Energy
and Minerals (left), with his
German counterpart

OMAN'S HYDROGEN POLICY: FRAMEWORK AND BACKGROUND

Oman's hydrogen policy is embedded in the country's overall development goals and is connected to its economy and efforts to fight climate change.

A general framework for the country's approach to hydrogen is provided by Vision 2040 – an overarching sustainable development agenda for 2021–2040 period. This is the country's primary strategy document, and it defines various goals as well as ways to harmonise and monitor how they are being achieved. Among those goals are economic leadership and diversification. To this end, future industries and key sectors that complement the petroleum business are being identified and developed. Within this context, Vision 2040 aims to have the contribution of non-oil sectors grow from 61 to 91.6 per cent of Oman's economic output; it also envisions their share of the public budget doubles to 18 per cent. Oman's green economy, especially clean energy, is to be expanded to increase the country's competitiveness. By 2030, Vision 2040 foresees 20 per cent of Oman's energy demand being met by renewable energy, and 35 to 39 per cent by 2040. Oman's current strategic approach to the energy sector and the wider economy is therefore to limit current spending while creating mid-term prospects in promising areas. It does so through capital structure management – especially by way of leveraging – and through targeted support for future industries. First, (partial) privatisation and debt leverage provide additional liquidity and reduce current liabilities, which eases the burden on the fiscal state. For example, in 2021, concessions for developing central oil fields were transferred to a newly founded company that is state-owned albeit debt-financed. Shares in various public (energy) companies are scheduled to be sold and traded in the future. Oman sees foreign and borrowed capital as the main source of funds for hydrogen, as the Sultanate considers itself a natural resource provider first and foremost. Secondly, Oman is targeting structural unemployment by onshoring jobs, reserving positions for nationals, and by identifying key sectors for investment in the future. Alongside Vision 2040, an "In-Country Value" framework stipulates that the Omani (energy) economy must demonstrate a substantial contribution to the socio-economic development of the Sultanate. The country is pinning its hopes on the hydrogen sector, where it expects to generate 70,000 new domestic jobs.

The creation of jobs in sectors of the future is also a key element of the country's strategy to achieve climate neutrality, which was published in November 2022. The document outlines the complete decarbonisation of Oman by 2050 along a pragmatic though ambitious path of transformation.

The hydrogen economy's central role in this vision is twofold. First, the plans intend for hydrogen to drive domestic decarbonisation in industry and transportation. Second, hydrogen is the main vehicle for the creation of the green economy and green jobs. According to the strategy, 55 per cent of the jobs created during the transformation and two-thirds of the economic growth are to come from the hydrogen economy.

THE BEGINNING OF AN OMANI HYDROGEN ECONOMY

In October 2022, Oman quantified and published its national hydrogen plans. Accordingly, it aims to produce 1 to 1.25 million tonnes (Mt) of hydrogen by 2030; and 3.5 and 8 Mt by 2040 and 2050, respectively. These are colossal goals for the rather small Gulf state. As an illustration, neighbouring Saudi Arabia, which is about eight times larger in terms of its area and population, plans to produce 4 Mt of hydrogen annually by 2030;

OMAN'S HYDROGEN POLICY IS EMBEDDED IN THE COUNTRY'S OVERALL DEVELOPMENT GOALS AND IS CONNECTED TO ITS ECONOMY AND EFFORTS TO FIGHT CLIMATE CHANGE.

the EU-wide production target by 2030 is "only" 10 Mt per year. The Sultanate projects that achieving its goals will necessitate electrolyser capacities of 8–10 gigawatts (GW) and additional renewable power generation of 16–20 GW by 2030, while increasing these requirements to 100 GW and 185 GW, respectively, by 2050. Oman's energy ministry estimates that €132 billion worth of investments will be required, including by way of infrastructure. Regions suitable for hydrogen production are dispersed across the country and linked to (deep water) ports (see figure). Duqm, Salalah, and Sohar are developed industrial ports and special economic zones, while Sur is home to the Sultanate's LNG terminals. Currently, the Omani energy ministry has pinpointed the regions around Salalah in the Dhofar governorate as well as Duqm and Al-Jazir in the Al-Wusta governorate as the sites most suitable for sustainable hydrogen production. They have favourable sun and wind conditions and are located near the coast – an important consideration as the water needed for electrolysis will be obtained from desalinated seawater. Also, their location near the coast eliminates the need for expensive transport pipelines to reach ports. Salalah (like Sohar) is an urban centre, which allows for better access to human resources. While the construction of hydrogen infrastructure will be the responsibility of various state-owned actors and will be tendered separately, Oman calls on private international consortia to implement hydrogen production. This approach matches Oman's general approach to the (energy) economy outlined previously.

Its plans will primarily be realised though a competitive bidding process for 47-year-long concessions for individual tracts (blocks) of land. In the (current) tendering phase A, six blocks will be at stake over two rounds. The first round comprises two blocks in Duqm that will be awarded in April 2023. Subsequently, four blocks in Dhofar enter the bidding process, which is scheduled to start in May 2023.

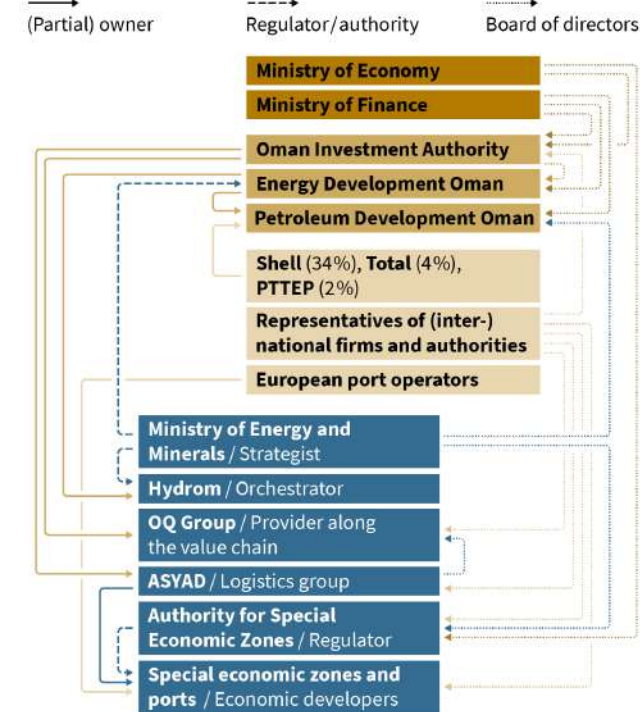
The procurement conditions seek to simultaneously satisfy domestic

interests – primarily, participation and local development – and create attractiveness for (foreign) investors. The framework stipulates certain floor prices: Any consortium must offer at least approximately €0.04 per square metre for the land lease, 5 per cent of the hydrogen produced as a royalty in-kind, and profit royalties. Moreover, the Omani group OQ, represented by its Alternative Energy unit, must be made a shareholder of at least 20 per cent of the project. Furthermore, consortia will be subject to corporate tax. Projects must be vertically integrated and contain all elements from electricity generation to producing hydrogen derivatives. The bidding rules stipulate that electricity is to be produced with a cost-efficient and

While the construction of hydrogen infrastructure will be the responsibility of various state-owned actors and will be tendered separately, Oman calls on private international consortia to implement hydrogen production. This approach matches Oman's general approach to the (energy) economy outlined previously.

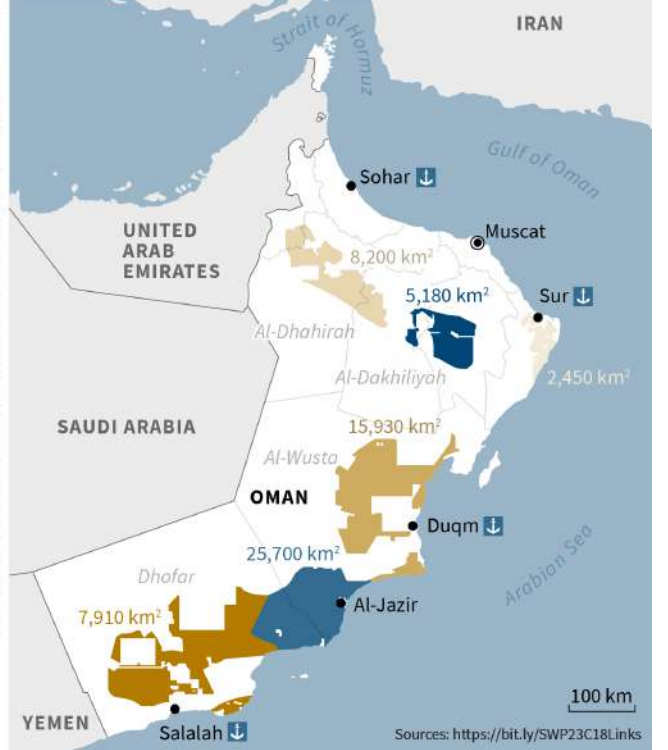


Simplified organigram of selected actors in Oman's hydrogen economy



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Map of Oman with ports and designated areas for hydrogen production



dynamically expandable solar-wind mix. The consortia are at liberty to choose electrolyser technology and the kind of hydrogen derivative. However, bidders are also expected to provide (preferably binding) buyers (so-called off-takers).

Ahead of the tendering phases, Oman's Ministry of Energy and Minerals has already signed numerous declarations of intent with potential importing countries, including Germany, Belgium, the Netherlands, and Japan, as well as with strategic partners such as the energy giant Shell. Beyond the open tender, some consortia have already signed land use agreements. The Hyport-Duqm project, led by the Belgian company DEME, for example, is working on producing green ammonia from 1.3 GW of solar and wind energy in the Duqm region. Coordination and cooperation within the region have been limited so far. There are declarations of intent for Saudi and Emirati investments in Oman's hydrogen sector as well, and Kuwait's sovereign wealth fund has

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also expressed interest in the past.

A distinctive aspect of Oman's plans is the deliberate inclusion of hydrogen and its derivatives for domestic use. Authorities plan to develop a local distribution network, through which the already existing demand from the petroleum and agriculture sectors will be decarbonised. The Sultanate is actively tapping into the potential of its ports as hydrogen hubs with export and production facilities. Most importantly, the plans also

consider the production and export of green steel. For example, Jindal Shadeed – the local offshoot of the Indian giant Jindal Steel and Power plans to invest about €2.8 billion in a plant that would produce five million tonnes of steel annually. OQ has also expressed interest in setting up green cement plants. Furthermore, there are purchase agreements with the Norwegian company Yara International for the use of green ammonia as ship fuel and exportable fertiliser.



Members of the Omani delegation and their German hosts during the landmark visit

KEY PLAYERS IN OMAN'S HYDROGEN ECONOMY

A national network of public companies and ministries is in charge of developing Oman's hydrogen economy. The two most central actors are the Ministry of Energy and Minerals (MEM) and the state-owned company Hydrom. MEM, whose mandate includes both the energy sector and other portions of the economy, provides political, strategic, and regulatory leadership with respect to hydrogen. Hydrom, which was founded in 2022, orchestrates the sector. Its responsibilities include arranging land concessions, developing shared upstream infrastructure, organising the bidding process, distributing product, and coordinating the various actors involved. Hydrom reports to MEM and is a subsidiary of Energy Development Oman (EDO).

Since a restructuring of the energy sector in 2021, EDO also controls the national oil company Petroleum Development Oman (PDO), which is not a hydrogen actor per se, but still has strong indirect impact on the sector due to its close ties to and role in hydrogen-related committees. The royal palace, which oversees all other actors, establishes the foundations of the hydrogen economy through royal decrees and the allocation of national resources (such as land).

Other public companies and authorities primarily occupy the mid- and downstream. For example, the OQ group – a vertically integrated conglomerate of Omani companies involved in the energy sector – not only supplies infrastructure, but also develops the production of hydrogen through its Alternative Energy division.

The ASYAD group – Oman's central logistics holding company – is responsible for the maritime transport of hydrogen and its derivatives as well as the management of several export ports. These ports are individual special economic zones with strong international ties, some of which operate as joint ventures with Belgian and Dutch firms. Oman seeks to develop these special economic zones into integrated hydrogen ecosystems in the spirit of the European "Hydrogen Valleys". The ports' locations along the Arabian Sea – which provides direct access to major international trade routes – extends their potential as international hubs, including for hydrogen-derived fuels.

The Public Authority for Special Economic Zones and Free Zones is an overarching entity that exercises regulatory power over the special

economic zones and, furthermore, coordinates all downstream hydrogen infrastructure. The Hy-Fly Alliance, established in 2021, brings together public and private as well as national and international hydrogen stakeholders in a comprehensive national coordination body.

Beyond these core actors, other players are also shaping the hydrogen economy. International oil companies hold shares in the national energy industry and have thus been able to quickly gain a foothold in the hydrogen sector. Some have already realised renewable energy projects in Oman and signed declarations of intent for joint hydrogen projects. Applied research institutes, especially the Oman Hydrogen Centre, compliment these developments with their technical and project-related studies.

In summary, the hydrogen sector exhibits a diffuse institutional

A SUCCESSFUL NATIONAL HYDROGEN ECONOMY WILL LEAD TO A STRONG OMAN, WHICH IS IN EUROPE'S GEOPOLITICAL INTEREST. IT IS ESSENTIAL FOR GERMANY AND THE EU TO FORGE NEW ALLIANCES IN THE REGION.

structure that features complex entanglements among key stakeholders. Among these institutions, one faction is primarily influenced by MEM while another is shaped by state-owned enterprises under the Oman Investment Authority. Established in 2020, the Oman Investment Authority is the nation's sovereign wealth fund, holding most public companies and reporting to the Council of Ministers, which is the Sultanate's highest executive body.

On the other side of the coin, public companies are guided by board members who represent a wide array of parties and interests. In this environment, despite MEM's dominance in the hydrogen sector and the monarch's absolute power, the hydrogen sector is comprised of deeply intertwined actors who create a unique system of checks and balances. This high degree of

institutionalisation may necessitate increased coordination on the part of international partners, but it also enhances the reliability of potential collaborations.

REASONS FOR COOPERATION: THE GEOPOLITICAL BALANCE IN THE GULF

Aside from energy concerns – particularly, the diversified and rapid supply of affordable clean energy – it is geopolitically prudent to import hydrogen from Oman and to collaborate with the country in the hydrogen sector. With Vision 2040 and the climate neutrality target, Oman is placing an all-in bet on industries of the future. Oman's national hydrogen industry will thus need to be rapid and reliable if the Sultanate is to be able to continue its constructive foreign policy engagement.

Furthermore, a successful national hydrogen economy will lead to a strong Oman, which is in Europe's geopolitical interest. It is essential for Germany and the EU to forge new alliances in the region. The Gulf states are on the path to becoming significant players in the global order. However, Europe (as well as the US) has long overlooked its relations with the region, leading to a decline in influence. Firstly, Europe faces challenges in representing its interests in the Gulf, as exemplified by its helplessness in preventing OPEC's decision to not increase oil production in 2022. Cooperation with Oman in the hydrogen sector can provide a strong foundation for deepening diplomatic ties with the Sultanate, thereby countering the region's accelerating decoupling from Europe.

VALUE-BASED TRADE, CLIMATE DIPLOMACY, AND POLITICAL RISK

Germany's decoupling from Russia has revived debates over value-based approaches to trade, its risks, and its benefits – especially with regard to energy imports from the Gulf states.

Moving beyond its orientalist

STRENGTHENING THE NATIONAL HYDROGEN ECONOMY OF OMAN ALSO SERVES GLOBAL EFFORTS TO FIGHT CLIMATE CHANGE, PROMOTE REGIONAL STABILITY, AND ESTABLISH KEY DIPLOMATIC PARTNERS FOR GERMANY. MOREOVER, OMAN STANDS OUT AS A REGIONAL CONFLICT MEDIATOR WITH LOW POLITICAL RISK. IT WOULD ALSO BENEFIT GERMANY, AS WELL AS GLOBAL CLIMATE EFFORTS, TO HAVE OMAN PRODUCE GREEN GOODS

“monarchy” label, Oman stands out in the region for being inclusive and moderate. Societal groups and minorities are broadly represented, and public discourse is open to competing views. In terms of value-based trade, is it also imperative to emphasise Oman’s essential role as a mediator and humanitarian actor in the war in Yemen.

A hydrogen partnership with Oman is also matter of climate diplomacy. The Gulf states do not just export carbon dioxide in the form of oil and gas exports, but they are also the world’s largest emitters per capita. With this in mind, climate diplomacy will have the crucial task of pragmatically involving oil and gas producers in global climate action. With the exception of Qatar, all Gulf states have recently announced plans to achieve climate neutrality. Among them, Oman stands out with the most ambitious target year of 2050 (shared with the UAE), the most mature strategy, and a direct link to the hydrogen economy. A rapid ramp-up of hydrogen production may foster a quick decarbonisation of Oman’s industry. The Sultanate could thus lead the way for its neighbours: Since environmental policy among the Gulf states is characterised by national(-istic) competition, Oman’s leadership could lead to a spillover effect on the other Gulf states and, thus, be an effective means to spurring global climate action.

Most importantly, Oman has proven to be extremely predictable in its policy-making over the past decade. This consistency stands in contrast to other regional actors whose foreign policies have become increasingly dynamic. Heightened political risks in providing stable energy supplies could also result in a loss of Germany’s ability to assert its foreign policy goals. In the case of Oman, the high degree of institutionalisation, including in its emerging hydrogen economy, mitigates the risk of erratic policy-making.

Oman’s tight fiscal situation and its resultant weak credit rating do spell financial risk, but they also point to the potential of Oman offering a valuable commitment. While the hydrogen ambitions

of other Gulf states are rather peripheral, a ramping-up of the sector is an essential goal for Oman in the medium-term. This is a strong driver for the realisation of Oman’s plans and explains its earnest approach to developing a robust and competitive hydrogen economy.

CONCLUSION: ALIGNING FOREIGN POLICY AND FAST-TRACKED HYDROGEN IMPORTS

As of July 2022, Germany and Oman have a declaration of intent

South Korea charging ahead. But also, other EU countries, such as Belgium and the Netherlands, are closing deals – partially anticipating the chance to someday resell hydrogen to Germany at a higher price. Exporters are also increasingly aware of their popularity, which could drive prices up instead of down. Critically, bottlenecks in electrolyser construction will initially make renewable hydrogen a scarce commodity.

With all of this in mind, Germany should coordinate public and private actors to acquire hydrogen imports

within the framework of direct intergovernmental cooperation.

This would support the expansion of German and European technological leadership in hydrogen and, at the same time, ensure hydrogen imports. The German government should also not shy away from taking a more proactive role in securing hydrogen, even in the form of a strategic reserve, for example.

At the same time, hydrogen imports can and should be linked to geopolitical, value-based, and climate diplomacy goals.

EU-China transport corridor. However, importing hydrogen from Oman would entail the same problem that befalls all potential imports from outside the EU neighbourhood: How far can the cost of maritime hydrogen transport truly fall, and how easy will it be to use hydrogen derivatives such as ammonia?

It would be advisable for Germany to establish a permanent hydrogen task force between its Federal Foreign Office and Federal Ministry for Economic Affairs and Climate Action. Such an instrument would



to collaborate in the hydrogen sector. However, progress towards its implementation is slow. This needs to change, and not only as a matter of energy policy.

Germany’s approach appears to be driven by the belief that the hydrogen market will continue to favour buyers, even in the medium-term, allowing them to continue their careful search for exporters. However, the number of buyers is rapidly growing, with Japan and

as soon as possible if it wishes to prevent high prices and further de-industrialisation. In addition to its current approach, joint ventures with other EU member states could help, especially with the Netherlands, Belgium, and Italy.

Such cooperative formats create synergies and prevent disparities in energy prices and competition within the EU. Furthermore, joint concession agreements involving the private sector could be formed

Strengthening the national hydrogen economy of Oman also serves global efforts to fight climate change, promote regional stability, and establish key diplomatic partners for Germany. Moreover, Oman stands out as a regional conflict mediator with low political risk. It would also benefit Germany, as well as global climate efforts, to have Oman produce green goods, such as steel and maritime fuel, in the centre of the heavily travelled

facilitate successful collaboration and allow for the effective assessment of future partnerships against criteria of energy economics and foreign policy alike.

In addition to ramping up the sector, Germany’s hydrogen import strategy should pay close attention to long-term diversification, both internationally and regionally. Hydrogen from the Gulf states, especially Oman, would be a crucial enabler of this approach. ■

CARBON CAPTURE, A LOOK UNDER THE HOOD

Technologies that capture and store carbon dioxide, or reuse it in a circular economy that recycles CO₂, are touted as a viable option in the toolbox to tackle climate change. But not everyone buys the industry's claims; skeptics call it a distraction.



SEBASTIAN CASTELIER
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Sebastian Castelier is a journalist and photojournalist covering how Gulf countries navigate the long-term energy transition economically, socially, and politically.

The atmospheric carbon dioxide (CO₂) concentrations are higher than at any time in at least two million years. Since the mid-18th century, humanity has put more than 1.5 trillion tons of CO₂ in the atmosphere, a greenhouse gas that warms the planet and causes climate change.

Besides reducing CO₂ emissions, described by scientists as the starting point to limit the warming of earth's atmosphere to 1.5 degrees Celsius above pre-industrial levels, capturing CO₂ emissions at source or directly from the air is one of the solutions being explored.

Technologies sucking, storing or reusing CO₂ are often mixed under the acronym CCUS. Still, they have "very different climate outcomes", said Wijnand Stoefs, carbon removals lead at Carbon Market Watch, a Belgian think tank. "Fossil fuel producers blur the lines on purpose to create confusion, so we ignore where the carbon comes from and where it ends up. They see it as a license to keep consuming their products," he told Energy Oman magazine.

Carbon capture and storage (CCS) works as trees - the "original CO₂ removal machines" - capturing CO₂ before industrial facilities or power generation release it into the atmosphere and store it underground. Earth cannot keep all humanity's CO₂ rubbish forever, but it could do so temporarily. The sixth assessment cycle from the United Nations body for assessing the science of climate change estimates the world's geological CO₂ storage capacity at about 1000 gigatonnes of CO₂. That is 10 million fully-loaded U.S. aircraft





carriers storing CO₂ for 10,000 years or more and more than CO₂ storage needed by 2100 to limit global warming.

A study on geological storage of CO₂ found that 99.9% of the CO₂ will be retained within the storage for at least 100 years following the injection. Depleted oil and gas fields are suitable spaces to trap CO₂, and the oil and gas expertise could come in handy to make sure it does not “leak” back into the atmosphere. Norwegian oil and gas company Equinor has operated the world’s first industrial-scale CCS project in the North Sea since 1996, storing up to one million tons of CO₂ per year,

the equivalent of two million barrels of oil consumed.

“Oil and gas companies have a lot of skills in terms of geology. Their know-how makes them best positioned to inject CO₂ underground,” Ludovic Leroy, a French engineer in the energy industry, told Energy Oman magazine. But the industry has a credibility issue. For decades, it misled the public about climate change while its own scientists knew global warming risks.

For its part, Carbon capture and utilization (CCU) gives a second life to captured CO₂ by turning it into

products like plastics, synthetic fuels, animal feed, carbonated drinks, building material, etc. or by injecting it into oil fields, a process called enhanced oil recovery (EOR).

Yet, the future market potential for CO₂-derived products is reportedly “difficult to assess”. The CCU proposition is attractive for businesses as it turns CO₂ emissions from liability to marketable products. “Instead of having to pay for your pollution, you get paid for your pollution”, Stoefs said. Yet, he added that recycling CO₂ is “overhyped” as the molecule will eventually be released into the atmosphere when synthetic fuels

and plastics are burnt.

OIL INDUSTRY’S DIRTY PLAY

The first carbon capture plant was proposed in 1938, but the technology was tried for the first time in 1972 to extract more oil from an oil field in Texas. According to the United States’ Department of Energy, it offers “considerable potential benefits” to extract more oil. Indeed, only 10% of an oil field

about 45 million cubic feet of CO₂ daily at one of the Middle East’s largest CO₂-EOR plants. The CO₂ captured helped the company double oil production from four wells at the Uthmaniyah oil reservoir since 2015. The world’s largest corporate greenhouse gas emitter is identifying other oil fields where enhanced oil recovery can boost production.

In Oman, the leading oil company is working on a CCUS trial and anticipates that oil output based on

technologies cannot”, a 2021 study by the International Renewable Energy Agency (IRENA) wrote. The sixth assessment cycle from the United Nations body for assessing the science of climate change agrees, recommending “CCS in the remaining fossil fuel system”.

The deployment of carbon capture is an opportunity to stay environmentally competitive for Gulf’s existing industrial clusters that produce steel, aluminum,



can be pumped out during primary extraction when natural pressure pushes oil out. During the second phase, water or gas is injected to recover another 20 to 40% of the reservoir’s oil. CO₂-enhanced oil recovery takes the stage when easy-to-produce oil has been depleted and offers the prospect to extract an additional 30 to 60% of the field’s oil. That’s music to oil producers’ ears. Saudi Arabia’s state oil company, Saudi Aramco, said it can capture

enhanced oil recovery would account for around 36% of its production by 2030.

LOW EMISSIONS INDUSTRIAL CLUSTERS

Carbon capture technologies “should not be a tool for propping up the weak business case for continued fossil fuel use, but they do have a role in addressing aspects of emissions reduction that other

cement, ammonia, methanol, petrochemicals, etc. Carbon capture, in addition to a shift to green hydrogen produced locally using solar and wind energy, would position the Gulf as “first mover” in low emissions industrial clusters, said Abdullah Al-Abri, an Omani consultant at the International Energy Agency (IEA). “If we move fast, there is a big opportunity”, he told Energy Oman magazine.

In fact, that is no longer a matter of choice. The European Union will start imposing a carbon tariff in 2027 on imported carbon-intensive products - for now: iron, steel, cement, fertilizers, aluminum, electricity and hydrogen - under the Carbon Border Adjustment Mechanism (CBAM). Al-Abri acknowledged that the GCC region could be “losing some of its industries” to other regions if it does not reduce emissions and capture the remaining ones.

All Gulf states, except Qatar, pledged to achieve net zero to stand as good global citizens.

The United Nations nuanced technological readiness though: CCS is “a mature technology” for gas processing and enhanced oil recovery but “less mature” in the power

sector, cement and chemicals production. CCS is energy and water intensive, eating into plants’ efficiency.

The widespread deployment of CCS to meet the 1.5°C climate target would “almost double” humanity’s water footprint, a 2021 study by the University of California, Berkeley found.

“It is a solution, but not the solution, the magic game changer,” Leroy said.

Moreover, neither CCU nor CCS is meant to be a permanent set-up but rather a bridge solution towards hard-to-decarbonise sectors powered by fuels produced using renewable electricity, like green hydrogen. That raises the risk of investing in stranded assets. CCS/CCU built on oil refineries is “probably a very bad idea, because they we will eventually have to close. In 15-20 years’ time, CCS might no longer be necessary in cement”, Stoefs warned.

The International Energy Agency counted only about 35 commercial facilities worldwide that apply CCUS to industrial processes with an annual capture capacity of 45 million tons of CO₂. That is the equivalent of 0.12% of global energy-related CO₂ emissions. CCUS deployment has been “behind expectations”, IEA noted, but 300 projects are in the pipeline.

According to the Paris-based agency, four CCUS projects are in development across the Middle East region, including deployment of CCUS at an aluminum plant in Bahrain and increasing CO₂ annual capture at Qatar’s gas fields from two to five million tons by 2050. “I do not see a big push to capture carbon in the Gulf. It is mentioned in presentations, but that is not their priority”, said Leroy, who led

workshops at Aramco and other Gulf oil companies.

CAPTURING HISTORICAL EMISSIONS

The annual rate of increase in CO₂ in the atmosphere since the 1960s is about “100 times faster than previous natural increases”, including when it occurred at the end of the last ice age. Simply put, vast amounts of historical emissions are already warming up the atmosphere. This is where carbon dioxide

bigger” joint project in Oman with Climeworks, Hasan told Energy Oman magazine. The durability of mineralisation removal is a game changer, the entrepreneur claims, adding that mineralization basically “removes it for millennia” as getting it out of the rock is “very difficult”, unlike geological storage that only buries CO₂ underground in its gaseous form.

The entrepreneur said he is excited about another value proposition of direct air capture: it is decentralized. That would solve the need for CCS to build

THE CAPTURE AND STORAGE OF CO₂ HAVE A “MODERATE BUT INDISPENSABLE ROLE TO PLAY” IN GLOBAL DECARBONISATION, THE IRENA STUDY SAID. BUT BEFORE GOING INTO THE MAINSTREAM, THE TECHNOLOGY STILL NEEDS TO DISSOCIATE FROM ITS IMAGE AS A DISTRACTION THAT LOCKS IN INDUSTRIAL REVOLUTION-ERA TOOLS.

removal (CDR) comes into play to suck CO₂ out of the air via natural removal solutions like planting trees or technological tools like direct air capture (DAC). In 2021, Swiss company Climeworks launched the world’s largest DAC plant in Iceland to capture 4000 tons of CO₂ per year, equivalent to 8,400 barrels of oil consumed.

“We have to pull CO₂ out of the air,” said Talal Hasan, CEO at 44.01, an Omani carbon removal startup that mineralised CO₂ into rocks. 44.01 runs a solar energy-powered pilot that captures CO₂ emissions from an ammonia plant and will soon announce a “multiple-fold

a network of infrastructures to transport CO₂ from collection points to storage locations, which could be “equivalent to the existing worldwide infrastructure associated with current oil and gas production”, as put in a 2007 study on EOR by the trade association that represents the US oil and gas industry.

But direct air capture energy needs are voracious to extract only a tiny amount of CO₂ from the air, which makes up just 0.04% of the atmosphere. Critics argue energy and capital investing in direct air capture would be better allocated to building sustainable solutions.

NOT CHEAP TO SOLVE

The lack of value proposition is the missing piece to the deployment of carbon capture technologies in Gulf economies. Currently, paying for CO₂ emissions is not seen as “a cost of doing business” since the region’s governments do not say “if you emit CO₂, you should pay a penalty per ton”, said Al-Abri, the consultant at the International Energy Agency

That is where carbon markets could play a critical role in streamlining the taxation of polluters and put a \$-figure on the benefits of capturing carbon emissions. “CCS proponents are always asking for subsidies. My response is, “support high carbon prices, and your CC project will be viable”. The starting point is to put pressure on polluters, make them pay [...] Carbon pricing and CCS are both tools; what we need is to price our pollution,” Stoefs said.

“It is not only decarbonizing, but also creating a market for it, and a value proposition for it down the line,” the UAE Minister of State for Advanced Technology told CNBC. Saudi Arabia’s sovereign wealth fund announced a voluntary carbon market firm in October 2022.

Direct air capture is still prohibitively expensive, though, at \$134 to 344 per ton. “Climate change was never going to be cheap to solve, but the policy and economic cost of tackling the crisis is far lower than having to deal with its consequences,” Stoefs said. Hasan said blue chip companies are “willing to pay the extra premium” to mineralize their CO₂ emissions.

The capture and storage of CO₂ have a “moderate but indispensable role to play” in global decarbonisation, the IRENA study said. But before going into the mainstream, the technology still needs to dissociate from its image as a distraction that locks in Industrial Revolution-era tools. As put by IEA: “The average age of coal-fired power plants in Asia is only 14 years, while the average technical lifetime of a power plant is 40-50 years. Retrofitting these plants with CCUS could address both economic and emissions challenges, allowing them to continue operating while recovering investment and reducing their carbon footprint.” ■

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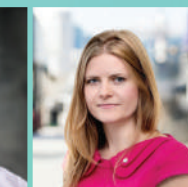
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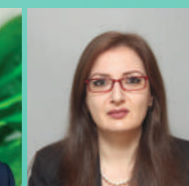
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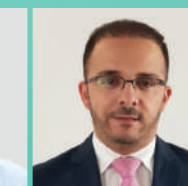
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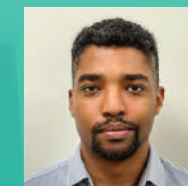
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OMAN DOUBLES DOWN ON HYDROGEN



BY YOUSUF AL-BUSAIDI

Yousuf Al Busaidi is an Omani lawyer with over a decade of experience working for the Government of Oman, in private practice, and in state-owned enterprises in the power and water sectors. He is also the co-founder of Qanoon.om and Decree.om, the most definitive sources for accessing all Omani legislation in Arabic and English, respectively.

OMAN DOUBLES DOWN

Just before the end of business on 26th February 2023, the Sultanate issued its first ever royal decree pertaining to the rapidly-developing field of hydrogen. Royal Decree 10/2023 Allocating Some Lands for the Purposes of Renewable Energy and Clean Hydrogen Projects is the first of its kind, earmarking sizable parcels of land purely for these projects.

This decree signals Oman's commitment to the global fight against climate change and its desire to become a hydrogen export powerhouse. However, it also raises some questions on project risk allocation and the meaning of "renewable" and "clean".

Adopting the principles of public-private partnership (PPP), this decree intends to bring in private developers, by way of auction, to build projects that use renewable energy for the production of clean hydrogen on the earmarked plots.

It also assigns the responsibility of the auction process, the resulting partnership, and what goes on top (and under) these earmarked plots, to Hydrogen Oman Company—more commonly known as Hydrom.

THE GROWING ROLE OF HYDROM

Established as a company that is fully owned by Energy Development Oman, Hydrom is central to the government's strategy of becoming a leading force in the nascent hydrogen industry. While not set out in the decree itself, Hydrom is assigned a wide array of duties, including developing the master plan for this sector, attracting foreign direct investment, managing the common infrastructure, and overseeing the execution of the projects.

Besides the multitude of responsibilities and duties, it appears that Hydrom is also taking on a de facto regulatory role in this space. For example, it alone will manage the auction process (as explained below) without the need for oversight of any other government body.

GOING ONCE, GOING TWICE, SOLD!

The auction process appears to be a departure from the government tendering process set out by the Tender Law and—for PPP projects—the Public Private Partnership Law. The decree does, however, seek to ensure fairness, transparency, and competitive tension by requiring the process to adhere to the principles listed in article IV, which are

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almost identical to the principles listed in article 5 of the Public Private Partnership Law.

While not set out in the decree itself, Hydrom's page on the auction process states that the project developers are expected to partner up with state-owned enterprises, to develop projects with a competitive levelised cost of hydrogen (i.e., competitively-priced hydrogen), to demonstrate their commitment to building out local supply chains, and to secure the offtakers (i.e., buyers) of the end-product, be it hydrogen or its derivatives.

WEAVING THE SUPPLY CHAIN FIBRES

It is clear that a bid committing to taking on a more active role in building out the local hydrogen supply chains will be seen favourably during the bidding stage of the auction. What is less clear is how much of these supply chains are expected to be built out by the project developers, and how much will be borne by the Omani government.

For example, will the government

take on the role of constructing and commissioning dedicated water desalination plants that feed water into the electrolyzers, or are the project developers expected to build their own desalination capacity?

Where the sought end-product is ammonia, will the project developers build their own ammonia plants or will Hydrom orchestrate the efforts to build large ammonia plants as part of the common infrastructure, with each train perhaps being owned by a different group of companies, as was done in the Atlantic LNG project?

Whatever the answer may be, there appears to be an intention to have these supply chains converge into some form of common infrastructure, used by other project developers in the future. If this is indeed the case, then questions on the ownership of this infrastructure (and, in turn, the project-financing models) will also need to be addressed.

TAKE THE HYDROGEN, KEEP THE LAND

Interestingly, article III of the



decree states that the earmarked plots are to be granted to Hydrom by way of usufruct rather than ownership, based on a request by the Ministry of Energy and Minerals to the relevant government entity in question, being either the Ministry of Housing and Urban Planning or the Public Authority for Special Economic Zones and Free Zones.

It goes on to elaborate in article IV that Hydrom can divide these plots and contract with the private developers to exploit them as needed. The form of agreement to be adopted for this contracting is unclear from both the decree and information pertaining to Hydrom in the public sphere.

It may be the case that a sub-usufruct framework is adopted, as is the case for some projects in the Special Economic Zone at Duqm; a partnership agreement framework, as most recently adopted for the Sultanate's first 42 schools public-private partnership project; or an entirely different framework altogether.

This, in turn, raises questions on the financing side—it is unclear how project developers will be able to mortgage these contracted plots in the absence of a usufruct agreement to which they are a party.

FOLLOW THE MONEY

Besides generating revenue from the usufruct fees it will collect over the leased-out parcels of land, the government will also indirectly enjoy the dividends generated by Hydrom and the state-owned enterprises that partner up with the project developers for each and every project on the earmarked plots.

Notably, the decree does not assign a dedicated usufruct fee for renewable energy and hydrogen projects. Accordingly, the fees set out in Ministerial Decision 92/2016 would apply, which could be pricey due to the considerable amount of space that renewable projects, such as solar PV, require.

The projects are also expected to bring in considerable foreign direct investment into the Sultanate,



which—like a domino effect—will increase Oman’s GDP, which in turn will have a positive multiplier effect on the overall economy of the country.

Last but not least, the projects will also generate jobs, create local expertise and know-how, and by the imposition of certain Omanisation rates, potentially alleviate the Sultanate’s current unemployment rates.

DEFINE “RENEWABLE”

Our minds tend to automatically think of solar panels and wind turbines when we talk about renewable energy. This is a reasonable assumption, given the prominence of these two technologies. However, the term “renewable energy” is wide-reaching—it encompasses any form of energy derived from a natural source that is replenished at a higher rate than consumed.

In other words, bioenergy plants, which generate energy from biomass (jargon for wood, charcoal, plants, and poop), and waste incineration plants could potentially also be proposed as projects for the earmarked plots.

A key point to highlight here is that “renewable” is not synonymous with “carbon-free”. Some forms of renewable energy, such as burning biomass, can produce more CO₂ emissions than fossil fuels. Waste incineration plants, or waste-to-energy plants, are also CO₂-belching plants with a high price tag per unit of electricity. Without carbon capture plants or other solutions to offset these emissions, these projects risk not being aligned with the Sultanate’s goal to be carbon neutral by 2050.

DEFINE “CLEAN”

The decree does not specify the permitted carbon intensity parameters of clean hydrogen. In other words, it is not clear if hydrogen produced by a combination of renewables and fossil fuels would still count as “clean” or not.

Take the EU’s recently unveiled Delegated Act—it sets out the definition of “renewable hydrogen”

(or “green hydrogen” if we’re following the colour scheme) and states that the resulting hydrogen can still qualify as being “renewable” if a portion of its electricity is sourced from the electricity grid at times of insufficient renewable energy output, provided that an equal amount of renewable energy is injected back into the grid at a later time.

This has upset environment-oriented NGOs, which have slammed the act as “greenwashing”, arguing that the electricity supplied by the grid can come from coal-fired power plants, one of the worst offenders in CO₂ emissions per unit of electricity, rendering the resulting hydrogen

the case that the earmarked plots are restricted to green hydrogen projects only.

REGULATING THE GIGAWATTS

As these projects will involve a considerable amount of electricity flowing to produce clean hydrogen, the Law on the Regulation and Privatisation of the Electricity and Related Water Sector will apply, meaning that project developers will have to obtain a licence (or an exemption) from the Authority for Public Services Regulation (APSR) before they can build their respective projects.

Further, if these projects intend

hydrogen sector—after several false starts, the momentum appears to be unstoppable this time. However, there are still some key issues that need to be answered before this sector can become a permanent fixture of the energy transition.

While this decree focuses on how hydrogen will be produced, it does not answer the question of how it will be exported. Ammonia seems to be the preferred choice here, but with a poor round-trip efficiency of only 11%, especially if cracked back into hydrogen and nitrogen at the destination port, it is unclear if the economics will ever make sense to ship more than a nominal amount of ammonia to wealthy countries that



more “brown” than “green”. Oman, thankfully, does not have coal-fired power plants, but the electricity in its grid is almost entirely generated by gas-fired power plants.

Furthermore, it is not clear if blue hydrogen, which is hydrogen extracted from natural gas with the resulting CO₂ being captured at source, would also be considered as “clean” for the purposes of this decree. As this decree revolves around renewable energy, it might be

to sell some of their renewable electricity into the grid, then in the absence of the liberalisation of the electricity market (as defined in the law), these projects will have to sell their output to the Oman Power and Water Procurement Company, in its capacity as the single buyer of electricity in the Sultanate.

FINAL THOUGHTS

This is an exciting time for the

are willing to pay for the green kind.

Another challenge, which unfortunately is not getting enough attention, is hydrogen’s potent impact on the atmosphere that is ton-for-ton 33 times worse than CO₂. Being the smallest molecule in the universe, hydrogen is bound to leak and could possibly cause more damage than the very fossil fuels it is trying to replace.

Proceeding with an abundance of caution will be key. ■



BIRBA INKS AGREEMENT WITH GCC AND GORD TO DELIVER MENA'S FLAGSHIP CCUS FORUM

Birba Energy has signed to a two-year strategic partnership with the Global Carbon Council (GCC) and the Gulf Organisation for Research and Development (GORD) to deliver the MENA region's first-ever Carbon Capture, Utilization and Storage Forum. Scheduled to be hosted at Le Royal Meridien Hotel in Qatar's Lusail City from 29 – 31 May 2023, the forum will promote CCUS technologies and share how innovation is spearheading global efforts to decarbonize and reverse legacy emissions.

“Carbon Capture, Utilization and Storage (CCUS) can play a critical role in addressing the environmental challenges faced by the MENA region, which is heavily reliant on fossil fuels. By capturing and storing carbon dioxide emissions from oil and gas production, CCUS can help minimize the impact of these carbon intensive industries on the environment and support the transition to a more sustainable energy system. Our support in organizing the region's first CCUS Forum is motivated by our belief that the development and implementation of CCUS technologies will be instrumental and imperative in achieving a carbon-neutral future and ensuring

a livable planet for generations to come. By partnering with Birba, GCC and GORD are steadfast in their commitment to environmental sustainability which we hope to catalyze at the CCUS Forum in May,” said Dr. Yousef Alhorri, Founding Chairman of GCC and GORD.

With a line-up of global speakers, masterclasses and a buzzing networking hub, the CCUS Forum will showcase groundbreaking technologies being developed to capture and remove CO₂ from the atmosphere, create commercial markets for utilizing the captured CO₂, and advance its permanent storage via geological sequestration.

The global shift to energy efficiency and zero-carbon energy is one of the most important industry transformations driving sustainable development strategies around the world. Collaborative efforts to scale up practical decarbonization solutions are opening pathways to meet 2050 emissions targets as well the United Nations' Sustainable Development Goals.

“The first-ever regional CCUS Forum will accelerate the push for decarbonization in the region where economies have traditionally been heavily dependent on the energy

sector. CCUS has immense potential to bolster economic diversification and generate new jobs and revenue streams that preserve our planet and facilitate the realization of our global vision, making Birba's partnership with GCC and GORD all-important to our mission. This forum allows us to collaborate, knowledge-share and build institutional capacity to enable a viable future for the next generation,” said Abdullah Al Harthy, CEO of Birba.

Global Carbon Council (GCC) is MENA region's first voluntary carbon market with international reach. It facilitates global stakeholders in implementing climate actions through a voluntary carbon offsetting program. The overall purpose of GCC is to contribute to achieve Paris Agreement objective of limiting global warming to 1.5°C by developing relevant standards and framework for voluntary carbon markets to catalyze, enhance and leverage climate change mitigation finance globally and especially for MENA region. In the Global South, GCC is the only CORSIA-accredited international program. GCC is also accredited by ICROA.

GORD is a non-profit organization spearheading MENA region's sustainability milieu. Headquartered in Qatar Science and Technology Park, GORD drives the transformation of societies, industries, and the built environment by influencing corporate ethos, fostering innovation, and developing capacity to enable low-carbon sustainable growth for present and future generations. The organization's key operations include R&D, standards setting, green buildings certification, accreditation services, voluntary carbon markets, performance testing, knowledge dissemination and advisory services on sustainability and climate change for governments, non-government, public and private sector organizations.

Birba is calling on organisations to play their part in the global solution. Find more information at ccusforum.com or via social media channels @ccusforum. Event Registration is open on the CCUS Forum website.

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An Omani startup has embarked on a ground-breaking initiative to localize breakthrough technologies in the production of clean energy from waste commodities in the Sultanate of Oman.

Aptly named 'X2E' – where X symbolizes a given resource and E stands for energy – the Muscat-based entity is no ordinary waste-to-energy startup. Unlike most businesses operating in the waste-to-energy space, this pioneering

a British-based investor in clean energy projects. Together, they bring to the table the requisite market knowledge, technological insights, access to funding networks, and more importantly, a business model that prioritises efficiency, agility and market savvy over size, scale and resources.

“Our goal is to position Oman at the cutting-edge of energy recovery from waste and other resources. By deploying the right

focusing on energy generation from bio-waste, he disclosed.

A successful investor in Oman's upstream Oil & Gas sector, Eyhab belongs to a new generation of business and tech-savvy Omani entrepreneurs with professional growth ambitions that also align with the Sultanate's strategic goals for socioeconomic development. Infused in these aspirations is also a commitment to being part of the global quest to finding sustainable



“OUR GOAL IS TO POSITION OMAN AT THE CUTTING-EDGE OF ENERGY RECOVERY FROM WASTE AND OTHER RESOURCES.”



GOING BEYOND GREEN

X2E: A NOVEL BLUEPRINT FOR WASTE NET ZERO IN OMAN

Omani-British startup X2E has ambitions to launch a pipeline of projects to unlock clean energy from waste resources by capitalizing on breakthrough technologies that are both cost-competitive and planet-friendly.

company has its sights on producing certifiably green commodities with an overall carbon footprint that is effectively net carbon negative, if not Net Zero, across the value chain. It's a level of commitment that's off the charts for most players seeking to operate successfully in the green energy space and going beyond green.

X2E is an Omani-British partnership co-founded by Eng. Eyhab bin Adnan Al Hajj, Group Managing Director of Hema Energy, an Omani oilfield technology enterprise with a diverse portfolio of businesses; and Mr. John Jones,

combination of technologies, we have the means to harness clean and sustainable energy, as well as unlock commercially valuable green commodities. Any CO₂ or greenhouse gases generated along the process are captured and converted into green products, thereby ensuring carbon neutrality along the entire value chain,” said Eyhab, X2E Chairman and Co-founder.

In X2E's sights are at least half-a-dozen project initiatives for clean energy generation from resources encapsulated by 'X'. First off the block is expected to be an initiative

solutions to the threat of global warming and climate change presently imperiling Planet Earth.

Between them, Eyhab and John have the passion, drive and resolve to see their X2E vision not only crystallise here in Oman, but also proliferate elsewhere in the wider Gulf, Middle East and Asia regions.

WASTE TO WEALTH

The opportunities represented by 'X' are virtually limitless, says John, X2E Co-founder and CEO. “As long as X makes business sense as a resource for clean energy generation,

we are up for the challenge. After all, we have a good track record of identifying opportunities, attracting investment, engaging with stakeholders and managing projects very well.”

X2E plans to kick off its pipeline of projects by focusing on commodities, such as bio-waste, for example. John explains: “The rationale here is quite simple! Instead of creating an entirely new energy resource, say green hydrogen, for example, which would require major investments in infrastructure, the X2E business model zeroes in on an existing resource, such as bio-waste. By processing this waste, you not only generate clean energy, but you also address the environmental challenges linked to waste accumulation. It’s a win-win! You end up requiring fewer landfills to maintain.”

SERENDIPITY

X2E’s journey from an embryonic concept to promising initiative with game-changing potential has been relatively swift. “It all happened by chance,” says Eyhab. “I received a call from John, an old buddy of mine who had also lived and worked in Oman many years ago. As a tech-savvy engineering professional with unparalleled knowledge of the green energy landscape, he ticked all the boxes for me as my business partner in the X2E initiative.”

Uncoincidentally, X2E’s vision syncs squarely with the decarbonization strategy of the Sultanate of Oman. Besides harnessing value from waste in the form of green fuels and byproducts, the startup also plans to explore the potential for further value creation through, for example, carbon credits, carbon capture and storage, and so on. The overarching objective, the partners stress, is to achieve Net Zero – at a minimum – across the value chain.

Among the many opportunities X2E is currently studying is a proposal to generate copious volumes of biogas from all kinds of organic waste, utilizing advanced technologies that dramatically speed up the process of harnessing methane from waste. This “digestion” process, which

typically takes about six weeks with conventional technologies, can be turbocharged to reach the desired outcome in a couple of days at most. This speedy process does away with the need for investments in massive numbers of large storage tanks to support utility-scale biogas projects, explains John.

Thus in addition to ensuring stable, commercial-scale volumes of methane for electricity generation or other value-add products, these technologies also result in zero carbon emissions from the process, as well as valuable compost.

“With these technologies, we will see efficiencies going through the roof, not to mention the huge contributions that will be made towards Oman’s decarbonization and Net Zero targets,” said John. “Furthermore, with Oman investing in a huge renewable energy programme to drive green hydrogen production, we see the potential for electricity from our projects to address the problem of variability in supply from solar and wind capacity, thereby ensuring stable supply to the electrolyzers.”

MULTIPLIER EFFECT

Significantly, X2E envisions multiple revenue streams associated with its operations in Oman. Thus, in addition to green energy and other valuable green byproducts being generated by its portfolio of projects here in the Sultanate, there are potentially millions of tonnes of CO₂ in emission reductions that can be monetized as well through carbon trading. This is in addition to green compost, biochar and a host of other green byproducts and chemicals that can be recovered and commercialised, according to John.

Other X2E initiatives will target the massive amounts of CO₂ emissions spewing out of smokestacks in the industrial clusters and power generation hubs of the country. By deploying technologies based on carbon-eating algae or bacteria, the startup plans to take decarbonization to new heights in Oman. If suitably scaled-up, this process can also open up a new, cost-competitive source of green hydrogen production, he adds.

In all of its endeavours, X2E

BETWEEN THEM, EYHAB AND JOHN HAVE THE PASSION, DRIVE AND RESOLVE TO SEE THEIR X2E VISION NOT ONLY CRYSTALLISE HERE IN OMAN, BUT ALSO PROLIFERATE ELSEWHERE IN THE WIDER GULF, MIDDLE EAST AND ASIA REGIONS.





is pledging to be unswervingly committed to Oman's Net Zero goals. "With the technologies that we have in mind, our projects will be zero carbon in their net emission output. We will take responsibility for ensuring carbon neutrality across the value chain, and not limit ourselves to just the easy parts. In fact, we foresee some of our projects going net negative in their carbon footprint, particularly where they will pull in CO₂ from the atmosphere as part the operative process," explained Eyhab.

SUSTAINABILITY MODEL

But far more than contributing to Oman's energy transition and sustainability goals, Eyhab also sees the X2E model laying the foundation for a new paradigm of business development in the Sultanate of Oman. Although just a two-man setup at the leadership level, X2E has the hallmarks of a joint venture partnership that has the potential to pull in potentially hundreds of millions of dollars in FDI into the projects that are envisioned for implementation over the coming years, Eyhab points out.

While X2E will remain as the parent company, new spinoffs in the form of Special Purpose Vehicles

"WE FORESEE SOME OF OUR PROJECTS GOING NET NEGATIVE IN THEIR CARBON FOOTPRINT, PARTICULARLY WHERE THEY WILL PULL IN CO₂ FROM THE ATMOSPHERE AS PART THE OPERATIVE PROCESS."

(SPVs) are proposed to be created to oversee the implementation of individual projects.

"We are confident that the X2E business model and philosophy – being small and agile – will enable us to hit the ground running and gain traction as we grow," said Eyhab.

"Along the way, we intend to take on new partners, local and international, join hands with international technology providers, and also work side by side with

public sector stakeholder entities to deliver on our ambitious projects."

Longer term, X2E foresees the potential to expand across the wider Gulf and Middle East region, as well as into markets in Asia and China – an aggressive growth strategy that will be achieved through partnerships and collaborative arrangements with like-minded climate champions from around the world. ■

ESG INVESTMENT AND HOW COP28 WILL IMPACT REGIONAL SUSTAINABILITY TRENDS

BY DAMIAN HITCHEN
CEO OF SAXO BANK MENA



In recent years, the UAE's commitment to accelerate its sustainability objectives from discussion to action have been highlighted through laser-focused implementation of Environmental, Social and Governance (ESG) plans and policies by numerous public and private entities throughout the country.

Having declared 2023 as the 'Year of Sustainability', the host nation of COP28 is escalating its efforts to lead global efforts on ESG education and benchmark the contribution levels expected from organizations across the Emirates. These latest moves are progressive and ambitious, but they also follow a clear pattern.

In 2021, the UAE announced its Net Zero by 2050 initiative, making it the first country in the densely populated, carbon economy-rich MENA region to publicly make the pledge. Last year, the Dubai Investment Fund launched an ESG Investment Department to monitor global and local markets to identify investment opportunities. Ever since, key regulators including Dubai Financial Services Authority (DFSA) and Abu Dhabi Global Market (ADGM) have continued maturing secure financial ecosystems with enforced sustainable frameworks for organizations to prioritise sustainability and align their policies with social and community impact.

Now, with sustainable practices permeating multiple industries domestically and internationally,

a rising trend of green stocks represents a massive opportunity for investors. Institutional investors are driving the sustainable market but interest from millennials has been growing steadily, creating a domino effect that will make companies become more purpose-driven and improve their sustainable business objectives. In this landscape, it is key to take a comprehensive view of potential ESG impacts and understand the long-term financial returns of the investment before determining whether to invest.

While the ESG data market is relatively nascent, there is no doubt the region's transition towards it – a shift which comes despite the many regional nations' historic dependence on carbon contributions to their economies and growth. Some of the key regional sustainability trends include financial entities promoting sustainable finance and encouraging stronger cooperation between public and private sectors. According to a Sustainable Future Study by Bloomberg Media, renewables and clean energy lead the pack in terms of return on investment. However, businesses are now being encouraged to explore other avenues of investment that deliver a more integrated approach to sustainability.

While the UAE's hosting of COP28 underlines its commitment to fight climate change, an investment pledge of AED 600 billion investment by 2050 comes with its own set

of challenges. As the effects of climate change intensify each year, there is an urgent need to transform multiple industries to meet sustainable development targets, avoid greenwashing, and create transparent and pragmatic resolutions.

With COP28 fast approaching, there is increased emphasis on regional and global leaders putting monolithic political and economic differences aside to explore the role of technology and how it is going to support sustainable development and influence investment opportunities to address sustainable agriculture, greenhouse emissions, marine ecosystems and clean energy resources. ■



HYDROGEN AS A CLEAN ENERGY SOURCE:

THE POTENTIAL FOR UNDERGROUND HYDROGEN STORAGE

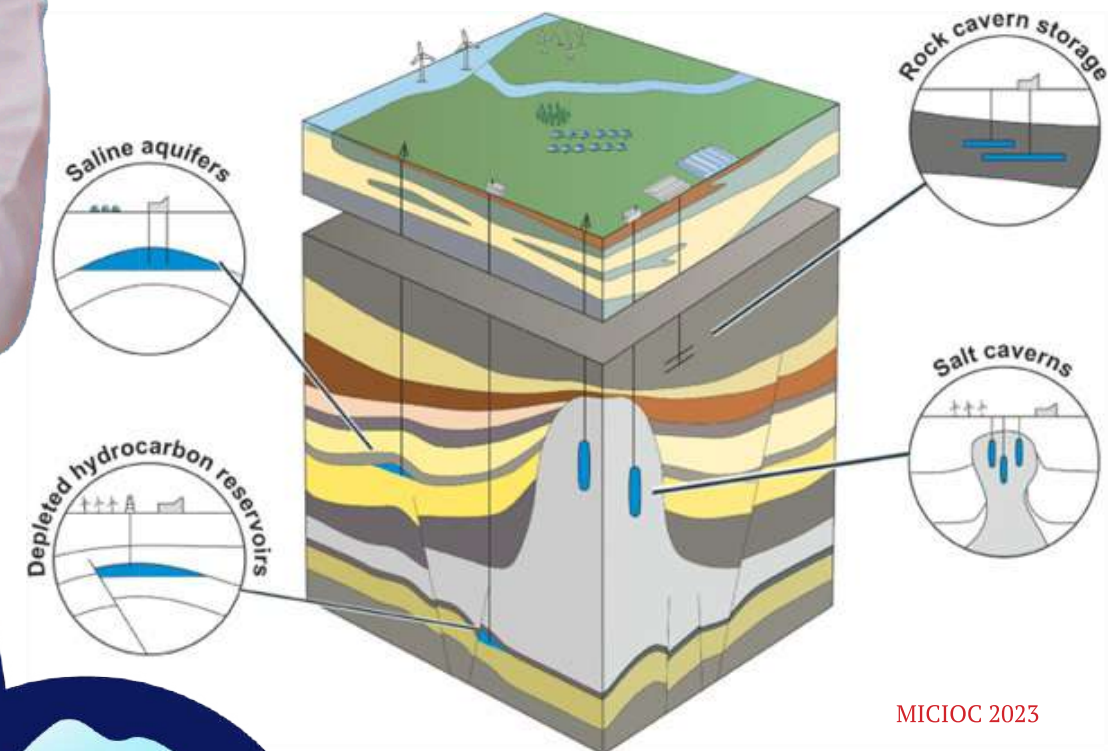
As the world continues to seek out more sustainable energy sources, hydrogen storage has emerged as a promising technology.

ABDULHADI AL SAADI

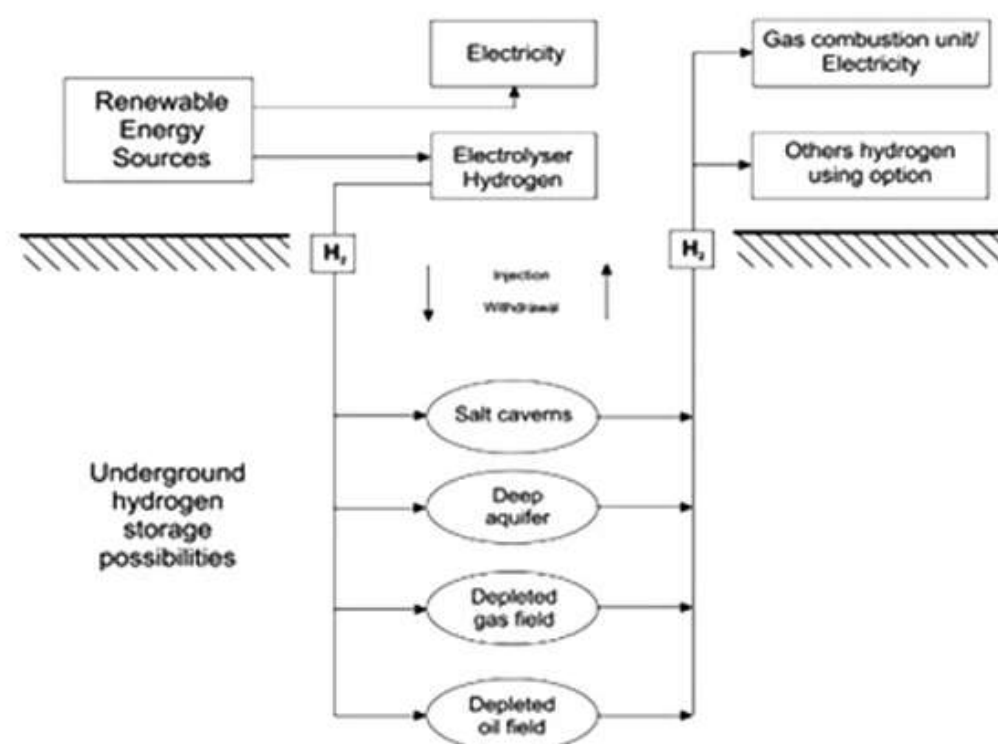
PROJECT MANAGER,
ATHR FOR INVESTMENT AND DEVELOPMENT
FOUNDER, GREEN HYDROGEN SOLUTIONS

As the world continues to grapple with the need for cleaner and more sustainable energy sources, hydrogen has emerged as a promising option. Unlike wind and solar power, which are highly reliant on weather conditions, hydrogen is a versatile and dependable clean energy source that can reduce our reliance on imported non-renewable energy sources, especially hydrocarbon power sources like oil. However, to fully utilize hydrogen's potential, we need to explore efficient storage solutions. One such solution is underground hydrogen storage.

Underground hydrogen storage involves the storage of hydrogen in caverns, salt domes, and depleted oil and gas fields. This method has been used to store



large quantities of gaseous hydrogen in caverns for many years. Storing large quantities of hydrogen underground in solution-mined salt domes, aquifers, excavated rock caverns, or mines can function as grid energy storage, which is essential for the hydrogen economy. By using a turboexpander, the electricity needed for compressed storage on 200 bar amounts to only 2.1% of the energy content.



Tarkowski 2019

1. THERE ARE THREE MAIN KINDS OF UNDERGROUND HYDROGEN STORAGE: DEPLETED GAS RESERVOIRS, AQUIFERS, AND SALT CAVERNS AS SHOWN IN THESE FIGURE:

a. Depleted gas reservoirs are among the best options for subsurface gas storage. These reservoirs are hydrocarbon-bearing geological traps covered with an impervious deposit known as caprock and are generally sustained from the bottom or margins by an aquifer. Depleted gas reserves are well described, with nearly all the required information accessible. Moreover, the tightness of depleted gas reservoir caprocks has been demonstrated. The presence of residual gas in a depleted gas reservoir is regarded as advantageous since it can serve as cushion gas. On the opposite side, if the leftover gas is capable of reducing the quality of

hydrogen, this might be viewed as a drawback.

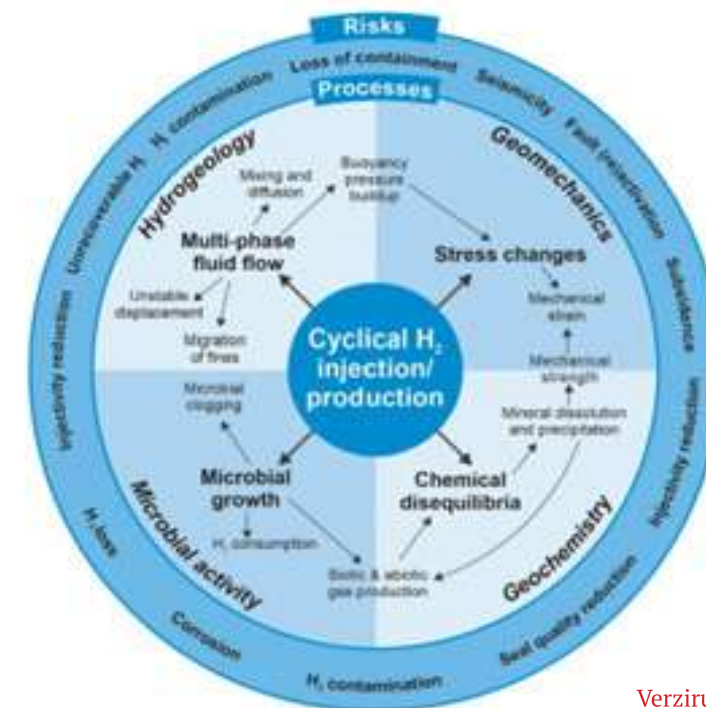
b. Aquifers are another option for subsurface hydrogen storage. These are porous and permeable rock structures in which fresh or salt water fills the pore space. They are found in all sedimentary basins across the earth or might offer an option for subsurface hydrogen storage in regions where exhausted hydrocarbon resources or salt caverns are unavailable. For years, they have been utilized securely as natural gas storage facilities.

c. Salt caverns are another viable alternative for hydrogen storage. Although studies have shown that salt caves storage is less applicable than other ways, salt caverns are ideal for storing various chemicals, in particular gases, at high pressures. Salt caverns are typically circular, man-made holes

in deep subterranean salt lakes that are constructed from the surface by pumping water into a well in the salt rock in a controllable environment. This is referred to as solution mining. Salt caverns are a viable alternative for hydrogen storage because of unique geological characteristics such as tightness, excellent mechanical characteristics of salt, and its resistance to chemical processes. Furthermore, the viscoplastic properties of Eocene rocks aid in their superior closing role, and because the salt caverns are mechanically robust, the procedure is flexible and suited for medium and short-term storage.

2. THE RISKS AND CHALLENGES OF HYDROGEN UNDERGROUND STORAGE:

However, there are also risks and challenges associated with underground hydrogen storage.

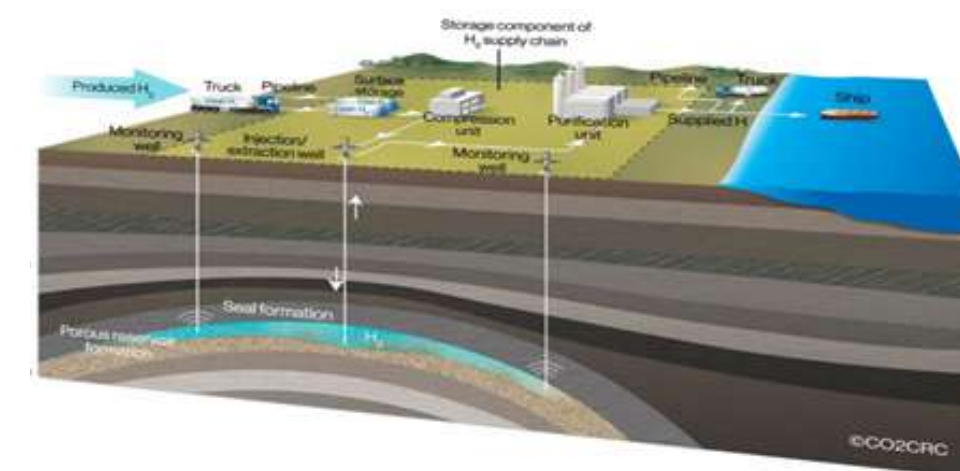


Verziruglo

Hydrogen has different physical and chemical characteristics than other geological formations captured fluids such as CH₄, air, or CO₂. Hydrogen can interact with geological minerals and fluids, possibly impacting storage processes. Additionally, the existence of hydrogen in the pore spaces can trigger the growth of hydrogen reactions with bacteria. Furthermore, the applied stress at hydrogen storage sites will vary throughout multiple injection-reproduction cycles, potentially jeopardizing encapsulation. As a result, suitable UHSP locations require special classification to ensure safe and cost-effective hydrogen injection and duplication. Uncertainties about possible loss, along with additional hazards including caused seismicity and hydrogen loss owing to bacterial behavior, also exist.

3. MAJOR OBSTACLES AND FUTURE OPPORTUNITIES:

As the world continues to seek out more sustainable energy sources,



hydrogen storage has emerged as a promising technology. While experience with hydrogen storage is still limited, there are clear parallels to natural gas storage. In fact, the experience gained from underground natural gas storage can serve as a valuable asset in developing research, pilot, and industrial-scale hydrogen storage projects.

Fortunately, we can draw on decades of experience in the storage of hydrogen-rich gas mixtures

to mitigate the risks associated with hydrogen injection. Through careful site selection and mitigation strategies, we can reduce the risk of biological and geochemical reactivity in the subsurface.

Moreover, the laboratory-based research on geological CO₂ storage that has been undertaken in the last two decades can serve as a model for fundamental research on hydrogen storage. Experimental equipment and workflows can be adjusted to accommodate hydrogen flow and reactivity.

Finally, we can rely on the basic concepts and technical challenges that have been successfully addressed in natural gas storage operations to inform the development of seasonal hydrogen injection, storage, and production strategies. From operational procedures to site management and safety protocols, there is a wealth

of valuable information that can be adapted for hydrogen storage in light of the latest advancements in research and development.

While there are certainly obstacles to overcome in the development of hydrogen storage technology, the opportunities are abundant. With careful planning and the application of lessons learned from natural gas storage, we can pave the way for a more sustainable future. ■

THE GCC AND THE ROAD TO NET ZERO

The Gulf Arab states, while major oil and gas producers, can play a significant role in supporting global efforts to close the gap and achieve net-zero goals.



BY DR AISHA AL-SARIHI
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According to the latest report from the United Nations' Intergovernmental Panel on Climate Change (IPCC), the world has already warmed by around 1.1°C compared to pre-industrial times and will likely approach 1.5°C within the next two decades. Every corner of our planet has already experienced the impacts of climate change, from extreme heatwaves and floods to devastating droughts. According to the IPCC report, to avoid the catastrophic impacts of climate change, global greenhouse gas (GHG) emissions will have to be cut by half by 2030 — relative to 2010 levels — and reach net zero around mid-century. To date, over 130 countries, covering 83% of global emissions, have acknowledged this urgency by committing to achieving such net-zero targets. These include five Gulf Arab states: Bahrain, Kuwait, Oman, Saudi Arabia, and the United Arab Emirates.

The gap between where the world stands today and where it needs to be in 2050 is substantial, however. For instance, in a net-zero emissions pathway, the share of renewables in total electricity generation globally should increase from the current 29% to over 60% in 2030 and to nearly 90% in 2050. Similarly, clean hydrogen production should increase six times from the current levels of 0.87 million tons (Mt) to 530 Mt in 2050. Achieving these targets will require incremental increases in clean energy investments, approximately \$2-4 trillion per annum between 2022 and 2030, roughly triple today's levels of \$755 billion. Closing this gap will require collective efforts from both the developed and developing worlds, but the speed with which countries can close this gap will depend on many factors, including political will; availability of natural resources; institutional, financial, and technical capabilities; and readiness.



The Gulf Arab states, while major oil and gas producers, can play a significant role in supporting global efforts to close the gap and achieve net-zero goals. That is because the Gulf Arab states are not only endowed with great potential for renewable energy resources as well as some of the world's lowest carbon content fuels, but also with, to varying extents, sizable financial resources. Yet, to unlock such huge potential, the Gulf Arab states will need to systematically identify and address the various challenges in their path to net zero.

THE GCC'S NET-ZERO TECHNOLOGICAL MIX AND WHERE COUNTRIES STAND TODAY

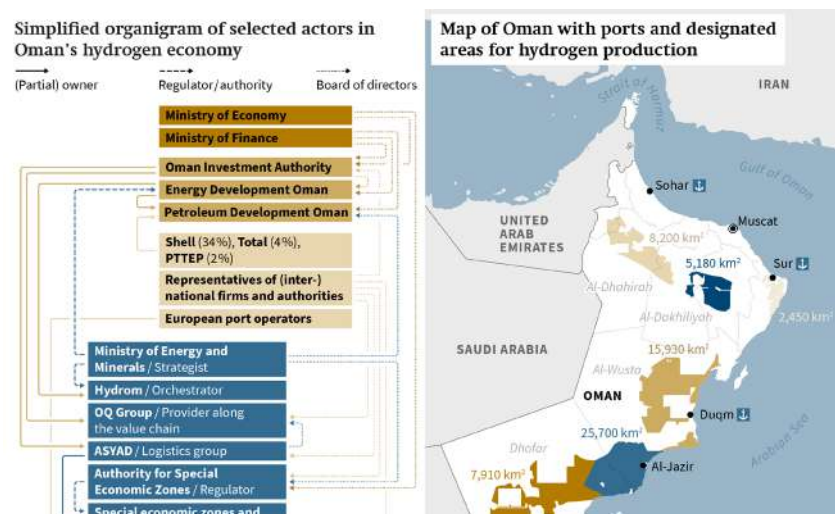
Different organizations such as BP and the International Energy Agency (IEA) have published projections of energy supply and demand in a net-zero scenario, consistent with the objectives of the Paris Agreement to keep global warming within 1.5°C. BP's 2020 net-zero scenario (suggesting a 15% decline in emissions by 2050 consistent with a 1°C rise in temperatures) and the IEA's 2021 net-zero emissions (NZE) scenario (suggesting around a 40% decline in emissions in 2030 and to net zero in 2050 for global energy-related and industrial process emissions) suggest a dramatic increase in the share of new and clean energy — including hydrogen, renewables, and nuclear — and a significant decline in that of hydrocarbons — coal, natural gas, and oil — in the future energy supply. Yet, in both scenarios, hydrocarbons will continue to play a role in meeting energy needs in a net-zero future, albeit a declining one. BP's net-zero scenario suggests that the share of hydrocarbons will be between 20% and 70% by 2050. The IEA's NZE posits that the share of fossil fuel will be just over 20% in 2050, falling from 72 million barrels per day (mbpd) in 2030 and to 24 mbpd in 2050.

Available reserves-to-production figures suggest that Gulf Arab states will continue to have access



to oil and gas reserves for the next 20-100 years (Figure 1). While the future energy outlooks suggest that hydrocarbons will continue to play a role in a net-zero future, they also suggest that the emissions generated

Figure 1: Gulf reserves-to-production ratios for oil and gas



by these fuels should be minimized using technologies such as carbon capture and storage (CCS) or by converting hydrocarbons to hydrogen or ammonia, which are free of global warming emissions.

The Gulf states have made strides in rolling out low-carbon energy investments and initiatives. Yet, the gap between the current scale of

these developments and where the countries want to be in a net-zero future is relatively substantial. For instance, at present, the Gulf Cooperation Council (GCC) is home to three major CCS facilities — in Saudi Arabia, Qatar, and the UAE — which together account for around 10% of global CO₂ captured each year, at 3.7 million tons per annum (mtpa). By 2030, Qatar targets 7 mtpa captured and the UAE 5 mtpa, while by 2035 Saudi Arabia intends to reach 44 mtpa. Similarly, Saudi Arabia aims to produce 650 tons per day (around 0.5 mtpa) of hydrogen and 1.2 mtpa of ammonia by 2025 for export; Oman and the UAE's Abu Dhabi National Oil Company (ADNOC) target 1 mtpa of green hydrogen output by 2030; and Qatar aims to produce 1.2 mtpa of blue ammonia by 2026. Assuming that these projects will run on renewable energy, the current scale of renewable energy generation, which is less than 1 gigawatt (GW) — around 4,000 megawatts — is far below what is required to meet the announced targets. It is estimated that producing 1 million tons of hydrogen would require around 6-9 GW of electrolysis capacity, operating with an efficiency of 75% for 5,000 hours per year, and around

10-16 GW of renewable energy capacity. This means that renewable energy capacity in the GCC needs to increase to almost 40-60 GW — a nearly 60-fold rise — by 2030 to meet the region's hydrogen targets.

ARE GCC GOVERNANCE, REGULATIONS, AND POLICIES ON TRACK TO REACH NET ZERO?

The Gulf Arab states have already taken strides and developed institutional architecture conducive to mitigating the effects of climate change. Before the announcement of net-zero commitments, each GCC state launched initiatives, regulations, and programs intended to mitigate different aspects of climate change impacts (Table 1).

• **Bahrain:** In 2007, Bahrain established a Joint National Committee on Climate Change, chaired by the Supreme Council for Environment, to oversee climate issues, including mitigation and adaptation measures.

• **Kuwait:** Kuwait established a National Committee on Ozone and Climate Change, chaired by the

Environment Public Authority, with representatives from the General Secretariat of the Supreme Council for Planning and Development, Ministry of Oil, Kuwait Petroleum Corporation, Ministry of Electricity and Water, Ministry of Foreign Affairs, and General Directorate of Civil Aviation. It also issued a National Adaptation Plan 2019-2030 in 2019 and aims to reduce its emissions of the equivalent of 7.4% of its total emissions in 2035 on a voluntary basis.

• **Oman:** Overseen by the Environment Authority (previously the Ministry of Environment and Climate Affairs), Oman launched a national strategy in 2019 to mitigate and adapt to climate change and announced a national hydrogen economy strategy in 2020. In November 2022, ahead of the United Nations Climate Change Conference (27th Conference of the Parties, COP27) the Omani government announced its strategy to reach carbon neutrality by 2050.

• **Qatar:** In 2021, Qatar's Council of Ministers approved the National Climate Change Plan to inform climate-conscious decision-making across sectors. In October 2021, Qatar formed an Environment and Climate Change Ministry to address climate-related issues.

• **Saudi Arabia:** In 2020, as part of its G20 Presidency, Saudi Arabia, led by the Ministry of Energy, put forward the concept of the Circular Carbon Economy (CCE) and placed it at the center of its climate mitigation plan. The CCE aims to achieve a pathway towards net-zero emissions by pursuing the "four Rs": Reducing emissions in the first place (through energy efficiency, renewables, and nuclear); reusing carbon as an input to create feedstocks and fuels (including through mobile carbon capture technology for transportation and CO₂-enhanced oil recovery); recycling carbon through the natural carbon cycle with bioenergy or natural carbon capture processes, such as forests and oceans, and the use of hydrogen-

based synthetic fuels to recycle CO₂; and, removing excess carbon by storing it through carbon capture utilization and storage (CCUS).

• **The UAE:** The UAE was the first Gulf state to announce a national climate strategy in 2017 and was also the first to link its climate strategy with its economic development plans, for which the UAE Green Agenda 2015-2030 was established as an overarching implementation framework. The UAE Council on Climate Change and Environment,

suit and roll out dedicated and detailed strategies to achieve their net-zero targets. These strategies need to be aligned with economic development plans and state budgets so that economic development and net-zero goals are not treated as separate agendas. Such alignment will also help to mitigate the possible unintended socio-economic consequences associated with implementing different climate policies, such as carbon pricing.

and Investment Support Scheme, launched as part of the UAE Green Agenda 2015-2030. In 2021, the UAE released its Sustainable Finance Framework (2021-2031) to encourage the private sector's involvement in the supply and demand for sustainable finance and strengthen the enabling environment for climate and green investments through strong stakeholder collaboration.

There are signs that financial institutions are increasingly participating in financing sustainable and climate-friendly projects. In

2016, more than 30 UAE-based financial institutions signed the Dubai Declaration on Sustainable Finance to promote sustainable financial practices in line with the UAE Green Agenda. In 2015, UAE national banks contributed to 10 sustainable finance initiatives, including the National Bank of Abu Dhabi targeting \$10 billion over 10 years to lend and invest in environmentally sound activities; HSBC Bank Middle East funding the UAE's first water research and learning center; sustainable integration frameworks for national banks that incorporate environmental and

social risk assessment into new project finance; and green loans to incentivize customers' climate action, such as promoting the driving of electric cars. In 2019, Oman's core financial services provider, Bank Muscat, established the country's first green finance scheme with scope to support rooftop solar panel installation, and in 2022, it introduced a green finance program focusing on rooftop solar for the residential market.

The region's sovereign wealth funds have also been a key part of efforts to support green investments. In 2022, Saudi Arabia's Public Investment Fund (PIF) developed a Green Finance Framework, under which it aims to raise

capital to support the financing and refinancing of environmental activities, covering the period 2021-25. Thus far, the PIF has released two green bonds — a financing instrument specifically earmarked to raise money for climate and environmental projects that comply with environmental, social, and governance requirements — including an initial tranche of \$3 billion in 2022 and a second, larger one of \$5.5 billion this year. The issuance of green bonds is aimed at supporting Saudi Arabia's green agenda, including green investments in Neom, the Saudi Green Initiative, and the kingdom's net-zero goals. Given the prospects for a net-zero future in which an oil-based economic model might not be as viable as it is today, Gulf countries should start developing and diversifying climate finance instruments dedicated to addressing climate mitigation and adaptation goals.

CARBON OFFSETTING: ARE NATURE-BASED SOLUTIONS VIABLE IN THE GCC'S NET-ZERO PATHWAY?

Evidence increasingly suggests that nature-based solutions (NBS) — a suite of actions or policies that aim to protect, restore, or sustainably manage natural ecosystems, biodiversity, seascapes, watersheds, and urban areas so they can tackle challenges such as food and water security, climate change, disaster risks, and human health — could contribute up to 30% of the climate mitigation needed by 2050 to meet the Paris Agreement's objective of limiting global warming. Examples of NBS include restoring wetlands, conserving mangrove forests, protecting salt marshes, restoring forest habitats, or managing landscapes and urban areas through tree planting.

Conserving mangrove ecosystems and planting trees are two NBS that are currently pursued in the Gulf. In March 2021, Saudi Arabia announced two NBS initiatives: the Saudi Arabia Green Initiative and the Middle East Green Initiative. These aim to plant 10 billion trees



in Saudi Arabia during the coming decades, with hopes of increasing the area covered by trees by 12 times from current levels and reducing carbon emissions by more than 4% of global contributions, as well as planting 40 billion trees across the Middle East. Given that the region is classified as the most water-stressed on Earth, planting trees might not be an optimal carbon offset solution for the GCC. Gulf countries should explore other innovative carbon offset solutions that are in harmony with the region's natural environment. Carbon capture and mineralization, a process that permanently mineralizes carbon dioxide within peridotite rock formations, could be a cost-competitive solution and compatible with the GCC's arid natural environment, given the abundance of peridotite rock formations across the region.

THE WAY FORWARD

Five Gulf Arab states — Bahrain, Kuwait, Oman, Saudi Arabia, and the UAE — have committed to achieve net-zero goals by or around mid-century. While the Gulf states have taken strides to flesh out their climate strategies and initiatives, this paper revealed that the GCC pathway to net zero, without

timely and innovative intervention, could be quite difficult to achieve. Without dedicated and systematic implementation efforts to close the gap between the current state and scale of technological, financial, and institutional efforts and where the GCC countries need to be to ensure a net-zero future, the region's ambitions might not become a reality. Timely implementation of climate policies that support net-zero goals, while challenging, will be imperative to support countries' economic diversification efforts and mitigate the future implications of global climate policies that could imperil their hydrocarbons riches. ■

[This article is part of a series that draws on the conclusions of a high-level workshop on economic diversification and the energy transition held on the sidelines of the American University of Kurdistan's annual Middle East Peace and Security (MEPS) Forum in November 2022. It was originally published by the Middle East Institute (MEI), an independent, non-partisan, non-for-profit, educational organization affiliated to the National University of Singapore.]

Country	Net-zero target	Renewable Energy targets	Emissions reduction target	National Climate Strategy	Other climate initiatives/governance entities
Bahrain	Yes, by 2060	5% by 2025 10% by 2035	N/A	No	• Joint National Committee on Climate Change (2007)
Kuwait	Yes, by 2060	15% by 2030	N/A	No	• Kuwait National Committee on Climate Change
Oman	Yes, by 2050	10% by 2025 30% by 2030	Reduce greenhouse gas (GHG) emissions by 7% relative to a business-as-usual (BAU) scenario by 2030	• National Strategy for Adaptation and Mitigation to Climate Change, 2020-2040 • National Carbon Neutral Strategy	• Regulations for the management of climate affairs (2016) • National Climate Strategy • Oman Sustainability Centre
Qatar	No	20% by 2030	Reduce 25% of GHG emissions by the year 2030	Yes	• National Climate Change Committee (chaired by the Ministry of Environment)
Saudi Arabia	Yes, by 2060	50% by 2030	Reduce, avoid and remove GHG emissions by 278 million tons of carbon dioxide equivalent (MtCO ₂ e) annually by 2030	Yes (National Circular Carbon Economy Program)	• National Committee for the Clean Development Mechanism/Designated National Authority (2009) • Saudi Green Building Forum (2010) • Saudi Energy Efficiency Center (2012) • PIF Regional Voluntary Carbon Market Company
UAE	Yes, by 2050	Clean energy 50% (44% RE, 6% Nuclear) by 2050	31% reduction compared to the business-as-usual scenario for the year 2030	Yes (2017: Green Growth Strategy/UAE Green Agenda 2015-2030)	• Dubai Integrated Energy Strategy 2030 • Abu Dhabi Carbon trading exchange and carbon clearing

Table 1: Climate-related strategies, policies, targets and initiatives in the six Gulf Arab states

established in 2016, is the committee responsible for overseeing the implementation of the Green Agenda.

To date, however, only Oman and the UAE have put forward an economy-wide strategy paving the way to achieving their net-zero targets. These strategies set out objectives for each economic sector to achieve decarbonization goals by mid-century. These, however, lack detailed information on how — financially, technically, and institutionally — the decarbonization of each sector can be achieved. Given that net-zero objectives have been only recently announced, other Gulf states are expected to follow

HOW WILL THE GCC FINANCE THE NET-ZERO TRANSITION?

At present, most climate-related projects are financed on an ad hoc basis. Earlier this year, for example, Saudi Arabia said it would invest up to 1 trillion riyals (\$266.40 billion) to generate “cleaner energy.” Back in 2015, the UAE announced a \$163 billion financial commitment to achieve its 44% clean energy target by 2050. These finances are mostly sourced from the sales of hydrocarbon exports. With the exception of the UAE, none of the GCC states has put in place a dedicated climate finance framework. In 2015, the UAE government established the Green Finance

FROM CARBON TO CURRENCY: THE IMPORTANCE OF CLIMATE FINANCE



BY ALENA DIQUE
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Last October, His Majesty Sultan Haitham bin Tarik announced plans for Oman to achieve net-zero emissions by 2050. Through this announcement, Oman entered a regional sustainability landscape with two distinguishing features.

The first is that COP28 will be hosted by the UAE at the end of 2023, bookending the year for the Middle East nicely with Egypt having hosted COP27 in 2022. Second, Oman and its regional peers are outlining ambitions to become global leaders in finance and in sustainability. Blending sustainability and finance gives climate finance, which is taking off like a rocket into space.

Climate finance refers to the suite of products and services within the world of finance that supports climate change mitigation and adaptation efforts. Several mechanisms are leveraged for directing financial flows towards low-carbon, climate resilient development. Banks can provide funding for infrastructure projects that advance reusability and resource circularity. Carbon markets allow market participants to offset emissions by purchasing credits. But one mechanism in particular – green bonds – gives the region an opportunity to drive the dialogue by assuming a leadership role.

Globally, the first green bond was issued in 2007, and it wasn't until 2017 that the Middle East saw its first issuance. And now, it isn't only banks delving into debt issuance for sustainability purposes. The larger umbrella term 'green' financing saw the Middle East boom at an exponential rate, with sustainability-linked debt issuance in the region reaching an all-time high of \$6.4 billion in 2022.

Emirati giants Majid Al Futtaim Group and Etihad Airways have issued green bonds in recent years to finance loans. In the past six months alone, Saudi Arabia's Public Investment Fund has raised over \$8 billion in two separate green bond issuances. Its latest issuance was more than six times oversubscribed.

Oman's largest lender, Bank Muscat, issued the country's first green loans worth \$58 million in 2019 to finance solar panel installations on residential properties. Shortly after, the Central Bank of Oman issued guidelines for green financing, providing a framework for entities to capitalize in a standardized way on the broader effort to promote the transition to a low-carbon economy.

These regional developments come on the heels of



a worldwide explosion in green bond issuance, from less than \$100 billion in 2013 to close to \$1 trillion in 2022. Internationally, leading investors such as BlackRock, Goldman Sachs, and Blackstone have said that ESG considerations are going to be key to their investments in the future. Regionally, the Abu Dhabi National Oil Company (ADNOC) is considering issuing its first-ever green bond, separately from the \$3-5 billion it plans to raise from conventional fixed income securities.

The future of green sukuk in the Middle East looks promising, too. Countries in the region, including Oman, are leveraging the potential of green bonds that enables fundraising for environmentally sustainable projects while adhering to Islamic financial principles that don't involve interest accumulation. They therefore attract more socially responsible investors to the region and drive further capital towards ESG initiatives.

Moving towards COP28 this year, we can expect to see continued growth in the issuance of these instruments to finance a wide array of green projects, from renewable energy to sustainable infrastructure and waste management. Although the Middle Eastern private sector has increased its involvement in green financing in recent years, governments must overcome a number of key challenges by clarifying regulations in the space of green deposits, green sukuk, green loans, and green insurance to harmonize sustainable finance rules and to support a possible future of low carbon-based financial and/or governing mechanisms. International standards in this area could accelerate progress and support local governments to facilitate green financing in the Middle East and North Africa region.

An optimistic regional outlook deems the creation of a robust low-carbon market as a source of structured revenue through sale of carbon credits; however, diving deeper into the establishment of these markets requires significant investments in infrastructure and regulatory frameworks – the question is: will Oman and its regional peers emerge as leaders in climate finance as we approach COP28 or will they feel the heat of limited emissions metrics, oil price volatility, lack of skilled expertise, and increasing ESG competition? ■



BY TOMAS VALDES
STRATEGIC ADVISOR

Tomas Valdes is a Dubai-based strategic advisor who delivers thought leadership solutions on the full value chain of the regional energy industry. He was a United States Fulbright Grant Recipient to the United Arab Emirates where he researched the UAE government's experience navigating the country through the Financial Crisis and COVID-19 pandemic. Before the UAE, he worked in asset management in the United States and Brazil, implementing scalable growth in assets under management. A native of the USA, Tomas holds an MBA from Georgetown University and a BA from Tufts University.

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BIG PICTURE VITAL TO DRIVE ENERGY INVESTMENT

BY **BADAR CHAUDHRY**
SVP ENERGY UNIT,
MASHREQ BANK



Ever-discerning investors seeking holistic progress will force some energy borrowers to really up their game this year, operating more transparently and boldly than ever.

High oil prices certainly boost the Middle East's financial outlook, but this is far from the whole story. Inevitable economic peaks and troughs means borrowers with a diverse toolkit and attitude of adaptability will be able to quickly capitalise on investors' appetite during the global energy transition – the greatest challenge in modern history.

The financing yardstick to release capital is surer than ever: proof of concept and the validity of the project must be extremely robust. For example, Mashreq has committed to provide or deploy \$30bn of sustainable financing by 2030 – a vast sum in a very short amount of time in a very ambitious space. Yet, our challenge is echoed by others in the financial ecosystem: finding the right commercial and environmental destinations to justify allocating the credit. Essentially, money is available across the Gulf Corporation Council (GCC), but borrowers need to elevate the strengthen of their proposals.

STREAMLINING THE SELL

Momentum to craft a mixed energy basket is undoubtedly moving fast, but more can be done. For one, more clarity is needed on the follow-through of climate commitments made at recent COPs – the world's biggest annual climate gatherings. This applies to COP27 in Egypt last November and COP28 in Dubai in ten months, as investors are very reassured by seeing tangible steps emerge from high-level dialogue. This is especially true for those being asked for big-ticket financings in relatively new energy markets, like circular markets and green hydrogen.

Other much-needed actions include ironing out policy frameworks and reporting standards, from carbon pricing to carbon capture and storage (CCS)

and more. There are far more questions in the energy transition than answers; investors want to see strategies that aim to reverse this global status. Of course, such frameworks and standards must meet international best practices, but it is equally crucial that they factor in local and regional nuances. Not only does this make them more useful and applicable, but it helps borrowers capture the attention of many types of investors.

Investors' need for greater visibility extends to the hydrocarbon sector – pivotal to sustaining energy security – especially as the Russia-Ukraine war affects supply-demand dynamics. With the International Energy Agency (IEA) expecting global oil demand to rise by 1.9mn barrels a day this year, to a record high of 101.7mn barrels a day, garnering investors' support to both expand and green hydrocarbon operations simultaneously is key.

Ramping up Environment, Social and Governance (ESG) efforts is another sure route to deepening

investors' buy-in. Many corporate clients already want to understand how to curate ESG guidelines and policies with long-term relevance; a fair enquiry when there are 600 reporting standards worldwide, according to Ernst & Young. Those who commit to designing the most appropriate and thorough system today will reap the reward as ESG credentials will carry great favor with investors, especially from 2025.

UP, UP, UP

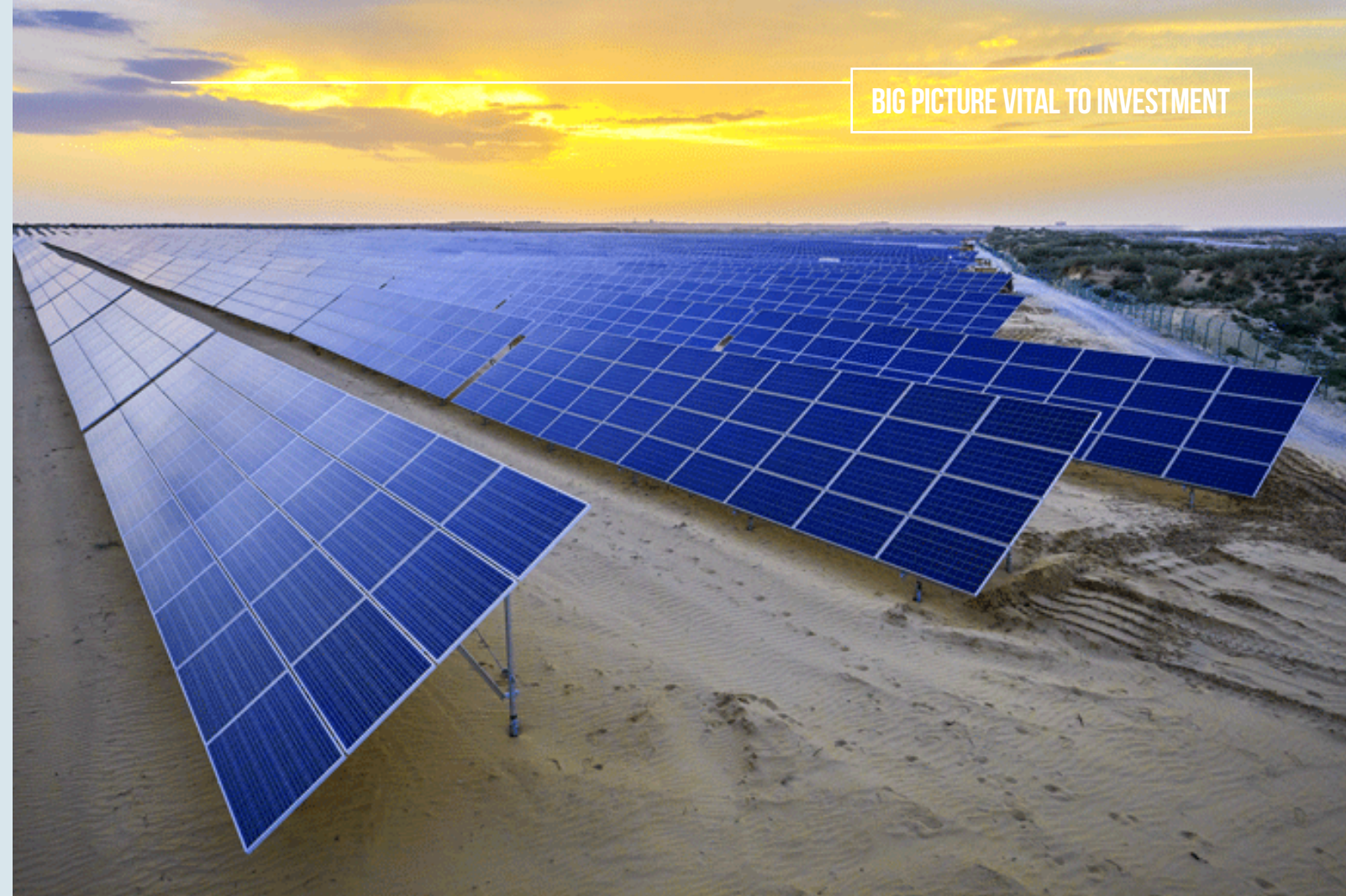
The UAE's gross domestic product (GDP) growth is expected to exceed 6% in 2022, improving from 3.8% in 2021, according to the International Monetary Fund (IMF) – a very strong trajectory. The organisation added that non-hydrocarbon growth alone this year could climb by 4%, which is an important nod to the breadth of economic potential for OPEC's third largest producer.

Local champions in the GCC are also actively playing their part in

enticing capital deployment and confidence in the region, such as Masdar. Abu Dhabi's green energy giant is targeting at least 100GW renewable energy capacity and the production of up to 1mn tons of green hydrogen by 2030, which is bold considering today's global green hydrogen market is miniscule.

That Saudi Arabia has pledged \$180bn to meet its Net Zero target by 2060 and the UAE has committed \$163bn to reach Net Zero by 2050 – the Middle East's largest and second largest economies, respectively – certainly reinforces investors' willingness to get involved.

Ever-discerning investors seeking holistic progress will force some energy borrowers to really up their game this year, operating more transparently and boldly than ever. This positive squeeze will create stronger capital markets that support the right projects at the right time, enhancing energy security and the climate agenda – both imperative, especially as the UAE prepares to open doors to COP28. ■



CLIMATE CHANGE: THE IPCC JUST PUBLISHED ITS SUMMARY OF 5 YEARS OF REPORTS — HERE'S WHAT YOU NEED TO KNOW

BY NATHAN COOPER

LEAD, PARTNERSHIPS AND
ENGAGEMENT STRATEGY,
CLIMATE ACTION PLATFORM,
WORLD ECONOMIC FORUM



The viability of humanity living within planetary boundaries rests on the actions we take in the next seven years. There's no time to lose to keep to the target of limiting the global average temperature to below 1.5°C.

"There is a rapidly closing window of opportunity to secure a liveable and sustainable future for all."

This is the conclusion of the Intergovernmental Panel on Climate Change (IPCC) in its latest report, which sets out to summarize the scientific data on global temperature rises, fossil fuel emissions and the impact of the climate crisis.

The AR6 Synthesis Report: Climate Change 2023 finds that, despite progress in policies and legislation

around climate mitigation since the previous such report in 2014, it's "likely that warming will exceed 1.5°C during the 21st century".

This is based on the expected levels of global greenhouse gas (GHG) emissions in the atmosphere by 2030, based on all countries' climate targets – known as nationally determined contributions or "NDCs" – announced as of October 2021.

Limiting warming to "well below 2°C", by 2030, as per the Paris Agreement targets, will be hard to achieve, but avoiding 1.5°C is still possible.

The report also lays out the economic imperative for taking action, finding that the "global

economic benefit of limiting global warming to 2°C exceeds the cost of mitigation in most of the assessed literature".

Here's what you need to know about the latest IPCC report, its findings and what needs to happen to ensure we stay on track to meet climate goals.

HOW IS THIS IPCC REPORT DIFFERENT FROM PREVIOUS ONES?

The Synthesis Report (SYR) is the culmination of a cycle of reports (the Sixth Assessment) that have been published over the past five years.

Since the Fifth Assessment Report

cycle, which ended in 2014, there has been an intensified focus around the globe on the climate crisis and efforts to mitigate its impacts, with the annual Conference of the Parties (COP) meetings driving this progress.

This report is the summary of all reports of the IPCC's 6th Assessment Cycle that were published between 2018 and 2023, which covered, including the landmark Global Warming of 1.5°C, the more recent reports demonstrating how anthropogenic greenhouse gases are causing unprecedented damage, and the report demonstrating that at current levels, many parts of the planet will become unliveable in the next few decades.

This summary report demonstrates an undeniable scientific consensus about the urgency of the climate crisis, its primary causes, its current devastating impacts – especially on most climate vulnerable regions – and the irreversible harm that will occur if warming surpasses 1.5°C, even temporarily.

Its aim is to provide policymakers with a high-level, up-to-date understanding of climate change, its impacts and future risks, and highlight solutions and options for addressing it.

As the next cycle, the Seventh Assessment Report, is not expected before at least 2027, this report provides the foundation for what

will be a critical seven-year period to 2030.

We're not going to have this time again, where we know what the situation is so conclusively. This scientific consensus, combined with the fact that the majority of climate solutions to avoid the worst consequences of climate change exist, provides a unique opportunity for us to address the gaps and take action.

WHAT ARE THE MAIN FINDINGS OF THE AR6 REPORT?

The new report, written by 39 scientists, is separated into three sections arranged by timeframes: Current Status and Trends looks back through history to the present day; Long-term Climate and Development Futures projects scenarios to 2100 and beyond; and Near-term Responses in a Changing Climate looks at current international policy timeframes between now and the 2030s.

HERE ARE SOME OF THE MAIN FINDINGS:

- Human-caused climate change is already affecting many weather and climate extremes in every region across the globe – with widespread loss and damage to both nature and people.
- GHG emissions will lead to increasing global warming in the near term, and it's likely this will reach 1.5°C between 2030 and 2035.
- We are currently at around 1.1°C of warming and current climate policies are projected to increase global warming by 3.2°C by 2100.
- IPCC has "very high confidence" that the risks and adverse impacts from climate change will escalate with increasing global warming.
- To keep within the 1.5°C limit, emissions need to be reduced by at least 43% by 2030 compared to 2019 levels, and at least 60% by 2035. This is the decisive decade to make that happen.
- Losses and damages will disproportionately affect the poorest and most vulnerable populations, particularly those in Africa and least-developed countries, creating more

poverty.

- Prioritizing equity, social justice, inclusion and just transition processes would enable ambitious climate mitigation actions and climate-resilient development.

- Tracked climate finance for mitigation falls short of the levels needed to limit warming to below 2°C or to 1.5°C across all sectors and regions.

- Public and private finance flows for fossil fuels are still greater than those for climate adaptation and mitigation.

- Among other measures to ensure energy systems are net-zero CO₂ emitters, we need a “substantial reduction in overall fossil fuel use, minimal use of unabated fossil fuels, and use of carbon capture and storage in the remaining fossil fuel systems; energy conservation and efficiency; and greater integration across the energy system”.

WHY DO WE NEED TO LISTEN TO THE IPCC?

The IPCC is the United Nations’ (UN) global organization for assessing the science related to climate change and is made up of 195 member countries.

Thousands of experts from all over the world volunteer to objectively assess the latest scientific research and write reports for the IPCC, which are signed off by the governments of member countries.

Over the course of a week-long session held in Switzerland, the 58th Session of the IPCC, governments have approved the shorter Summary for Policymakers of the Synthesis Report line by line and have adopted the longer report.

This will then shape international climate change negotiations at the future COP meetings – the decision-making body of the UN Framework Convention on Climate Change.

IS IT TOO LATE TO STAY WITHIN 1.5 °C?

We need to see 1.5°C not as a target but as a ceiling. Overshooting 1.5 °C means we are entering a danger zone, beyond planetary limits in which



Climate impacts at 1.5°C and 2°C of warming.

Image: Climate Council

natural, animal and human life has flourished for millions of years.

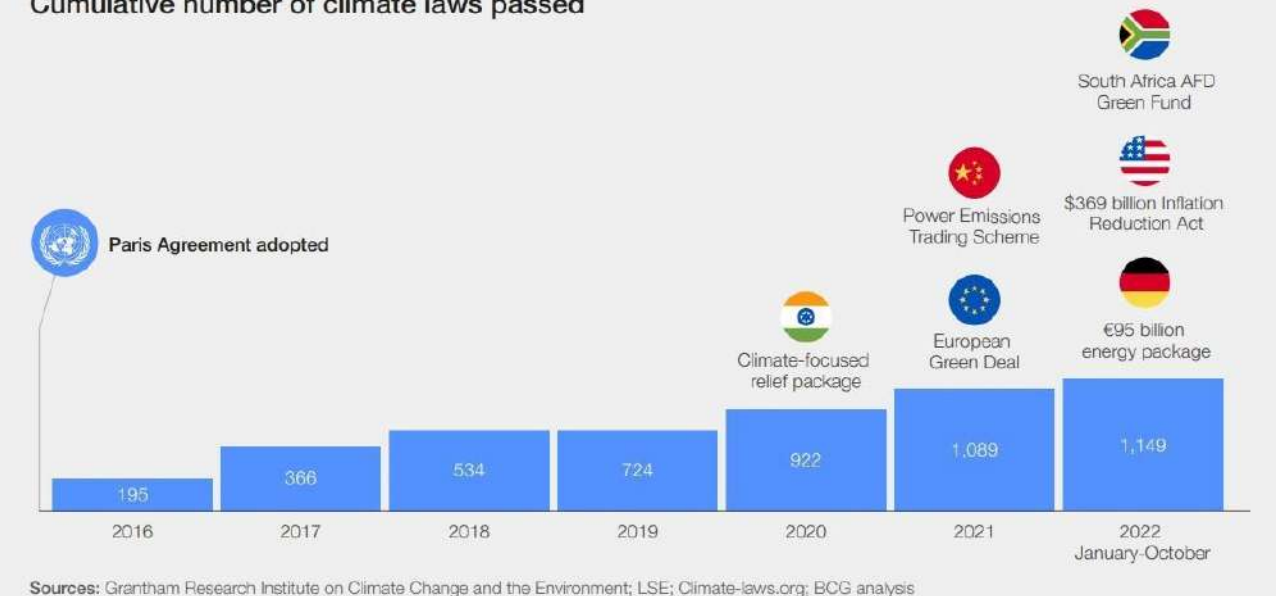
As the IPCC report shows, we're not too late to avoid passing 1.5 °C, but the greatest threat is apathy. The impacts of climate change will only get worse.

The cost of inaction is far greater than the cost of action – and the financial implications will impact everyone, from governments to companies and families.

Every fraction of a degree counts. We're already seeing the disproportionate impact the warming of 1.1°C is having globally, particularly on the lives and livelihoods of more vulnerable communities.

The IPCC finds nearly half of the world's population live in this danger zone of climate impacts, where their lives and livelihoods are under threat from more frequent and intense extreme weather events, such as

Cumulative number of climate laws passed



Momentum is building to tackle climate change.

Image: Alliance of CEO Climate Leaders

flooding and drought, which impacts on food and water security, as well as loss of vital natural ecosystems.

In reality, the difference between 1.5°C and 2°C degrees is not merely a temperature rise of 0.5°C – but as the chart below shows, it means climate risks will be at least two times worse.

We need to act now to protect climate-vulnerable communities, while also taking action towards a cleaner, healthier and more prosperous future.

WHAT NEEDS TO HAPPEN NOW AND WHAT IS THE WORLD ECONOMIC FORUM DOING?

The solutions are out there to reduce emissions by at least 43% over the next seven years.

The IPCC highlights that to achieve this we need to transition “from fossil fuels without carbon capture and storage (CCS) to very low- or zero-carbon energy sources, such as renewables or fossil fuels with CCS, demand-side measures and improving efficiency”.

Governments, businesses, civil society and communities can work

together to transform our energy, food, transport and manufacturing systems. This can be achieved through clear, courageous and concerted policies to further unlock the transformative power of financial markets, industry, and innovators.

The UN Secretary-General António Guterres outlined a major new Acceleration Agenda in his video message to launch the Synthesis Report, which includes:

- Ensuring net-zero electricity generation by 2035 for all developed economies and 2040 for the rest of the world.
- Ceasing all licensing or funding of new oil and gas – consistent with the findings of the International Energy Agency.
- Stopping any expansion of existing oil and gas reserves. Shifting subsidies from fossil fuels to a just energy transition.
- Establishing a global phase-down of existing oil and gas production compatible with the 2050 global net-zero target.
- Speeding-up efforts to deliver climate justice to those on the frontlines.

We have seen a miraculous breakthrough in renewables, where solar and wind are now the cheapest source of new power in countries representing 90% of electricity generation, and electric vehicles are projected price parity with internal combustion engines in the next 2-3 years.

We need similar breakthroughs across the so-called “hard-to-abate” sectors of heavy industry and long-haul transport – and this is where the World Economic Forum’s work with the First Movers Coalition (FMC) is leveraging the power of demand to accelerate the supply of transformational near-zero-emission solutions.

Since it was launched at COP26 in 2021, 74 companies and 12 governments have joined this global, public-private coalition, which aims to decarbonize heavy industry and long-distance transport responsible for 30% of global emissions. To date, FMC represents a strong early market signal of \$12 billion in demand for near-zero-emission solutions. ■

© World Economic Forum

BRINGING HYDROGEN TO THE FOREFRONT

While 2020 may be remembered for the tragic COVID-19 crisis, it was also an unprecedented year for the global energy transition and the growing momentum of hydrogen technology. Many countries, in aligning their pandemic response with longer-term goals, have announced strategies to develop hydrogen as a key energy carrier. In parallel, numerous countries, cities and companies have adopted net-zero targets for energy-related carbon dioxide emissions, bringing the need for hydrogen to the forefront.

But not all types of hydrogen are compatible with sustainable, climate-safe energy use or net-zero emissions. Only “green” hydrogen – produced with electricity from renewable sources – fulfils these criteria, which also entail avoiding “grey” and hybrid “blue” hydrogen. Green hydrogen uptake is essential for sectors like aviation, international shipping and heavy industry, where energy intensity is high and emissions are hardest to abate.

Green hydrogen, however, is still not ready to take off without widespread and coordinated support across the value chain. The Collaborative Framework on Green Hydrogen, set up by the International Renewable Energy Agency (IRENA) in mid-2020, offers a platform to strengthen support in co-operation with IRENA’s member countries and partners.

The past two years have witnessed increased momentum, with around 20 countries adopting a national hydrogen strategy or announcing their intention to do so. Industry investors plan at least 25 gigawatts of electrolyser capacity for green hydrogen by 2026. Still, far steeper growth is needed – in renewable power as well as green hydrogen capacity – to fulfil ambitious climate goals and hold the rise in average global temperatures at 1.5 degrees Celsius.

Green hydrogen, on average, costs between two and three times more to make than blue hydrogen, with the true potential and viability of the latter requiring further investigation. With electricity input accounting for much of the production cost for green hydrogen, falling renewable power costs will narrow the gap. Attention, meanwhile, must shift to the second-largest cost component, electrolyzers.

With larger production facilities, design standardisation and insights from early adopters, the proposed strategies could cut costs by 40% in the short term and up to 80% in the long term, this study finds.

In price terms, the resulting green hydrogen could fall below the USD 2 per kilogram mark – low enough to compete – within a decade. This opens the way for large-scale manufacturing capacity, new jobs and economic growth. But getting there depends on defining the right business model, creating markets, and optimising the supply chain in a way that both developed and developing countries, equally, can enjoy the transition to a clean, resilient energy system.

IRENA stands ready to help countries worldwide, whatever their energy challenges or level of economic development, make the leap.

FRANCESCO LA CAMERA
Director-General, IRENA

PERSPECTIVE

MAKING THE BREAKTHROUGH: GREEN HYDROGEN POLICIES AND TECHNOLOGY COSTS

As global economies strive for carbon neutrality, cost-competitive renewable hydrogen is possible within the decade.

As global economies strive for carbon neutrality, cost-competitive renewable hydrogen is possible within the decade.

Green hydrogen, produced by renewable power, can help eliminate carbon dioxide (CO₂) emissions in challenging sectors like steel, chemicals, long-haul transport, shipping and aviation. Thanks to the decline in renewable power costs, hydrogen could become a cost-competitive clean energy carrier worldwide by 2030.

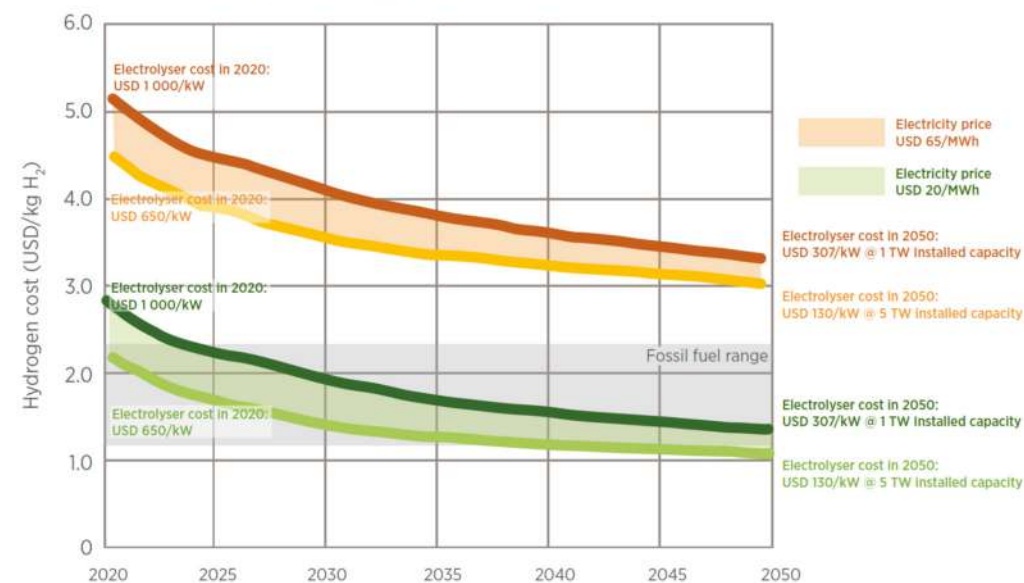
However, ongoing innovation and

consistent policy attention are needed to make green hydrogen viable as part of a sustainable energy mix. Regulations, market design, and the costs of power and electrolyser production will all come into play.

The International Renewable Energy Agency (IRENA) has released two in-depth studies on how to scale up hydrogen production based on renewable power sources in time to meet climate goals:

- Green hydrogen: A guide to policy making (Nov 2020)

Figure 1 How electrolyser scale-up drives down costs



Note: Efficiency at nominal capacity is 65%, with an LHV of 51.2 kilowatt-hours per kilogram of hydrogen (kWh/kg H₂) in 2020 and 76% (at an LHV of 43.8 kWh/kg H₂) in 2050, a discount rate of 8% and a stack lifetime of 80 000 hours. The electrolyser investment cost for 2020 is USD 650-1 000/kW. Electrolyser costs reach USD 130-307/kW as a result of 1-5 TW of capacity deployed by 2050.

Assuming average (USD 65/MWh) and low (USD 20/MWh) electricity prices, constant over the period 2020-2050.

Based on IRENA analysis.

MAKING THE BREAKTHROUGH

Green hydrogen policies and technology costs



- Green hydrogen cost reduction: Scaling up electrolyzers to meet the 1.5°C climate goal (Dec 2020)

As the world strives to cut greenhouse gas emissions and reach carbon neutrality by 2050, energy-intensive industries and transport present a major challenge. Emissions are especially hard to abate in sectors such as steelmaking and cement, aviation and long-haul shipping. Hydrogen based on renewables, or green hydrogen, has emerged as a vital clean energy carrier.

This is the only hydrogen type fully compatible with net-zero emission targets and sustainable, climate-safe energy use. Grey and hybrid blue hydrogen can also boost energy supply, but without eliminating fossil fuel use. Blue hydrogen, while cleaner than grey, still relies on carbon capture and storage (CCS).

Energy planning has recently started to include green hydrogen for several reasons:

- It results in no residual greenhouse gas emissions.
- It can increase system flexibility, particularly through seasonal storage, helping to integrate higher shares of solar and wind

power.

- Although currently expensive, it will become more competitive due to rapidly falling costs for electricity from renewables. Solar photovoltaic (PV) and wind power costs have already declined 80% and 40%, respectively, in the last decade, with these trends expected to continue.

Hydrogen, meanwhile, can be converted into other energy carriers like methanol, ammonia and synthetic liquids for a broadening range of uses.

Green hydrogen now costs USD 4-6/kilogram (kg), 2-3 times more than grey hydrogen. The largest single cost driver is renewable electricity, which is becoming cheaper every year. But electricity itself is not the only factor to consider.

Electrolyzers – which split water into hydrogen and oxygen – must also be scaled up and improved to make green hydrogen cost-competitive. Their costs, having fallen 60% since 2010, could fall another 40% in the short term and 80% in the longer term, the latest IRENA analysis indicates. Achieving these reductions hinges on innovation to

improve electrolyser performance, scaling up manufacturing capacity, standardisation, and growing economies of scale.

This could bring green hydrogen costs below the USD 2/kg mark – a crucial milestone for cost competitiveness – before 2030 (see Figure 1).

Four policy pillars would help move green hydrogen from niche to mainstream:

- Developing national hydrogen strategies. These define each country's level of ambition and can provide a valuable reference for private investment and project finance.
- Setting priorities. Along with use as a fuel or re-conversion to electricity, hydrogen can support a wide range of end uses for industry and transport. Policy makers must identify the applications that provide the highest value. Industrial uses, for example, could be prioritised over low-grade heat or fuel blending.
- Requiring guarantees of origin. Clear labels are needed to reflect carbon emissions over the whole life cycle of hydrogen. This would increase consumer awareness and allow incentives for green hydrogen use.
- Adopting enabling policies. With the right overall policy framework, green hydrogen can create significant industrial, economic and social value, including new jobs.

Green hydrogen promises to become a game changer for energy efficiency and decarbonisation. To achieve its potential, it needs to be widely affordable, including for developing economies seeking affordable ways to build sustainable future energy systems. With the right policies put in place now, it could soon become a cornerstone of the world's shift away from fossil fuels. ■

[Credit: IRENA]

TETHYS OIL IS IN A TRANSITION PHASE

BY MAGNUS NORDIN
MANAGING DIRECTOR



2022 saw heavy investment and a lot of time and effort put into our three operated Blocks. 2023 will see less investments and a little less effort but more excitement as we move into the phase of drilling exploration wells to unlock future reserves.

As usual, I am inclined to say, another strong quarter with good revenue and profit. However, looking more closely it is apparent that Tethys Oil is in a transition phase. Our operated interests in Blocks 58, 56 and 49 are moving to the forefront and our non-operated 30 percent interest in Blocks 3&4 is, at least temporarily, receding a bit.

On Block 58 we have reached the important milestone of establishing drillable prospects with estimates of prospective resources that could be unlocked by the exploration drilling scheduled for the second half of 2023. And the numbers are impressive. If drilling is successful, the time, effort and money spent on Block 58 could be a transformative event for Tethys and a new source for future oil reserves.

On Block 56 the 2,000 km² of state-of-the-art 3D seismic acquired in early 2022 over the Central Area of the Block, at a cost of some MUSD 15, is now readied for interpretation. Over the next months, work on this Block should reach the same milestone of maturity, definition of drillable prospects with estimates of prospective resources, as we have reached on Block 58. While in parallel we continue to wait for the long-term test results from the Al Jumd discovery in Block 56. The rather delayed process of finalising the approval of the metering system reached a crucial milestone this week when basic acceptance of the flow computer was obtained.

Coming steps include the moving of the metering skid from the construction yard in Abu Dhabi to the oil delivery point near Nimr in Oman. With all other preparations completed, the final installation of the metering system and its commissioning is now eagerly awaited and expected around March first.

On Block 49 the Thameen-1 well will undergo re-testing in the first half of the year. Rock studies completed during 2022 suggests that the reservoir rock is very tight. To attempt to establish flows during the re-test, the reservoir sandstones will be fractured to create increased permeability to allow the reservoir fluids to flow to surface.

2022 saw heavy investment and a lot of time and effort put into our three operated Blocks. 2023 will see less investments and a little less effort but more excitement as we move into the phase of drilling exploration wells to unlock future reserves.

Blocks 3&4 is a slightly different matter. The operating cash flow continues to be strong, but production has been disappointing throughout the year. In the fourth quarter we saw a mild stabilization but also increased costs. The reserve replacement ratio was below 100 percent and the picture emerging is of mature fields that have reached their peak. And

in part, this is true. Some of the wells on Block 3&4 have been in production for over ten years. And cumulative production from the Blocks stands at more than 130 million barrels. A sizeable amount of oil.

So, is slow decline all we can expect from Blocks 3&4? There are several reasons why this scenario, which by the way would continue to generate good if not great cash, may not be true.

First, a large part of the exploration potential remains untapped. With drilling rigs scarce during the pandemic and through most of 2022 the operator has focused on seismic acquisition rather than drilling exploration wells. In 2022 only two wells were drilled. This will be rectified in 2023 with at least four exploration wells planned.

Second, production limitations and subsequent underinvestment during 2020-2022, exacerbated by delays in getting needed equipment, has continued to have an impact for longer than we had anticipated. The investment program for 2023 reflects several efforts to catch up with these investments. We guide for a stable to slightly lower production during 2023 compared with 2022 while remaining optimistic that increased exploration drilling and remedial surface efforts could change this outlook during the course of the year.

So stay with us. The proposed dividend will, if approved by the AGM, keep all shareholders with a cash cushion while awaiting the exploration drilling results and keeping fingers crossed for increasing production from Blocks 3&4.

STRONG FINANCIAL YEAR 2022 SETS THE STAGE FOR EXPLORATION FOCUSED 2023

PRODUCING ASSETS — BLOCKS 3&4

Tethys Oil's share of production from Blocks 3&4 during the fourth quarter 2022, before government take, amounted to 868,589 barrels of oil. The production corresponds to 9,441 barrels of oil per day, four percent below the third quarter production. In total, the production before government take for 2022 amounted to 3,628,074 barrels of oil, corresponding to a full year average of 9,940 barrels per day.

Production continued to disappoint in the fourth quarter with rates coming in lower than expected. Production has underperformed throughout the year due to a multitude of factors, most of which are related to constraints in the performance of the processing facilities, particularly the facilities related to water handling, and flow lines which has hindered newly drilled wells from contributing to the overall production. In addition, performance of the Anan field and some newly drilled wells on Block 4 disappointed and thus contributed less than expected.

A full programme of remedial actions has been initiated which includes the production assurance and asset integrity projects as well as increased general maintenance. The projects include the replacement of current flow lines and additional loop lines as well as water handling initiatives in order to increase the output from wells with high water cut.

The development drilling with the aim to increase production ramped up in the fourth quarter following the start up of the fourth drilling rig in September. In total, twelve new wells were drilled in the fourth quarter, of which nine were development wells - seven production wells and two injector wells. In addition to the development wells, one exploration well and two appraisal wells were drilled in the quarter.

FULL YEAR 2023 PRODUCTION GUIDANCE

Tethys Oil expects full year 2023 average production to be in the range of 9,000-10,000 barrels of oil per day with the outcome dependent upon the performance and timing of the wells to be drilled in the 2023 work programme and the timeliness and effectiveness of the debottlenecking of surface facility constraints. Monthly fluctuations outside of the yearly average production range is to be expected.

Any production from the upcoming extended well test on Al Jumd on Block 56 does not constitute commercial production and is thus excluded from the production guidance.

EXPLORATION ACTIVITIES

The Blocks 3&4 partnership

aims cover 100 percent of the Blocks with 3D seismic before the end of 2024. During the quarter seismic acquisition has been ongoing in the southern part of Block 4 where an area comprising 3,500 km² is being covered. As of 31 December 2022, this area was almost halfway complete.

OPERATING EXPENDITURE FOR 2023

Tethys Oil expects operating expenditures to be USD 14.5 per barrel (+/- 1.0 per barrel) in 2023. The expected level of operating expenditure per barrel reflects the expected production guidance range together with cost levels on par with or slightly higher than 2022.

INVESTMENTS

Tethys Oil's total investments in oil and gas properties in 2023 is expected to amount to MUSD 85-95. The range is on par with the 2022 investments in oil and gas properties of MUSD 89 spread across the Blocks. The 2023 investments in oil and gas properties are expected to be funded by the Group's cash flows as well as cash on hand.

Investments on Blocks 3&4 are expected to be MUSD 65-75 (2022: MUSD 63.4). The expenditure reflects increased spending on drilling, a total of 47 new wells compared to 36 in 2022, as well as increased facility investments for power generation and produced water handling. The range denotes uncertainty related to spending driven by exploration success and the ability to fulfil facility upgrade plans given supply chain constraints.

2023 spending on Block 49 is expected to be MUSD 1.5 (2022: MUSD 0.4) with expenditure related to the re-entry and re-testing of the Thameen-1 well.

On Block 56, Tethys Oil's 2023 investments, including carry arrangements, is expected to amount to a total of MUSD 8.0 (2022: MUSD 23.8) relating mainly to the drilling of an exploration well in the central area of the Block during the second half of 2023.

On Block 58 Tethys Oil's 2023 investments are expected to amount to MUSD 10.5 (2022: MUSD 1.4) relating primarily to the drilling of an exploration well at the beginning of Q3 2023. ■

CARBON MARKETS: POWERING THE DECARBONIZATION OF THE ENERGY SECTOR

As the world continues to prioritize climate mitigation, carbon markets can become a crucial tool in decarbonizing the energy sector, especially for the MENA region's hydrocarbon-rich economies. Addressing this need, the Global Carbon Council (GCC) has emerged as MENA's first international voluntary carbon market with full approval by ICROA, ICAO's CORSIA scheme for the pilot phase and conditional approval for the first phase.

Following a brief slowdown amid the global pandemic, energy-related carbon dioxide emissions hit 36.3 Gt in 2021, representing the largest annual increase in emissions ever recorded. According to the International Energy Agency, the energy sector is responsible for two-thirds of global greenhouse gas emissions, with oil and gas accounting for a significant portion of this. Understandably then, to achieve the Paris Agreement's goal of limiting global warming to well below 2°C, it is imperative to ensure emissions reduction in the energy sector. To this end, carbon markets can play a crucial role as they establish a price tag on carbon and incentivize companies to invest in cleaner technologies, reduce emissions, and offset the remaining emissions through carbon credits.

In 2022, the global carbon market was valued at the highest ever \$909 billion, representing an annual growth rate of 14%. On national levels, over 66% of countries intend to utilize carbon markets to fulfill their commitments outlined in the Paris Agreement, known as the Nationally

Determined Contributions (NDCs). That said, despite their promising potential, carbon offsetting and finance in the MENA region have yet to be normalized. To address the gap, the region's first international carbon market called the Global Carbon Council (GCC) was established in 2016.



Today, GCC operates as the first and only international voluntary carbon market and sustainable development program in the Global South. It facilitates climate finance for the private sector and compensates projects that reduce greenhouse gases to address climate change. Following best international practices in setting and maintaining the highest standards of environmental integrity with each carbon credit it issues, GCC is fully approved for the pilot phase and conditionally approved

for the first phase by the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) of United Nations' International Civil Aviation Organization (ICAO) as well as fully approved by the International Carbon Reduction and Offsetting Accreditation (ICROA).

Since its inception, GCC has received a wide range of GHG reduction projects implemented globally. With approximately 1,500 GHG mitigation project submissions from over 45 countries, the program facilitates global stakeholders in implementing climate actions, taking into account the carbon revenues to be accrued over their 10-year crediting periods. This goes a long way in contributing to achieving the Paris Agreement objective of limiting global warming to 1.5°C. As the first CORSIA-accredited international voluntary carbon market in the Global South, GCC's growing portfolio owes to the robust approaches and procedures the program has instituted to safeguard the environmental integrity of the carbon credits sourced through environmental preservation and restoration projects.

While the program has global reach and applicability, a key focus of GCC is to provide a platform for organizations and governments in the MENA region to participate in carbon markets as a means to reduce their carbon footprint, and contribute to global efforts to mitigate climate change. GCC's voluntary carbon market model allows companies to generate carbon credits by reducing their greenhouse gas emissions or investing in carbon reduction projects. These credits can then be traded on the GCC platform, providing companies with a financial incentive to invest in cleaner technologies and reduce their carbon footprint.

As the world continues to grapple with the challenges posed by climate change, the importance of carbon markets in reducing emissions cannot be overstated. While initiatives such as the GCC are a step in the right direction, the real outcome of such programs lies in the normalization of carbon finance. This requires collective efforts from governments, businesses and individuals, all working towards a shared goal of achieving a net-zero future. ■



The only CORSIA-approved carbon market in the Global South

Attracting GHG mitigation projects from
40+ countries with 2 billion carbon credits
expected to be issued by 2032.

Driving Climate Actions



TIGHTER MARKETS ARE HERE TO STAY WITHOUT INCREASED INVESTMENT

Upstream Oil and Gas Investment Outlook

IEF

Investment Needs Rise Amid Market Uncertainty

A Report by the International Energy Forum and S&P Global Commodity Insights

February 2023

INTRODUCTION: WHAT A DIFFERENCE A YEAR MAKES

The state of the global economy and the energy sector has been transformed since our last upstream investment report (Investment Crisis Threatens Energy Security, December 5, 2021).

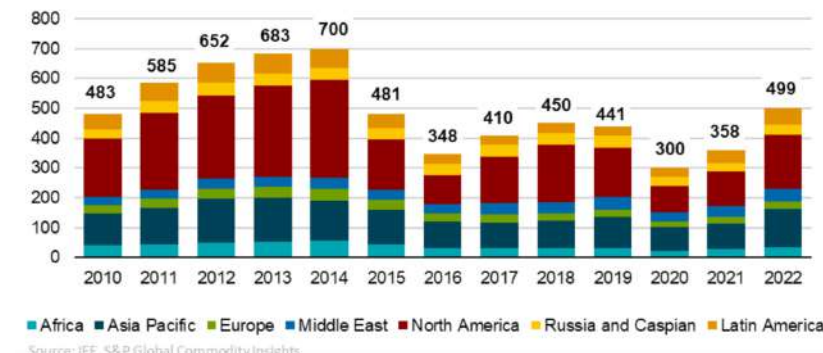
The economic outlook for the near-term has deteriorated significantly while the geopolitical risks, and price volatility, across the energy sector have surged following Russia's invasion of Ukraine.

For the time being, long-term demand uncertainty has been overshadowed by turmoil impacting near-term supply and demand. On the supply-side, there are many outstanding questions about the depth and duration of a reduction in Russian production. On the demand side, there are many outstanding questions about the depth and duration of a global economic slowdown and how much China's lifting of COVID-zero policies will offset sluggish demand elsewhere.

For policymakers, security of supply has re-emerged as a top priority. However, there is lingering uncertainty as to whether increased interventionism by governments in energy markets are a symptom of extraordinary circumstances in 2022 or a strategic shift that will transform into long term policies, market structures and price formation.

Market upheaval has led to higher and more volatile energy prices, resulting in record profits for

Global Oil & Gas Upstream Capex
Billion USD



oil and gas producers. After decades of lackluster stock performance and free cash flow, oil and gas companies are now outperforming every other major industry. Prices for long-dated futures (the back-end of the forward curve) appear to have decisively broken above \$70 per barrel for the first time since the 2014 collapse. This has shifted the primary constraint on investment from capital availability to producers' willingness to invest. As long as crude prices remain above \$70 per barrel, there are enough profitable oil and gas reserves and projects to meet demand over the next decade, but the primary uncertainty is whether companies will commit sufficient investment to develop them.

The failure to increase and sustain investment in oil and gas upstream could lead to recurrent price shocks across commodities caused by the disparity between the slower-moving demand transition and the rapidly thinning supply buffer resulting from insufficient investment and geopolitical developments. This will result in increased price volatility across the energy complex and adverse economic consequences. Further, the combination of short-term price volatility and long-term demand uncertainty could further deter investment and further exacerbate volatility, with resulting energy insecurity inviting further government interventions.

New challenges and hurdles have emerged in the past year that are no less difficult than the obstacles we highlighted in December 2021. While oil prices ended 2022 at nearly the same level as the end of 2021 – the world is a different place. There is a lot more capital available for the upstream industry, but also acute short-term uncertainty.

More than anything else, 2022 may have marked the end of the era of perceived energy abundance and the restoration of energy security. In this new energy world, investment has a critical role to play.

INVESTMENT IN 2022 AND BEYOND GLOBAL UPSTREAM INVESTMENT REBOUNDED IN 2022

Oil and gas upstream capital expenditures rebounded by 39% (\$141 billion) in 2022 to \$499 billion – the highest level since 2014 and 13% above 2019's pre-COVID level. Upstream capital expenditures in North America increased the most, rising by a robust 53% (\$61.7 billion) year-on-year. Increased spending reflects both increased costs and increased activity. Cost inflation was up 15-20% year-on-year in 2022, with more expected in 2023. While the global rig count is up ~22% year-on-year, it is still ~10% below 2019 levels. The industry has achieved significant improvements in capital efficiency over the past decade, but a high-cost environment means the sector will need even more investment than previously expected to ensure adequate supplies.

Our previous upstream investment report highlighted how 2022-2023 would be crucial years for financing projects. In 2022, nearly 2.2 million barrels per day of new capacity was approved or sanctioned – falling short of 2019's high. In line with pre-pandemic trends, companies are still favoring small, modular, or phased projects over megaprojects (a single large-scale project with peak production of >500 thousand barrels per day with new infrastructure).

Notably, there are still no new greenfield megaprojects planned in

the next five years despite of higher prices. In contrast, almost 250 small- to medium-scale projects are expected to begin by

2030, assuming companies move forward with investment. These projects require less capital, have shorter payback periods, and are more insulated from long-term risks.

If upstream capex fails to accelerate, the risk of markets facing a period of substantive supply shortfalls in the medium-term rises significantly. Recent market events and trends have dealt producers a sudden cash injection but also eroded many of the oil market's supply buffers (commercial and strategic inventories and OPEC+ spare production capacity). Without traditional supply buffers, demand in the medium-term will need to be primarily met through increased investment in existing and new production.

PRIMARY HURDLE FOR INVESTMENT HAS SHIFTED FROM CAPITAL AVAILABILITY TO WILLINGNESS TO INVEST

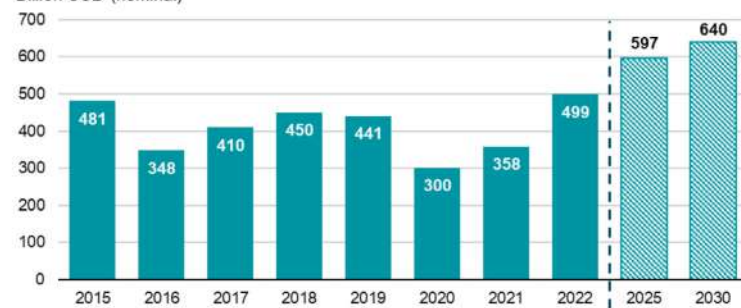
This year's record profits mean companies can afford to invest from operating cash flow, shifting the major constraint to companies' willingness to invest. This is a significant change from recent years when the primary constraint on investment was capital availability due to weak cash flow, reliance on external capital, and waning investor appetite.

Whereas the challenge through most of the 2015-2021 was mainly prioritizing limited capital in a low commodity price environment, the challenge for investment in 2022 and beyond consists of how to allocate excess capital in a high(er) commodity price environment.

Seven of the largest global IOC's reported free cash flow deficits every year except one between

2013 and 2020. The aggregate net free cash flow for the same group of IOCs between 2000 and 2020 equaled a deficit of \$104 billion, but those deficits have been erased by record profits in the past two years. Major IOCs saw a record \$97 billion surplus in 2021 that grew to an estimated \$173 billion surplus in 2022. The surplus in 2022 is more than three times greater than the largest annual surplus experienced in a 20-year period between 2000 and 2020.

Global Oil & Gas Upstream Capex
Billion USD (nominal)



Source: IEF, S&P Global Commodity Insights

After prioritizing returns to shareholders, share buybacks, and debt repayment, companies still have record levels of free cash flow. The question is, will companies re-invest? If so, where? And if not, why? This entails company-level decisions to re-invest proceeds into upstream operations (existing or new developments) or divert windfalls to other ends, be they returns to shareholders and stakeholders or low-carbon/alternative investments. These decisions will be complex and depend on a number of factors including shareholder and stakeholder priorities, regulatory environment, existing operations, geography, in-house expertise, etc.

Many oil and gas companies face investor pressure to use cashflow from fossil fuels to invest in lower carbon options such as renewables and hydrogen. However, the sector also understands the cyclical nature of the business and that profits today do not guarantee profits tomorrow. In addition, some NOCs may have governments that want to use the windfalls to boost their domestic economy. Other companies will not want to overcommit or base project economics on today's environment knowing that while short-term energy security concerns have clearly increased and improved the near-term profitability, the long-term trajectory of hydrocarbon demand remains dictated by ambitious energy transition objectives. With most green-lit projects likely to produce well into the 2030s, the lack of long-term demand certainty remains a potent deterrent for investment, particularly for longer-term prospects such as exploration.

Willingness to invest remains

the key variable only as long as profits remain high. If profits fall due to lower prices or policies (such as windfall taxes) – then capital availability becomes a key constraint again. There is still negative investor sentiment and other hurdles to obtaining external capital.

UPSTREAM INVESTMENT WILL NEED TO INCREASE TO \$640 BILLION ANNUALLY BY 2030 TO MEET FUTURE DEMAND AND OFFSET DECLINING PRODUCTION

While upstream investment in 2022 returned to an eight-year high and posted the largest year-on-year increase in history, it will need to rise even further to stave off a global supply shortfall this decade. Annual upstream investment will need to increase from \$499 billion in 2022 to \$640 billion in 2030 and a cumulative \$4.9 trillion between 2023 and 2030 to meet market needs, even if demand growth slows toward a plateau. This is a significant ask from investors and companies, but one that has become critical in light of the 2020-2021 downturn and erosion of supply buffers in the market.

Continued upstream investment is needed just as much, if not more, to offset expected production declines than to meet future demand growth. Without additional drilling, we estimate that non-OPEC production would decline by 9 million barrels per day by 2026 and 17 million barrels per day (or 31%) by 2030.

SLOWING ECONOMY AND MONETARY TIGHTENING

ADD TO INVESTMENT CHALLENGES BUT ALSO PROVIDES OPPORTUNITIES

For an industry tasked with jump-starting upstream investment after stalling in 2020-2021, the broad-based slowdown in the global economy in 2023 and compounding tightening in global monetary conditions present clear challenges to both the demand outlook and access to capital.

However, unlike previous economic downturns, commodity prices are likely to remain elevated in light of supply concerns and geopolitical pressures, shielding industry returns even amid slowing demand. Additionally, as China unwinds COVID-zero policies, pent-up demand in China may partially offset some of the weakness caused by slowing economies elsewhere.

This presents a critical opportunity for the sector. In our previous investment report, we highlighted that the investment challenge was primarily a mismatch in velocity, with the recovery in upstream investment post-pandemic lagging global demand recovery. The slowdown in global demand over the latter part of 2022 and at least part of 2023 imposes some restraint on demand and affords some time for supply to catch up. But that will require operators to look through complex short-term economic risks.

GLOBAL SPARE PRODUCTION CAPACITY WILL REMAIN LIMITED IN THE NEAR-TERM

Traditionally, tight markets have found relief by drawing inventories, utilizing spare production capacity, or ramping-up short-cycle production (U.S. shale). Over the past twelve months, markets relied heavily on all four but have yet to find sustainable breathing room that would ease supply concerns. Strategic and commercial inventories have been tapped extensively and are below the 5-year average in most regions, and U.S. producers are tempering growth despite higher prices. All that remains is global spare production capacity.

Current global spare production capacity is at only ~2.0-2.5 million barrels per day; nearly all of it is held by Saudi Arabia and UAE. Global spare capacity rarely falls below 2.0 million barrels per day for any

extended period. With a few notable exceptions, Gulf producers typically maintain a buffer to increase production in unexpected supply outages and emergencies.

Saudi Arabia plans to increase capacity to 13.2 million barrels per day (from their current 12.2 million barrels per day) by 2027, and UAE plans to expand to 5 million barrels per day (from 4.2 million barrels

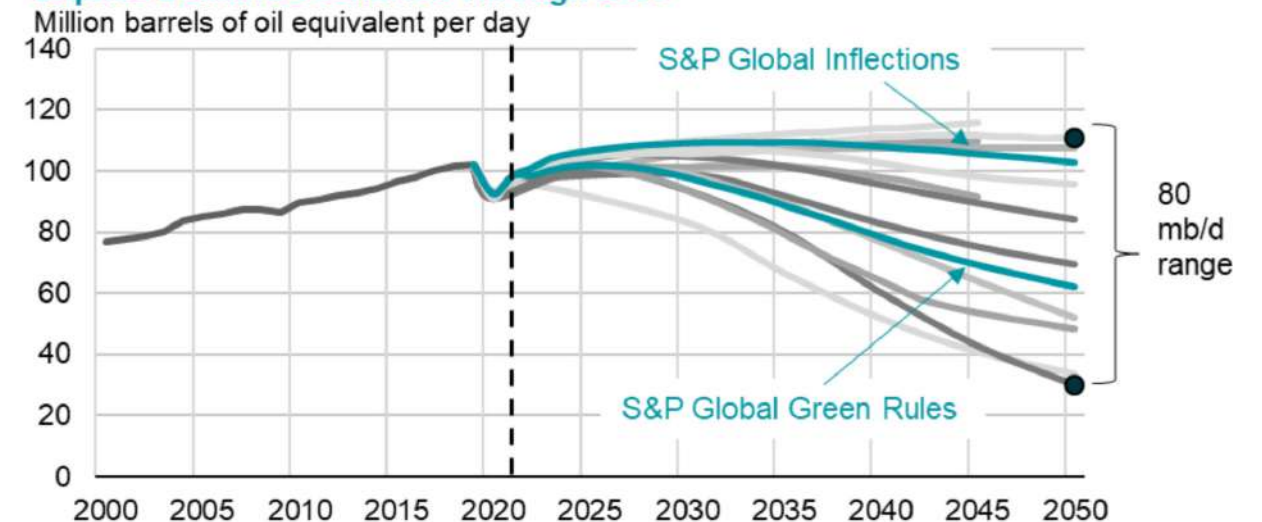
If policies for energy security are viewed as temporary measures, they will not spur the investment needed. The re-emergence of energy security helps break the cycle of the energy abundance mindset and leads to a more accommodating environment for investment.

LONG-TERM DEMAND UNCERTAINTY REMAINS

difference between oil demand in the highest and lowest case for 2050 is 80 million barrels per day. The range in outlooks is equal to ~80% of today's market – a massive divergence.

Long-cycle projects that would come online in the mid-2020s are meant to produce well into the 2030s and often beyond into the 2040s. These projects now face a wide range of long-term price scenarios and

Liquids Demand Scenarios Through 2050



Source: IEF, S&P Global Commodity Insights, IEA, OPEC, BP, BNEF

per day) by 2027. However, actual production increases will depend on OPEC+ policy and their desire to maintain their traditional safeguard.

ENERGY SECURITY AND ENERGY TRANSITIONS

ENERGY SECURITY NEEDS TO BE ACCEPTED AS A LONG-TERM ISSUE

Energy security is back at the forefront of policymakers' minds, leading to a more accommodating stance towards exploration and consumption in some countries but investors look longer-term and need regulatory and policy certainty.

A KEY CONSTRAINT ON INVESTMENT

Traditionally, decisions to invest in long-cycle upstream projects consisted of balancing economic considerations such as full-cycle breakeven prices and above-ground risk affecting developments.

Now, investment decision-makers must also consider if demand will still be there over the lifetime of a specific project and the impact of government policy changes.

While short-term demand and supply concerns have overshadowed long-term concerns recently, long-term demand uncertainty remains a key constraint on investment.

Of the various long-term forecasts and their varying scenarios, the

growing uncertainties. This means what may be profitable in today's environment may no longer be tomorrow.

Operators seek to mitigate this risk by accelerating the payback periods for new investments and raising the return thresholds to account for additional risks. The current focus on smaller, incremental, and more modular projects, with access to infrastructure and the ability to be brought on faster, reflects this trend.

Long-term demand uncertainty, likely reinforced by short-term trends, remains a powerful restraining force and by far the greatest source of investment risk

Adequate investment is needed for

stable markets now and in the future. If investment falls short, it increases the risk of high-prices and high-volatility becoming the new standard.

Underinvestment threatens to undermine energy security in the short and medium-term and it can also stall progress on climate goals as demonstrated by the increased reliance on coal.

Prolonged cycles of energy price volatility are detrimental to economic growth. On the micro-level, it can affect individuals' and companies' costs and revenue streams, making planning difficult. At the macroeconomic level, volatile oil prices fan inflation, hinder investment, delay consumption of durable goods, reduce total economic output, dent equity returns, and entrench energy poverty.

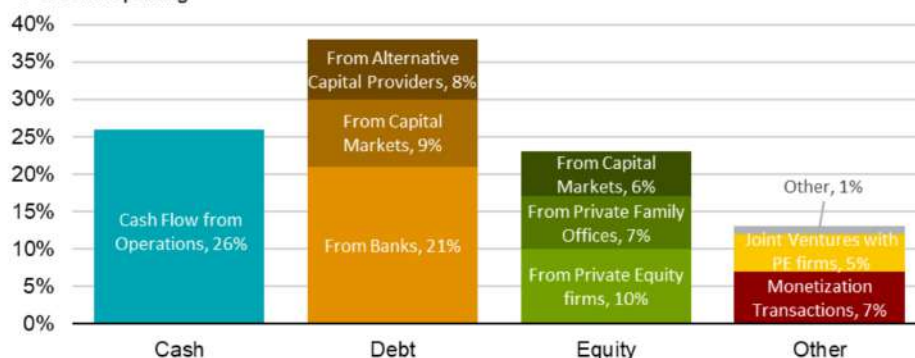
The uncertainty surrounding future supply/demand can impact prices before the market is under/oversupplied. Delayed investment decisions and the increased reliance on short-cycle production, increases the uncertainty of where or if future production will be sourced. Concerns about reduced FIDs and lower investment today can raise current prices even if the current market is well-supplied.

WAYS FORWARD: INCREASED COOPERATION & SUPPORTIVE POLICIES

To move forward and enable stable markets through the medium term, there needs to be intensified dialogue between, and supportive policies from, both producers and consumers. The traditional framework of energy markets is evolving, and market players and governments need to adapt. Energy trade is being reshaped by geopolitics, shifting demand hubs, historical underinvestment in some traditional supply regions (e.g., West Africa), and new business models by short-cycle producers.

Increased dialogue between suppliers and consumers, and data

Q: Where are producers planning to secure capital in 2023?
Percent reporting



Notes: Respondents could select more than one option, 338 total responses.
Sources: IEF, Haynes Boone Borrowing Base Redeterminations Survey (Fall 2022)

transparency are needed to ensure security of supply and market stability through the current energy crisis and the energy transition. History has shown that without market management, boom-bust price cycles prevail and wreak havoc on economies, particularly in regions that are still developing.

In addition to active and continuous dialogue, governments can help by providing regulatory and policy certainty, including those related to ESG. In many parts of the world, environmental policies and regulatory frameworks related to the energy transition are in flux. As a result, companies must consider the impact that future regulatory changes may have on the costs of compliance and returns over time. Unforeseen or newly introduced regulations can lead to higher costs and reduced revenues.

Consumer countries can support markets by sending clear signals about future demand, building and maintaining sufficient inventories, supporting long-term offtake contracts, and preventing prohibitive policies.

Meanwhile, producers can support markets by promoting investment. Operators need a certain level of assurance and regulatory certainty to invest in capital-intensive, long-cycle projects. They will be increasingly constrained in committing capital, or will require higher returns to do so, as risks evolve. Future supply must clear an acceptable hurdle rate that accounts for policy uncertainty, variable oil and gas prices, and, increasingly, carbon price assumptions.

Additionally, governments should base policies on realistic energy

demand outlooks and to ensure adequate and affordable energy supplies during the transition. The energy industry needs more certainty from policymakers over penalties and incentives for future energy investments to ensure sufficient capital for all technologies is mobilized to meet the climate challenge. This requires government policies grounded in realistic assumptions about demand and disruption risks. In particular, governments need to ensure assumptions do not underestimate energy demand growth coming from the 80% of the global population in the developing world.

CONCLUSION

Today's energy market is defined by uncertainty and volatility. It is hard to predict where markets will stand in a year, nevertheless, in 8 years. But decisions made today will impact the availability and affordability of future supplies. Increased dialogue with clear and decisive policies can help reduce the uncertainty inherent in a complex and integrated market. Low-cost resources and capital are available – but the investment environment needs to be de-risked and producers need incentives to re-invest. Adequate investment would help foster market stability, economic growth, and enable a just and orderly transition for all. All it requires is a commitment of capital, market transparency, and open dialogue between producers and consumers. ■

[Credit: International Energy Forum and S&P Global Commodity Insights]

CONNECTING STAKEHOLDERS FOR THE GREEN ENERGY TRANSITION

On the sidelines of 'Connecting Green Hydrogen MENA 2023', which was held in Dubai in March 2023, Energy Oman magazine caught up with senior representatives of:

Deloitte
EDF Renewables
Howden

for their insights into the respective roles that their organisations – all reputable players in their fields of expertise – aim to play in the emerging green hydrogen economy.



‘OMAN’S GREEN HYDROGEN STORY IS NOT ONLY ABOUT THE ENERGY TRANSITION, BUT ALSO INDUSTRIAL DIVERSIFICATION’

• **Tarek Helmi, Partner Deloitte - Future of Energy Lead**
 • **Bart Cornelissen, Partner Deloitte - Energy, Resources & Industrials Lead, Middle East**

What makes Oman special is its multi-fuel story, starting from natural gas and then the potential to move from natural gas to blue hydrogen. The addition of green hydrogen is very important because by having blue and green hydrogen, you open up the possibility for companies to have much more flexibility in terms of what to produce for local consumption and what you can export.

I think that Oman has a tremendous advantage compared to other countries in the region when it comes to green hydrogen production, because of the intermittency issue. This is because Oman doesn’t have an issue with intermittency, as it is blessed not only with solar, like the rest of the region, but also with wind.

At Deloitte, we look forward to playing a role both on the blue and

the green side as well, not only in terms of understanding the market potential in Oman, but also in terms of helping companies deliver on their in-country value (ICV) plans. We are playing our role in terms of supporting companies in their bids for land blocks for development purposes related to green hydrogen, ICV, and so on. After all, the green hydrogen story is not only about the energy transition, but also industrial diversification. So it’s a fantastic opportunity for Oman to build up a new clean-energy based industry.

Moreover, there is a debate going on as to where will the green energy ecosystem be developed in the Middle East. Will that be in Saudi Arabia? Will it be in the UAE? Or will it be in Oman? And I think there’s a fantastic opportunity there for Oman to get it done here, but we have to get it right. You need to really incubate that right now to make sure that you get ahead of the rest in the region.

I think what Oman is doing really well is that they have issued a country strategy with specific targets. That should give comfort to stakeholders that Oman is serious about implementing its green hydrogen strategy. Oman has also gone into the specifics of even how much of CCS is needed, how much green electricity, and so on, all of which also give comfort. We are aware that Oman is working towards a package of incentives that hopefully will be announced in the next three to four months. That is another step towards further confirming the commitment of the country towards clean energy.

Furthermore, the fact that Oman has announced multiple blocks for

green hydrogen investment – and not just one – provides credibility and confidence for people to come forward and invest in the country. Besides that, with different kinds of organizations and companies getting involved in this sector, investments are happening at a big scale by players who know how to operate in the energy space. And that gives confidence too!

Certification:

Yes, certification issues will initially be problematic because an expensive new fuel like green hydrogen is being introduced into the system. But certification is not just an issue for Oman, but for the wider global industry. I think Oman should take the lead or play a big role in defining a certification system primarily because of the different colours of hydrogen fuels it is looking to produce. At the very least, it should take the lead in helping set up certifications in the region.

Oman is also very well-positioned to serve the Asian markets, such as Japan and Korea, but also potentially Europe. The fact that you can serve both, I think gives Oman the flexibility, but also the ability to define standards and guidelines that help you serve both markets. If you look at other countries in the region, a large part of their production will be for domestic consumption, whereas Oman will be very much export-driven in its strategy. Accordingly Oman will need to be actively involved in the international landscape to get these things right.

Deloitte, for its part, works with stakeholders across the whole ecosystem because it’s important to look at the whole value chain and not just parts of it. So we work with



‘OMAN IS WELL-POSITIONED TO PLAY A MAJOR ROLE IN GLOBAL ENERGY TRANSITION’

• **Salah Mahdy, Global Director Renewable Hydrogen – Howden, A Chart Industries Company**

The recent signings by Oman for the development of green hydrogen blocks is great news indeed for the Sultanate. As a country, Oman is well-positioned to really play a key role, not just in the region’s energy transition, but globally as well.

I was privileged to be associated with one of the world’s first green ammonia projects which, incidentally, is being implemented at Duqm in the southeast of the country. I was the Principal Consultant for that project.

It’s a reflection of the abundance of economical natural resources that are available in Oman, and taking

developers, operators, distributors, customers, investors as well as the public sector and the regulators. If you want to move things forward, you need to make sure that everybody is involved because it’s about incubating a whole new sector. You can’t do that with just a developer or an operator; you need to involve everybody else – and the government has also an essential role to play in that.

In-Country Value:

Imagine as a developer you have the ability to secure the needs of part of the local market instead of just exporting your green energy output! This approach will also help investors de-risk their projects. By serving the local market, you also do not have to convert your green molecules into ammonia for shipment overseas.

Secondly, Oman is a very unique country, even within the region. Doing business in Oman is very easy. The talent is available as well. So I think the conditions for investors to develop and meet the ICV targets is facilitated.

This is also true for establishing manufacturing capacity linked to green energy projects. If there is clarity on what the demand will be, whether solar panels, wind turbines, electrolyzers and so on, combined with a regulatory framework, it will attract the right investments into the country to build the local ecosystem. What Oman gains is potentially a whole new manufacturing sector that didn’t exist before.

into consideration the location as well, the Sultanate is positioned to play a key role in this exciting market.

Howden already has presence in the Gulf region general and the Omani market in particular. We have been serving these markets for years, particularly in the Oil & Gas and mining sectors, among others. When it comes to renewable hydrogen, we have been in contact with all the major players in the Omani market and we are looking forwards to taking things to the next level. We are excited about the potential future for the hydrogen in Oman.

As for the exciting developments under way in Oman, our position is that we like to engage as early as possible with the project developers and our partners, so we can add value to their projects and the right solution is applied. This early involvement allows us to ensure optimisation across the life cycle of the project from both a CapEx and OpEx perspective.

Howden, as you know, is a global leader in mission-critical air and gas handling solutions including steam turbines and hydrogen compression solutions. With over 165 years of expertise in this field, we support our customers across a number of industries with innovative solutions that make a cleaner and more sustainable future possible. These solutions range from hydrogen processing, renewable thermal energy, demand side energy efficiency improvements, through to carbon capture and storage.



'EDF'S AMBITION IS TO BUILD PARTNERSHIPS ACROSS THE GREEN HYDROGEN SUPPLY CHAIN'

• **Francois Dao, Vice-President, Middle East & Africa – EDF Renewables**

EDF has been actively involved in the utility sector of Oman for years now. We have teams present there, particularly focused on opportunities in renewable projects for which we have been participating in a couple of tenders – both large utility-scale projects as well as small ones. One such tender floated by Tanweer (part of Nama Group) aims to decarbonize its operations in remote areas by replacing or reducing existing diesel generation capacity with solar PV systems.

So, yes, Oman is definitely part of the countries that we believe we have the expertise and experience

to support with innovative solutions to decarbonize the electricity sector. Our goal is to support the Sultanate in achieving in a short term its ambitions to produce 40% of its energy mix from renewables by 2030, as well as in supporting its long-term vision of carbon neutrality by 2050.

While our interest in Oman has focused on solar projects, EDF Renewables has a strong knowledge in wind energy development. Over 50 per cent of our renewables portfolio around the world comprises on wind energy projects – both onshore and offshore. We strongly believe in wind projects because they ensure a high load factor and operate in the evening when solar energy declines for the day. So, combined with solar, they contribute close to the base load.

ICV:

In Country Value (ICV) development, to be honest, can be quite challenging, particularly as any project has to be both economical and robust. But EDF is committed to delivering on ICV by exploring tangible solutions. To give you an example, we are presently building a very large wind farm in South Africa which will use towers made of local concrete instead of steel towers. This involves local contractors, create business and job opportunities, tax revenues for the government, and so on.

Looking at the Sultanate with its advantageous location overlooking the Indian Ocean, it is well-positioned to target Europe and Asia with its green energy exports. It has fantastic natural resources in the form of solar and wind. Oman has all it takes to become a major player in the region to lead the energy transition. After all, I still remember that the Sultanate was the first country in the region to launch power projects based on the Independent Power Project (IPP) model.

EDF Renewables is also keen to be part of the green hydrogen industry in Oman. I'm happy to see that with the recent agreement signings by Hydrom, a lot of momentum has already been created. EDF is looking forward to being involved across the supply chain all the way through to production of hydrogen or its derivatives. To achieve the most robust, most bankable and most economical project, you would also need to know who your offtaker or end-customer is. Accordingly, we will be looking to partner with large offtakers in Asia as well as Europe. Moreover, we have a leading role in Europe as a 360-utility company for electricity generation and increasingly as a hydrogen producer. Our ambition is to build partnerships that cover the entire supply chain all the way to the offtaker. ■



**GREEN HYDROGEN SUMMIT OMAN 2022:
5-7 DECEMBER 2022, MUSCAT**

ONBOARDING A CLEAN ENERGY FUTURE FOR OMAN



BY DR ABDULLAH AL ABRI
CONSULTANT – IEA



BY DR. KHALIL AL HANASHI
– PDO AND HY-FLY

BY MARIYAM JEDDA
INDEPENDENT ENERGY
RESEARCHER

EXECUTIVE SUMMARY:

The Green Hydrogen Summit Oman (GHSO), held under the auspices of the Omani Ministry of Energy and Minerals, offered an unparalleled opportunity for international and Omani energy organisations to meet, engage and network to unlock business and partnership opportunities in addition to knowledge sharing in relation to green hydrogen. The goal of the summit was aligned with Oman's energy transition objectives aimed at ensuring energy security, diversifying energy sources, opening up a new local revenue generation stream, and driving decarbonisation to attain Net Zero by 2050.

The summit was attended by more than 2,500 key international and local stakeholder representatives and covered a range of commercial, legal and technical topics spanning the entire hydrogen value chain. The summit comprised a total of six different sub-events sessions each catering to a distinct constituency within the green energy space.

The sub-events, and the corresponding takeaways, are outlined here below:

1. Energy Executives Circle (ministerial and energy executives event)
2. Strategic Conference Sessions (7 group presentation sessions & 5 panel discussions)
3. Technical Conference Sessions (6 group presentation sessions)
4. 4 Master Classes (Green Hydrogen Technology, Application, Policy, and Safety)
5. Exhibition (with the participation of more than 30 companies and organisations)
6. Future Energy Leaders research competition for students.

In conjunction with the summit, the following related events and activities took place:

- Oman-Korea green hydrogen forum (hosted by Korean Embassy in collaboration with H2 Korea (Korean Hydrogen Alliance) and Oman's National Hydrogen Alliance (Hy-Fly))
- MOUs and agreements were signed between various organisations, aiming to drive the development of local hydrogen initiatives, including:
 - (i) Sohar International Bank & Fortescue Future Industries
 - (ii) Sohar International Bank & IFC.
- In addition, bilateral G2G (Oman-Germany, Oman-Netherlands) meetings and many B2B meetings were conducted during the summit.

KEY MESSAGES AND DISCUSSION POINTS:

Energy Executives Circle – 5th December 2022:

Held on the eve of the Summit, the theme of the Energy Executives

Circle was 'Energy Security and Green Hydrogen'. HE Salim Al Aufi, Minister of Energy and Minerals, opened the forum by welcoming the distinguished gathering. He traced the progress made on the green hydrogen front over the last 12 months (i.e. since the time of the previous summit in 2021), including the targets set, the formal announcement of the hydrogen blocks and auction process, incentives to attract investment, the launch of Hydrom as the national orchestrator of green hydrogen development in the country, and other transition opportunities that Oman is considering (renewables, EVs, etc).

The session began with two keynote speeches by Mr Joao Galamba, Secretary of State for the Environment and Energy, Government of Portugal, who talked about the aspirations of Portugal to develop green hydrogen to decarbonise local industries as

well as for international trade; The second speaker was José Miguel Bermúdez Menéndez, Energy Technology Analyst - International Energy, who presented on the outlook and challenges of hydrogen trade.

An executive panel discussion then took place with the following participants: HE Salim Al Aufi (Minister of Energy and Minerals of Oman), HE Dr. Michel Heijdra (Deputy Vice Minister for Climate and Energy at the Ministry of Economic Affairs and Climate Policy of the Netherlands), Mr. Hirohide Hirai (Vice Minister for International Affairs at the Ministry of Economy, Trade and Industry of Japan), HE João Galamba (Secretary of State for Environment and Energy of Portugal) and Ellen von Zitzewitz (Deputy Director Bilateral Energy and Climate Cooperation, German Federal Ministry for Economic Affairs and Climate Action).



KEY MESSAGES:

- Green hydrogen development in Oman is planning-led through the announcement of concessions, blocks, national targets, and state governance capacity.
- It requires a market-oriented focus on demand aggregation and cost reductions.
- It calls for cross-border collaboration focusing on offtake, supply chains, joint investments, etc. Cooperation on hydrogen can help in balancing short term energy security needs and long-term decarbonisation goals.
- Enhancing energy security will require the creation of links with new and reliable partners and will necessitate a reduction in fossil fuel demand as soon as possible.



- European governments need to consider that, as ETS matures, green hydrogen will increase its competitiveness
- Portugal said there is a need for actions to match project developers with potential off-takers. Mandatory sectoral quotas are a good option to create demand and facilitate off-take
- Netherlands and Oman signed an MoU to cooperate on hydrogen at COP27 with a view to facilitate H2 trade. Port of Rotterdam has already close links with Oman since it has a JV to develop and operate the Port of Sohar (north of Oman). Japan and the EU have just signed an agreement to cooperate on hydrogen standards.
- Japan thinks that there is a need to use “all colours” of hydrogen to scale up the market and to push for innovation. They are planning to run auctions of hydrogen projects and will provide details at the end of the year.



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Ministry of Energy and Minerals



GREEN HYDROGEN SUMMIT OMAN

DEC 12-14, 2023
MUSCAT, SULTANATE OF OMAN

TOWARDS A CLEAN ENERGY ECONOMY

Following the overwhelming response from the previous two editions, with over 2500 attendees in the second edition alone, the third edition of the Green Hydrogen Summit Oman 2023 (GHSO23) will be held from 12th to 14th of December 2023 at the Oman Convention and Exhibition Centre, Muscat, the Sultanate of Oman.

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GHSO EXHIBITION





OMAN-SOUTH KOREA CONFERENCE



MASTERCLASSES

GREEN HYDROGEN SUMMIT ME A

JULY 25-27, 2024
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This time we are moving abroad to share Oman's pioneering experience globally, at Green Hydrogen Summit MEA. The summit will take place in the Kingdom of Morocco due to Morocco's strategic and geographical advantages, which are similar to those of the Sultanate of Oman.

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