CRITICAL INSIGHTS TO EMPOWER YOUR BUSINESS GROWTH

Energy OMAN

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EXPLORING THE ENERGY TRANSITION AND NET-ZERO STRATEGIES OF GULF OIL PRODUCERS

OMAN SET TO BE THE LARGEST HYDROGEN EXPORTER IN THE MIDDLE EAST BY 2030

CLIMATE RESILIENCE FOR ENERGY TRANSITION IN OMAN

POWERING A LOW-CARBON FUTURE

How can the Middle East leverage its natural resources to spur global decarbonisation?

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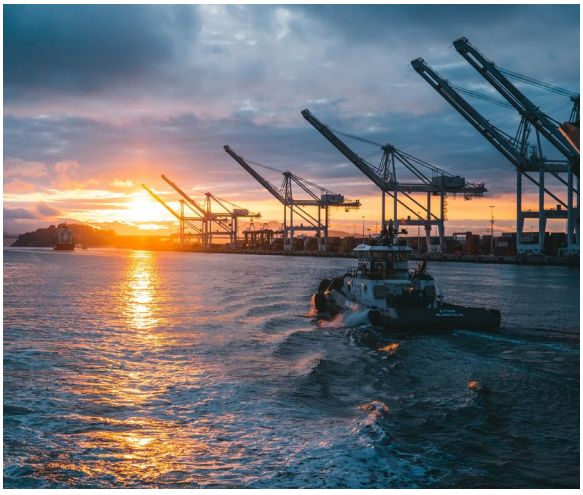

Energy OMAN
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Account Manager
Reem Al Harthi
reem@birbaenergy.com

Editorial
Conrad Prabhu
editor@energyoman.net

Energy Analyst
Amal Ben Yahmed
amal@birbaenergy.com

Marketing and Communication
Mohanad Muhammed
mohanad@birbaenergy.com

Marketing and Sales
Claudette Macleod
claudette.macleod@birbaenergy.com
Warith Al Naamani
warith@birbaenergy.com

Web Developer
Ahmed Alsir
ahmed@birbaenergy.com

Birba Energy Service L.L.C

Address
Bldg. No. 278, Way No. 272, Al Azaiba North,
Sultan Qaboos St., Muscat
Tel.: +968 92855714
Email: info@energyoman.net
www.energyoman.net
www.birba.om

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MESSAGE FROM THE CHAIRMAN

Dear Readers,

With two sets of land blocks already awarded to green hydrogen developers, and a third round penciled in for Q2024 1, *Oman's energy* transition is leapfrogging many of its regional peers to rank among the global pacesetters in the green energy space. This recognition of Oman as a first-mover was also affirmed by the International Energy Agency (IEA), which in a recent report applauded the bold steps taken by the government to vigorously press ahead with its vision for a sustainable future based on green hydrogen.

Vindication of these bold steps has come from the prestigious array of international investors that have pledged an estimated US30$ billion in the roughly half-dozen mega-scale ventures lined up for implementation over the next 7 years.

Staying with the hydrogen story, this edition of *Energy Oman* discusses a wide spectrum of topics that robustly underscore the game-changing benefits that will accrue to the local economy, and indeed the rest of humanity, once usage of this zero-carbon fuel becomes universalized.

While *Energy Oman* continues to bring you up to speed on the breathtaking developments surrounding this promising new industry, our parent organization Birba Energy is busy finalizing the third edition of its flagship event, the Green Hydrogen Summit Oman (GHSO) exhibition and conference, set to be held in Muscat later this year. With much of the world looking to Oman for leadership in driving wider uptake of this planet-saving fuel, GHSO 2023 is expected to bring in record numbers of delegates, exhibitors and other participants.

Stay tuned with *Energy Oman* for unmatched insights into the world of opportunities linked to this emerging industry.

Abdullah Al Harthy

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.

ROBUST OPTIMISM

DR ANWAR AL KHARUSI
VICE PRESIDENT - UPSTREAM BUSINESS DEVELOPMENT
UPSTREAM BUSINESS UNIT, OQ

As many of the recently signed green hydrogen projects have demonstrated, partnerships are the way forward in the successful delivery of these mega schemes. Almost all of them are truly transcontinental partnerships that involve players from different corners of the globe, each bringing to the table their respective technological expertise, operational capabilities, financial wherewithal and market understanding. Given the immense capital costs involved and the risks inherent in an industry still in its nascent stages of development, it's a reflection of their faith in Oman's vision for a zero-carbon future powered by green energy.

SOUNDING BOARD

DR AISHA AL SARIHI
RESEARCH FELLOW, NATIONAL UNIVERSITY OF SINGAPORE, MIDDLE EAST INSTITUTE

A NEW ENERGY POLICY TO ALIGN WITH VISION 2040

Oman's commitment to carbon neutrality by 2050, announced in November 2022 just ahead of COP27, defines a new direction for the Sultanate's energy policy and economic growth -- one that is an orderly transition from a hydrocarbon-based to a carbon-neutral economy.

Oman's National Strategy for an Orderly Transition to Net Zero, released in November 2022, sets a pathway for unlocking investments in alternative energy sources including renewable energy and hydrogen, while simultaneously decarbonizing existing hydrocarbon resources.

This new energy policy direction aligns with the goals set in Oman's Vision 2040, launched in 2019, aiming to diversify economic activities and establish an economic environment where dependence on hydrocarbons is kept at a very limited level.

DR. SALIM AL HUTHAILI
CEO
SOLAR WADI

CUSP OF TRANSFORMATIONAL CHANGE

Any lingering doubts about Oman's ambitious contribution towards a cleaner energy future shifting towards green hydrogen would have quickly vanished when the IEA, no less, weighed in on the Sultanate's energy transition. In its landmark report of 10th June 2023, the IEA boldly affirmed its belief that Oman is well on its way to becoming one of the largest exporters of hydrogen in the world by 2030. The report also underscored Oman's potential to become a competitive hub for renewable energy and hydrogen. As emphasized in that report, the entire nation remains poised to herald the growth of a new energy future balanced by zero-carbon hydrogen. We are indeed on the cusp of transformational change that also bodes well for the future of our planet. However, the challenges remain, and bold decisions are needed to enable this change with open minds that there is still a lot of ambiguity surrounding these topics, but we cannot stand still. We must keep moving forward and deliver projects in energy efficiency, renewables and small scale hydrogen to build capabilities and understand the challenges of the new energy paradigms.

DR ZAKIYA AL AZRI
CORPORATE RESEARCH & DEVELOPMENT
ADVISER PETROLEUM DEVELOPMENT OMAN

SEMINAL YEAR FOR OMAN'S ENERGY INDUSTRY

For a relatively modest-sized economy like the Sultanate of Oman to have pulled off a global-scale feat in charting its green hydrogen-based economic future, is nothing short of spectacular.

The past 12 months have been momentous, starting from October last year when Hydrom was established alongside the unveiling of a new regulatory framework for the green energy economy.

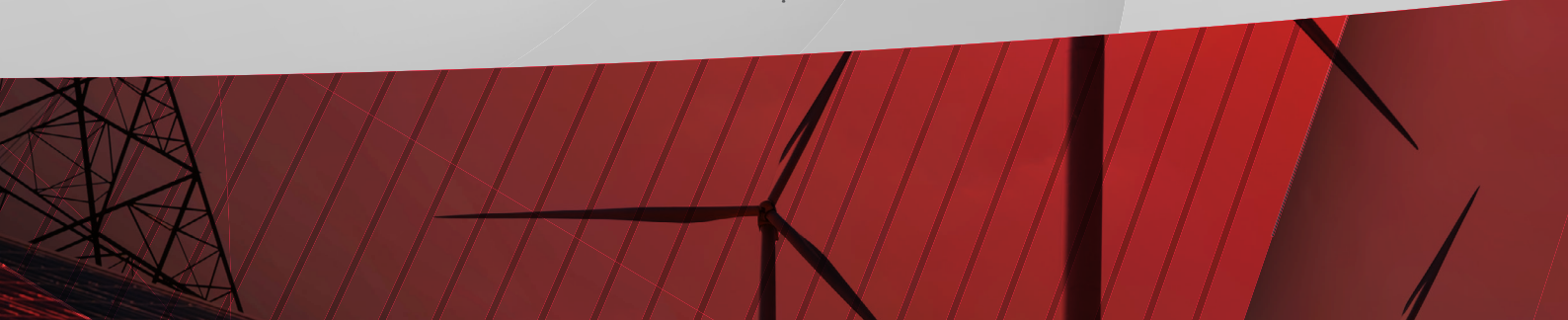
Oman has a firm ambition to achieve carbon neutrality by 2050. The single biggest contributor to this goal will be the green hydrogen industry, towards which investments of a significant US$30 billion have already been pledged.

2023 has indeed been a seminal year for Oman's energy sector. The energy transition is well and truly under way.

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

BOOST FOR E-MOBILITY

It's heartening to see multiple government ministries and public sector stakeholder agencies working collaboratively to facilitate the adoption of greener, low-carbon transport solutions in Oman. In recent months, the Ministry of Energy and Minerals, Ministry of Transport, Communications and Information Technology, Ministry of Commerce, Industry and Investment Promotion, and the Authority for Public Services Regulation (APSR) have made significant announcements that bode well for the growth of, among other initiatives, electric vehicles (EV) and EV charging infrastructure in Oman. It is commendable that the authorities have decided to waive customs tax, VAT and registration fees against EV purchases. The potential use of hydrogen cells for heavy transportation is being actively explored as well. E-mobility is getting the right boost early on in Oman's energy transition.



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Building on the incredible response from the past two editions, GHSO 2023 promises to be bigger and better to meet the growing interest in green hydrogen. Join us for the third edition of the Green Hydrogen Summit from December 12th to 15th at the Oman Convention and Exhibition Centre in Muscat, Oman, where we bring together energy experts from around the world.

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#GHSO23

Oman shows how a fossil fuel producer can embrace clean energy

The country is using its existing energy infrastructure to fast-track its green transition.

*HE **Salim Nasser Al Aufi***
Minister of Energy and Minerals, Oman

Ahead of the COP28 climate talks in Dubai later this year, the role of oil and gas-producing economies in the clean energy transition is coming into sharp focus.

Ensuring that countries – including those that have relied on oil and gas revenues to support their economic development – can transition to a low-emissions future in an orderly manner is essential to international efforts to limit global warming to 1.5 °C, one of the key goals in the Paris Agreement.

Oman is a clear example of one such country that is setting a bold energy transition vision at home – in line with its international commitments.

Oman's oil and gas industries account for around 60 percent of its income from exports. In addition to a heavy reliance on revenues from this trade, oil and gas activities – including power generation and industry – are also responsible for the majority of the country's emissions. Natural gas alone accounts for over 95 percent of electricity generation while iron, steel, aluminium, petrochemicals and refining also contribute significantly to the national emissions footprint.

But the country has prepared itself for change. The government has its sights firmly set on its target of achieving net zero emissions by 2050, which was adopted late last year.

Reducing emissions in Oman's flagship industries is an important component of the country's broader decarbonisation agenda. Establishing a path to net zero is an opportunity for Oman to create economic value, improve industrial competitiveness and attract investment to help diversify and strengthen the country's economy. The government has already committed to ramping up clean energy production in which renewable energy, green and low carbon hydrogen and derivatives will play a starring role.

Beyond fossil fuels, Oman is endowed with significant natural resources such as solar and wind and to some extent, geothermal and tidal energy.

Expanding renewable power generation can bring many positive impacts. These include opportunities to decarbonise domestic industries, making them more competitive, as international markets are set to have more opportunities for the trade of low-emissions industrial products such as steel.

Furthermore, the rapid deployment of renewables will also enable Oman to gradually capture gains from the solar and wind value chains as well as those of other clean energy technologies such as hydrogen and low-emissions synthetic fuels.

Additional renewable power can also support the electrification of a portion of Oman's oil and gas supply chains, thereby reducing the industries' emissions intensity.

Bottom of Form.

Oman has already taken steps to lay the groundwork for achieving its ambitions. It has set up an independent entity to oversee its national hydrogen strategy an important step that demonstrates the country's commitment and provides the certainty that investment and industry stakeholders will need to support the development of the sector.

If the strategy is implemented in full and on time, renewable hydrogen production could eventually exceed the size of Oman's current liquefied natural gas (LNG) exports.

But the size of the task is significant: Oman anticipates that cumulative investments would need to reach $140bn through 2050 to achieve the targets set out in its strategy, which utilise only 30 percent of the designated high potential solar and wind land.

*HE **Fatih Birol***

Executive Director of the International Energy Agency

To help advance this, Oman's Ministry of Energy and Minerals has worked with the International Energy Agency to examine in depth both the potential and the challenges of scaling up hydrogen production from renewable electricity in the country.

Oman's position as an exporter of fossil fuels means that some of the foundations for a renewable hydrogen economy are already in place. Existing infrastructure such as transport networks, industrial ports and gas storage can be used directly or repurposed to support a hydrogen enterprise.

HE Salim at the World Hydrogen Summit in Rotterdam

In addition, Oman's workforce has important skills related to chemical, temperature and fluid engineering, the distribution and handling of fuel, as well as related health and safety expertise. These give the country a significant edge to fulfil its renewable hydrogen ambitions.

Oman currently benefits from a first-mover advantage. According to the IEA's latest global assessment of announced hydrogen projects, it is on track to become the sixth largest exporter of hydrogen globally by 2030. It is, with other Gulf producer economies such as Kuwait, Qatar, the United Arab Emirates and Saudi Arabia among the frontrunners who can help to support an orderly transition to a low-emissions global energy economy.

As Oman moves forward on its energy transition journey, it is poised to become a significant player in renewable energy and a model for other nations.

By harnessing its natural resources, its established trade links and its longstanding reputation as a trusted energy partner, Oman has a strong point of departure, not only for securing its economic and energy future but also to be one of the leading oil and gas producing economies in the fight against climate change ■

Oman engages with potential EU partners

Round 1 awards of green hydrogen blocks

OMAN SET TO BE THE LARGEST HYDROGEN EXPORTER IN THE MIDDLE EAST BY 2030

Oman could become the sixth largest exporter of hydrogen globally by 2030, and the largest exporter in the region, says the International Energy Agency (IEA) in a key report issued jointly with the Sultanate's Ministry of Energy and Minerals.

The production of hydrocarbons has a dominant role in Oman's economy with oil and gas representing around 60% of total export income in recent years. In 2022, Oman announced a target to become net zero by 2050 and an aim to significantly ramp up the domestic production of hydrogen from renewable electricity.

The country is well placed to produce large quantities of renewable hydrogen and hydrogen-based fuels like ammonia thanks to its high-quality renewable resources. Oman has also vast amounts of land for large-scale project development, and existing fossil fuel infrastructure that can be used or repurposed for low-emission fuels.

Oman can become a competitive producer and exporter of renewable hydrogen and ammonia already by the end of this decade, while simultaneously increasing the share of renewables in its power mix.

This new IEA report – the first of its kind analysing the potential of renewable hydrogen in a producer economy indicates that renewable hydrogen is set to bring multiple benefits in terms of investment, natural gas savings and avoided CO_2 emissions as Oman transitions towards a net zero economy.

Joint meeting of Omani and IEA officials at the launch of the report

KEY FINDINGS

Oman is a producer economy with net zero ambitions.

Hydrocarbon production has a dominant role in Oman's economy with oil and gas representing around 60% of the country's total export income in recent years. Currently, Oman's energy needs are almost entirely met by domestic fossil fuel resources, with natural gas accounting for over 95% of electricity generation. In 2022, Oman announced a target to become net zero by 2050. It also aims to significantly ramp up domestic production of hydrogen from renewable electricity. This commitment is in addition to earlier targets to increase the use of renewables in the power mix.

Long-term targets for renewable hydrogen exceed the size of current LNG exports.

The country has set targets to produce at least 1 Mt of renewable hydrogen by 2030, up to 3.75 Mt by 2040 and up to 8.5 Mt by 2050. Achieving this would make renewable hydrogen a significant new source of export revenue. Meeting Oman's 2040 hydrogen target would represent 80% of today's LNG exports in energy-equivalent terms, while achieving the 2050 target would almost double them.

The country is well placed to produce large quantities of renewable hydrogen and hydrogen-based fuels.

Oman benefits from high-quality renewable resources (both solar PV and onshore wind) and a convenient location, well-placed to access the main import markets like Europe and Japan. The country also has vast amounts of land for large-scale project development, and existing fossil fuel infrastructure that can be directly used or repurposed for low-emission fuels. The country has extensive expertise in handling and exporting both LNG and ammonia that are directly applicable to renewable hydrogen and hydrogen-based fuels.

Oman has the potential to become one of the most competitive producers of renewable hydrogen.

Under the current global pipeline of hydrogen projects, the total installed capacity of electrolysers is expected to increase by a factor of almost 300 by 2030, leading to capital cost reductions of 70%. With this trend, the cost of producing renewable hydrogen in Oman could be as low as USD 1.6/kg H_2 by the end of the decade, positioning Oman as one of the most competitive producers of renewable hydrogen globally.

Oman is on track to become the sixth largest exporter of hydrogen globally by 2030.

According to the IEA's global assessment of announced hydrogen projects as of end 2022, Oman could become the largest exporter of hydrogen in the Middle East this decade. Oman is actively working to realise its renewable hydrogen targets. In 2022, the government established an independent entity, Hydrogen Oman (HYDROM), to lead and manage the implementation of its hydrogen strategy. So far, 1 500 km2 of land has been put aside for development with a potential to produce around 1 Mt/yr of renewable hydrogen. By April 2023, HYDROM had released the result of the first auction for land allocation to renewable hydrogen projects, with six projects being awarded.

The total amount of land identified by Oman as suitable for renewable hydrogen production in the long term is 50 000 km2, an area the size of Slovakia. This amount of land would be enough to potentially produce 25 Mt of hydrogen, three times Oman's 2050 targets.

Renewable hydrogen exports are likely to be transported initially in the form of ammonia.

Based on globally announced export-oriented projects, ammonia seems to be the carrier of choice for marine transport of hydrogen until at least 2030 due to the lack of suitable infrastructure for handling and transporting liquid hydrogen in large quantities. Given the anticipated reductions in the cost of hydrogen and the relatively low cost of transporting ammonia by sea, the supply cost of renewable ammonia from Oman could be as low as USD 450 / tonne (over a distance of 10 000 km) by the end of this decade. This would make renewable ammonia cost comparable with the higher end of ammonia market prices over the period of 2010-2020, and well below the record levels of more than USD 1000/tonne experienced globally in 2022 due to price hikes of natural gas.

Ammonia infrastructure needs to significantly expand to facilitate anticipated export volumes.

Oman already exports around 0.2 Mt/yr of ammonia, but this must expand if its hydrogen targets are to be realised in the form of ammonia. Depending on the share of domestic H_2 use, by 2030 Oman could need up to 20-30 times more ammonia export capacity than today. This would require significant growth in new export infrastructure, in particular storage tanks and dedicated deepwater jetties. As the completion of ammonia infrastructure usually takes more than three years, the planning and construction of export facilities would need to begin in the next few years for them to be operational by 2030.

Developing a domestic market for renewable hydrogen can strengthen Oman's position while international demand develops.

Currently, only 17% of planned global export projects for 2030 have potential off-takers. The infrastructure for transporting fast growing trade volumes needs time to scale.

Domestic demand for renewable hydrogen can start with the refining sector, which uses around 0.35 Mt of fossil hydrogen today and which could be replaced by renewable hydrogen at a production cost of USD 1.6/kg by 2030. Unlike exports, domestic use of renewable hydrogen will also reduce Oman's emissions. Displacing fossil hydrogen in

refining would cut emissions by more than 3 $MtCO_2$/yr, or 4% of current domestic emissions.

Renewables can also benefit the power system, as solar PV and onshore wind can produce cost-effective electricity today.

Meeting Oman's hydrogen targets requires massive build-out of renewable captive power. Around 50 TWh of electricity would be already needed to meet the 2030 target, more than the current size of the electricity system. This will have positive implications for cost-effectively achieving Oman's renewables targets, respectively 20% by 2030 (10 TWh), rising to up to 39% by 2040, which take into account technical and contractual flexibility constraints in the power system. Based on the recently awarded bid prices in the region, utility solar PV and wind are likely already competitive with natural gas in Oman.

Simultaneous large-scale deployment of captive renewables for hydrogen production can further improve the competitiveness of renewables in the power mix. A secure system integration of the 20% renewables target can be achieved via more flexible operation of gas-fired power plants, renewables forecasting and grid expansion.

Scale-up of renewable hydrogen production requires significant investments.

Cumulative investment needs by 2030 would be around USD 33 billion, respectively USD 20 billion for captive renewable power dedicated to H2 production and USD 13 billion for electrolysis and ammonia conversion, with an additional USD 4 billion required for achieving the 20% renewables share target in the power mix.

Renewables and domestic use of hydrogen reduce the need for natural gas.

By 2030, total annual gas savings could be 3 bcm, of which half could be saved annually by replacing 20% of natural gas in power generation with renewables and further half by replacing fossil hydrogen in refining. These savings would be equivalent to roughly 20% of 2021 LNG exports. Oman may consider expanding its LNG infrastructure to increase export volumes, depending on LNG demand and supply trends in the coming years.

Renewable hydrogen can bring multiple benefits to Oman's net zero transition.

Already in this decade, a large-scale roll-out of renewable hydrogen and renewables in the power mix would require an investment of USD 37 billion, reduce domestic need for natural gas by 3 bcm/yr and avoid Oman's total CO_2 emissions by 7 MtCO2, equivalent to 7% of baseline emissions by 2030. By then, ammonia export and domestic replacement of fossil hydrogen could generate an economic value of more than USD 2 billion a year, which could rise to double-digit USD billion levels in the long term. Regardless of the eventual allocation of renewable resources between electricity production and hydrogen for domestic use or exports, renewable hydrogen is set to bring multiple benefits as Oman transitions towards a net zero economy.

H.E. Dr. Fatih Birol with H.E. Eng Salim bin Nasser Al Aufi, Minister of Energy and Minerals, pictured during the release of the landmark report in Paris on June 11, 2023

OMAN'S VISION FOR THE CLEAN ENERGY TRANSITION

In 2022, ahead of COP27, Oman announced a commitment to reach net zero emissions by 2050, becoming the third Middle East oil and gas producer to make a net zero pledge, after the United Arab Emirates and Saudi Arabia in 2021. The commitment is supported by Oman's National Strategy for an Orderly Transition to Net Zero, a document detailing how Oman plans to reach net zero emissions by 2050 in the energy sector. The document identifies industry, oil and gas, and transport as the main emissions sources in the country. The total investment needed to support the clean energy transition is estimated at USD 190 billion, which would cover primarily power and hydrogen infrastructure needs (i.e., upgrading and extension of electricity grid, hydrogen pipelines and storage, electric vehicle charging infrastructure and deployment of long-duration energy storage).

In addition to emissions reduction, the strategy also recognises positive impacts on the Omani economy (i.e., higher GDP, freeing-up natural gas), society (i.e., new jobs) and improved energy security. To lead the clean energy transition, an independent body – the Oman Sustainability Centre has been set up to lead and supervise the implementation of Oman's plans and programmes for emissions reduction.

Beyond decarbonisation targets, the clean energy transition is further motivated by the following additional drivers:

Limited gas reserves. Although natural gas has long been a key driver of Oman's economic growth, resources are now slightly dwindling. Oman has managed to stabilise gas reserves through the recent gas field discoveries such as Khazzan, Ghazeer and Mabrouk, but with 0.7 trillion cubic metres (tcm), Oman has the smallest gas reserves in the Middle East after Syria (0.3 tcm) and Bahrain (0.2 tcm). Whilst in the short- and medium term, gas reserves are expected to be enough to fulfil current levels of consumption, in the long-term growing population and industrial aspirations could put a strain on domestic gas resources.

Uncertainty of fossil fuel export revenues. The global oil market today is facing both short and long-term uncertainties driven by current energy crisis, the tightening of climate commitments and rising appetite for clean fuels and products.

As countries strive to meet their climate goals, they need to reduce their demand for oil and gas in favour of clean fuel options. For producer economies like Oman, the uncertainty around future fossil fuel demand puts oil and gas export revenues at stake.

Rising emissions. Between 2000 and 2022, total greenhouse gas emissions in Oman rose from 22 million tonnes (Mt) CO2/year to 81 Mt CO2, due to an increase in domestic fossil-based energy demand. National electricity and energy demand are also projected to increase until 2028 as a result of population growth, rising demand for air conditioning, infrastructure investments and growth in energy intensive industries. If no action is taken now, emissions are projected to surpass 100 Mt CO_2/year before 2030, jeopardising the country's ambitious net zero emissions goal by 2050.

OPENING THE DOOR TO HYDROGEN EXPORTS

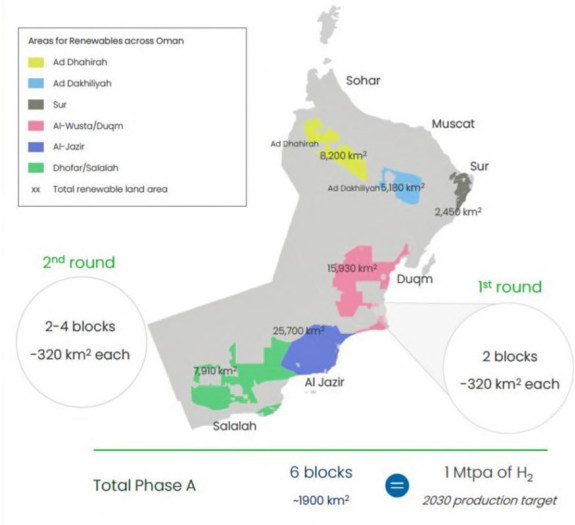
Oman is currently building competencies for hydrogen export, enabled by its existing infrastructure and extensive experience in exporting LNG. The Ministry of Energy and Minerals established a National Hydrogen Alliance ''Hy-Fly'' in 2021. The alliance gathers 15 public and private organisations including government bodies, oil and gas operators, academia, research institutes, and ports that will work together to support and facilitate the production, transport, and utilisation of renewable hydrogen for domestic use and export.

As a follow-up, in October 2022, the government of Oman unveiled its green hydrogen strategy, which includes a target of 1 Mt to 1.25 Mt of green hydrogen production by 2030, rising to 3.25 Mt to 3.75 Mt per year by 2040 and further to 7.5 Mt to 8.5 Mt per year by 2050. The government has estimated that a cumulative investment of USD 140 billion until 2050 would be needed to achieve these targets (this comes in addition to the USD 190 billion of cumulative investments needed for the National Strategy for an Orderly Transition to Net Zero).

Three regions along the coastline have been identified as locations for renewable hydrogen production: Duqm, Dhofar and Al-Jazir, and a total of 50 000 square kilometres of land – an area the size of Slovakia – have already been identified for hydrogen project development. This land area is estimated to have the potential to produce 25 Mt of hydrogen per year (from 500 GW of renewables). The produced hydrogen is set to cover domestic demand, as well as exports, mainly to European and Asian countries.

To lead the strategy, the government has established Hydrogen Oman (HYDROM), a fully owned autonomous subsidiary of Energy Development Oman. The mandate of HYDROM includes the structuring of the large-scale green hydrogen projects and managing the auction process for allocating government-owned lands for green hydrogen projects, assisting in the development of common infrastructure and connected ecosystem industries and hubs, and overseeing the execution of hydrogen projects.

In mid-March 2023, the first public bids were held for the awarding of the first land blocks to meet the 2030 target. By April 2023, HYDROM had released the result of the first auction for land allocation to renewable hydrogen projects, with six project worth USD 20 billion being awarded. The earmarked area stretches over 1 500 km2 and will supply a total of 15 GW electrolyser capacity. The agreements are for a period of 47 years, which includes 7 years for development and construction and 40 years of operation.



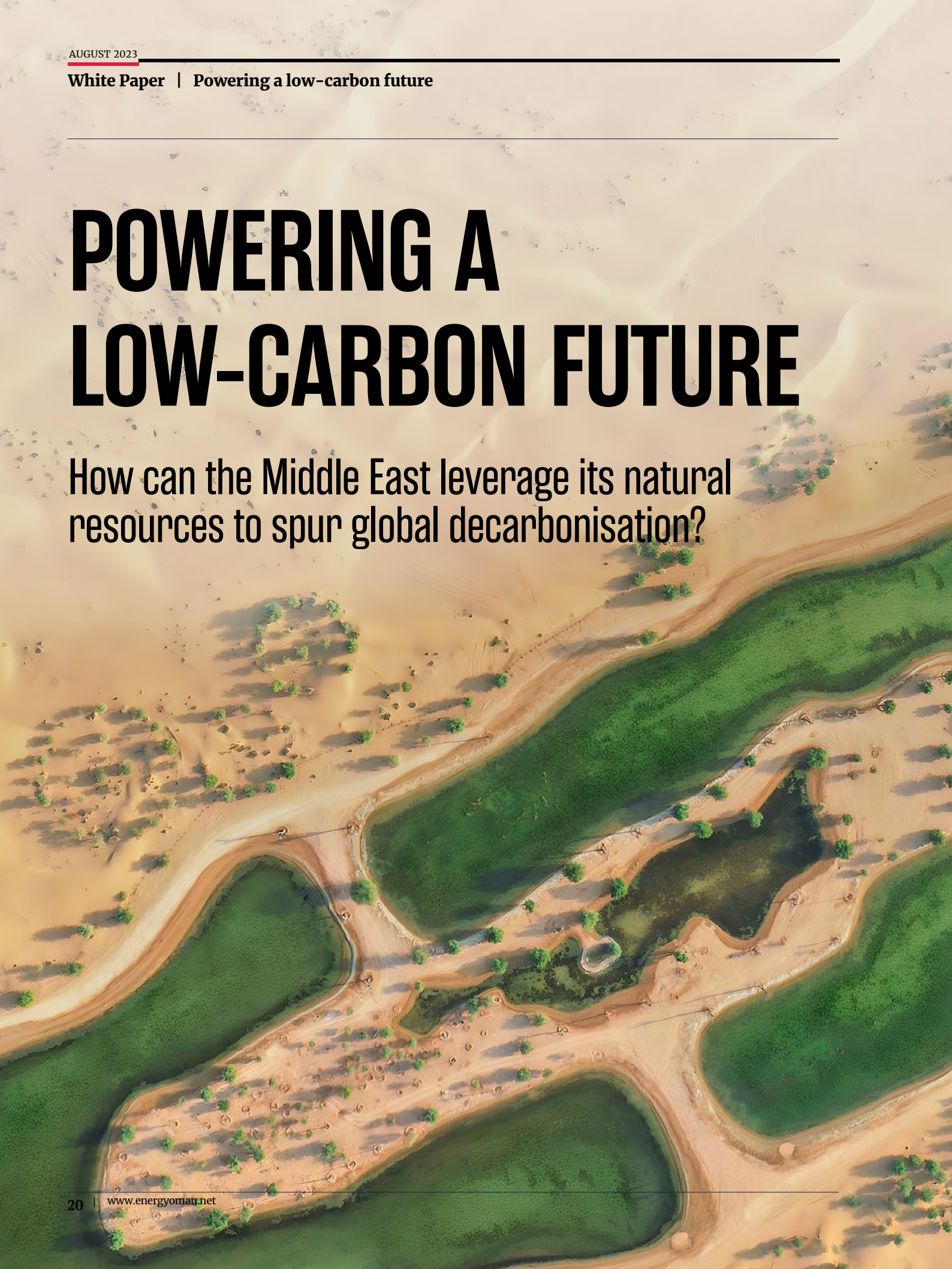
Based on IEA analysis of the current pipeline, Oman could become the sixth largest exporter of hydrogen globally by 2030, and the largest exporter in the region. Oman would represent 61% of total hydrogen exports from the Middle East (equal to 1.1 Mt H_2/year), followed by the United Arab Emirates (20%) and Saudi Arabia (16%). Even if projects have not yet stated a clear preference, ammonia would represent the most common form for the export of hydrogen by sea in 2030.

Many of the export projects are planned in shared industrial hubs, namely ports, such as Duqm, Salalah and Sohar. Concentrating developments to industrial hubs offers opportunities for shared infrastructure and energy integration. Furthermore, establishing large, dedicated land areas for such industrial zones away from densely populated areas or sensitive ecosystems could also reduce infrastructure permitting and siting challenges ■

*- **Excerpted from: 'Renewable Hydrogen from Oman: A producer economy in transition', published by IEA***

POWERING A LOW-CARBON FUTURE

How can the Middle East leverage its natural resources to spur global decarbonisation?



Global energy demand in 2050 will be around 8% lower than today, but it will be expected to service an economy twice as large, with a staggering 2bn more people (totalling 9.8bn by mid-century). The urgency of meeting this challenge has been magnified by the severe warnings from COP 28 – the world's biggest climate gathering.

Energy companies are benefiting from the vast amount of emerging low-carbon energy opportunities and relying on investors to support the capital needed to progress. "I have money to spend, but I do not know where to spend it," is a sentence often heard from the investment community, one roundtable participant shared.

For the sake of the climate clock, this disconnect must urgently be resolved through comprehensive, sustainable and transparent strategies.

Essentially, energy companies need to start joining the dots and collaborating with their partners in technology, academia, finance and government. Government- led initiatives, in terms of more supportive regulations and policies, will also help bolster investors' confidence as they broaden their energy portfolio, especially those historically focused on fossil fuels. Whilst the bright city lights of Dubai can be seen from space, Lebanon and Jordan grapple with power shortages. Instead of aspiring for an elusive ideal solution for the region, energy stakeholders must instead focus on building progressive partnerships that truly deliver results –alliances that mean both the environment and energy economics thrive.

Amina J. Mohammed, the Deputy Secretary-General of the United Nations, stated: "In our fight against climate change, failure is a choice – not a certainty." The Middle East has chosen to positively utilise its natural resources to drive global decarbonisation, but the pressure is on to get it right. As the adage goes: With great opportunity, comes great responsibility.

"In our fight against climate change, failure is a choice – not a certainty." The Middle East has chosen to positively utilise its natural resources to drive global decarbonisation, but the pressure is on to get it right. As the adage goes: With great opportunity, comes great responsibility.

Amina J. Mohammed
Deputy Secretary-General
United Nations

Multifaceted offering

Oil and gas will always spring to mind when discussing natural resources in the Middle East, the historical epicentre of fossil fuels. Up to 45% of the world's oil will come from the Middle East by 2050. However, the whole story is more multifaceted.

The region is fast becoming one of the world's leading hubs for the largest and lowest-cost renewable energy projects, and also has ambitious plans for carbon capture and storage (CCS) with natural carbon sinks.

The region's natural resources are also underpinning ambitions for it to become a globally competitive clean hydrogen hub in the 2030s.

In addition, the region has world-leading infrastructure in terms of size and sophistication, plus the invaluable skills developed from its decades of energy expertise and inter-regional and international relationships.

Clean hydrogen:

Delivering on expectations

Great enthusiasm currently surrounds the development of clean hydrogen, with some calling it the "New oil of the 21st century".

If the Middle East continues to act proactively, it could become a global leader in clean hydrogen application in the steel, cement, shipping, aviation and aluminium sectors. However, the actual market is still minimal and there is a long way to go in just eight years.

The Middle East certainly has the right ingredients. For one, surplus solar and wind energy supports some of the world's lowest-cost renewable energy. This includes the world's largest solar photovoltaic (PV) plant, Al Dhafra, at 2GW.1 It also has vast land availability, a well-established industrial presence and increasing government appetite.

As opportunities abound, energy stakeholders need to gauge the best route forward. Plans must consider the entire CO_2 footprint of low-carbon hydrogen production: not just the final product, but the whole supply chain.

Doing so now means scaling up the clean hydrogen industry into an ecosystem that will be far more durable and competitive in the long-term and therefore, more effective in supporting decarbonization. A carbon-aware and well-validated supply chain will be a powerful differentiator amongst competitors in the 2020s. The relatively condensed nature of the Middle East's energy facilities can also help as the tracking and monitoring of the growing market can be accurately reported via digital tools, heightening energy efficiency and powering decarbonisation.

Big steps forward

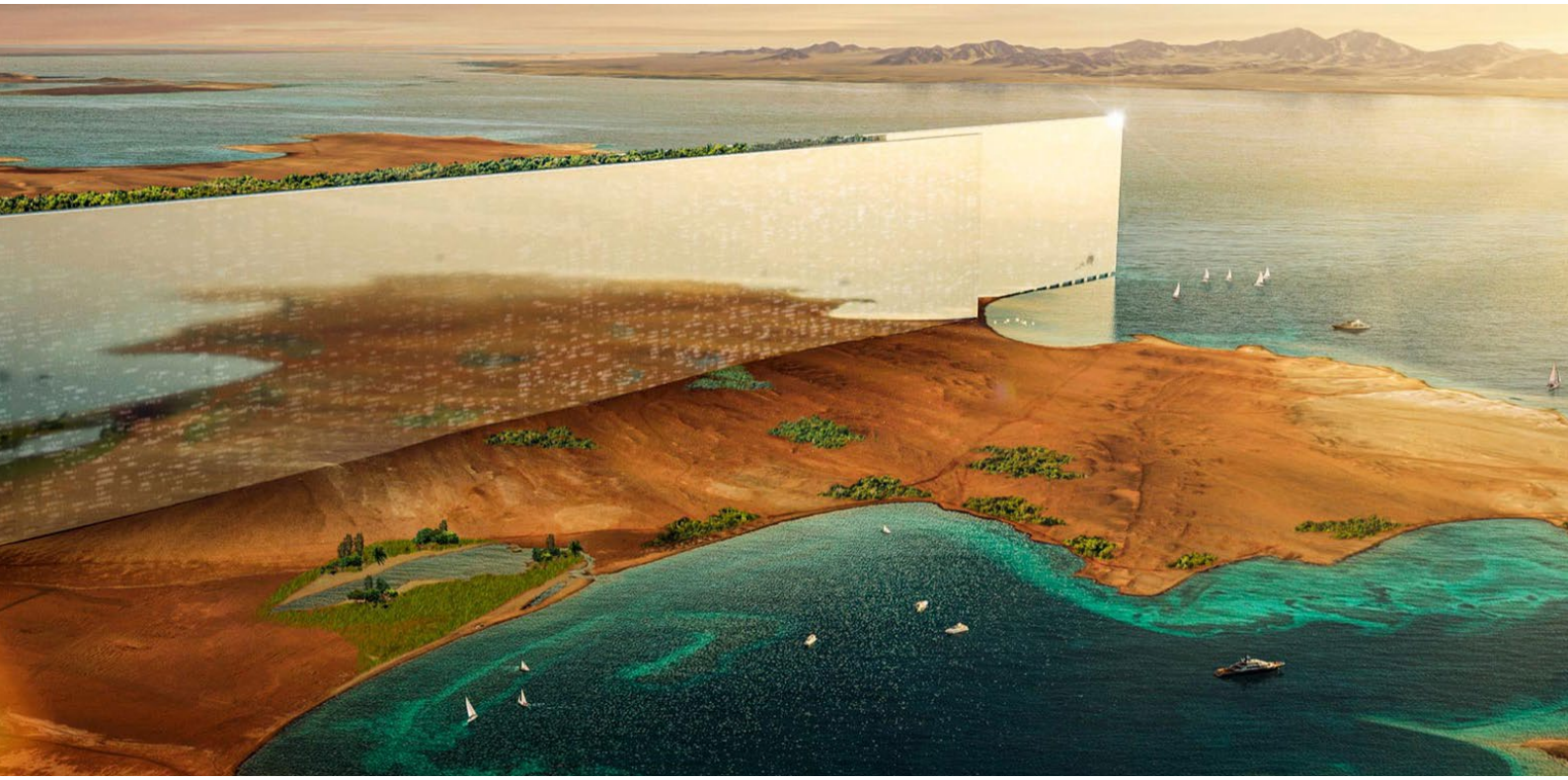
Announced projects in Saudi Arabia, the UAE and Oman alone are set to produce 3mn t/yr of hydrogen in the 2030s, with Oman's 14-GW Al Wusta and Saudi's 4-GW NEOM projects among the world's most ambitious to date.

The world's biggest price reporting agency, S&P Global Platts, recently launched new low-carbon hydrogen assessments in the Middle East as the region strives to become a major exporter. Initial prices revealed the region is currently one of the cheapest producers of renewable hydrogen worldwide – second to Australia in the potential markets assessed by Platts.

Other areas of progress this year include the creation of the Abu Dhabi Hydrogen Alliance by ADNOC, Mubadala and ADQ, which aims to spur the Emirate's leading role in hydrogen opportunities.

ADNOC plans to expand its carbon capture, utilisation and storage (CCUS) capacity sixfold to 5mn mt of CO_2 captured by 20305 and Saudi Aramco is planning to use its $110bn Jafurah gas field for blue hydrogen production.

Meanwhile, Oman's OQ and its partners will produce 25GW of renewable solar and wind energy to generate millions of tonnes of green hydrogen per year.



Head-to-head

Regional competition between energy and economic leaders – Saudi Arabia and the UAE – can accelerate the development of clean hydrogen and subsequently, help drive decarbonisation. OPEC's (Organisation of the Petroleum Exporting Countries) biggest and third-biggest producers, respectively, are charging ahead to capture the largest share in a relatively unexplored green energy market speaks volumes about clean hydrogen's appeal.

Of course, this cannot dim the value of regional and international partnerships. Such alliances are vital to boost financiers' confidence amid new territory. This is especially true as countries in the Middle East are currently developing formal hydrogen roadmaps; tools that help garner investors' appetite in other regions, such as Europe.

Looking ahead, more regulatory clarity, financial guarantees and knowledge-sharing on technical and safety guidance will pay significant environmental, commercial and reputational dividends, capture the largest share in a relatively unexplored green energy market speaks volumes about clean hydrogen's entire CO_2 footprint of low-carbon hydrogen production: not just the final product, but the whole supply chain.

Carbon pricing: The time is now

Putting a price on carbon is not a simple endeavour, but it is an essential one. Decades of start-stop efforts must evolve into clear carbon pricing policy to provide

energy stakeholders and investors with much needed visibility.

The world's 65 carbon pricing initiatives covered 11.65 $GtCO_2e$ of global GHG emissions in 2021 – 21.5% of the total. While this is far more than the two carbon pricing initiatives tracked in 1990, it is still a long way from being a key engine of global decarbonisation. This is true in the Middle East, which, at this time, has no carbon pricing mechanisms. Still, there are small signs that the tide is changing. Saudi Arabia, the world's top oil exporter, plans to launch a trading platform for carbon offsets and credits produced in the Middle East and North Africa (MENA) region. However, it remains unclear when it will be launched.

To the East, Oman has signalled plans to develop a tradable "energy efficiency" credit based on the international carbon credit market.

Other progress includes S&P Global Platts' launch of the first ever daily carbon offset premiums alongside monthly carbon intensity (CI) calculations for 14 major crude fields around the world. The marginal CI calculations for different oil fields will help producers, investors, shareholders and downstream purchasers better understand the emissions associated with the production of the crude oil. Over time, the CI of the production process can become its own attribute of the crude oil itself, like the density and how much sulphur is included.

While not a carbon price, it does help increase economic environmental visibility of fossil fuel operations in the Middle East, giving energy stakeholders a better idea of where they need to address their CO_2 footprints. Further clarity on the details of Article 6 (carbon pricing) during COP26 also showed a meaningful step in the right direction.

Realistic expectations

Putting a global price on carbon, essentially a "Brent for carbon", is far too complex a task for now, considering the business, socio-economic and environmental differences between regions.

Cross-border communication, supply chains and trading mechanisms between the world's 195 sovereign nations are far too complicated to have a 'one mechanism suits all' approach. However, finding common cornerstones to form global fundamentals in carbon pricing that can support countries' decarbonisation efforts is a feasible goal for the 2020s and 2030s.

For now, creating a regional carbon framework within the next few years is a realistic objective for the Middle East to pursue. Today's absence of carbon pricing signals in the region acts as an environmental and economic inhibitor, which stops countries from reaching their full potential.

The EU's Emissions Trading Scheme (ETS), the world's oldest, established in 2005 – has reported several new record highs this year, peaking at €66/t during COP26 in mid-November. This was a welcomed sign for the energy stakeholders, who believe the €100/t-plus range indicates a healthier carbon market that will help realise net-zero goals. Carbon prices are also climbing in countries like Canada, Germany and Ireland. These stepping-stones provide a useful template for the Middle East, who can start to build their own carbon pricing strategy in the next few years, or at least offer more insight into how countries across the region expect to proceed in the long-term.

Talent and culture: Keeping pace

As the energy landscape evolves, so must the minds that power it. As a leader in oil, the world's most commercialised commodity market, the Middle East region has deep-rooted technical expertise when it comes to maximising energy resources. The value of national and imported talent cannot be underestimated, but the talent pool and mindset must also evolve.

When asked about the main reasons for the ongoing skills shortage in the energy industry, 56% of recruiters said the biggest challenge they face is an aging workforce and lack of skilled staff. Meanwhile, 40% felt the biggest driver of the skills shortage is insufficient education and training. So why the disconnect? In short, the surging renewables sector (there are now 12mn jobs in the global renewable energy market), plus the rapid growth of digitalisation. Both areas are advancing faster than the available training and education. This means energy stakeholders not only need to address their decade-long talent squeeze, but they must also deal with the additional demand for talent with skills in sustainability and digitalisation. This is a difficult challenge for industry – and there are no simple fixes.

For the first time ever, the momentum to craft a more global carbon pricing ecosystem is gaining pace.

Diversification of the Middle East's energy job market, and the cultural push for low-carbon growth, cannot lead to an increasing shortage of talent for oil and gas. Both will remain critical in coming decades, with the region representing up to 45% of the world's total oil production in 2050. Inevitably, amid talk of peak oil and the growing attractiveness of careers in green energy, the oil and gas community in the Middle East is having to work harder to harness talent.

Highlighting the region's environmental and digital credentials, both of which remain strong, is one way the oil and gas community can enhance their global reputation as appealing employers, particularly to attract younger generations looking at careers in STEM (Science, Technology, Engineering and Mathematics).

Mastering the tightrope

The region's vast potential of "soft" power is clear: 66% of the population in the MENA region is under the age of Mastering the tightrope. There is also a very high level of digital awareness (for example, digital penetration reaches 99% in the UAE). This pool of potential talent – often referred to as "the champions of tomorrow" – is increasingly underpinned by a growing educational focus on critical and creative thinking (often considered under the umbrella of adaptable intelligence [AQ]) and digitalisation.

This dynamic offers an exciting proposition for the Middle East's energy market, but there is a flip side if it is not smartly managed. The MENA region is the only area in the world where the risks of unemployment rise as levels of education increase. To steer away from this trend, the energy industry can help channel this vast natural resource towards a constructive future by making the industry more enticing to work in, benefitting both energy and social security. This presents an opportunity for NOCs, social and commercial champions, and for international oil companies (IOCs) looking to bolster their Environment, Social and Governance (ESG) credentials in international operations. It is also key to stopping the resource gap in a region as a high level of imported talent relocate to their home countries during the pandemic.

Ibri II Solar

Digitalisation:
Becoming future ready, now

Strengthening digital awareness, from the classroom to the boardroom, is vital in helping the Middle East efficiently leverage its natural resources. A data-led approach to boost transparency, accuracy and pinpoint even opaque operational trends that support decarbonisation is now a "must have" of boardroom agendas.

Digitalisation, as per the 4th Industrial Revolution, is an important ally for energy stakeholders' who are looking to cut CO_2 emissions, sustain energy security, explore new markets, all while being commercially robust and socially responsible. Adopting digital tools allows energy companies to realise value from low hanging fruit at a far greater speed – an advantage that must also be utilised to hasten decarbonisation. The industry does not have "ten years to scale up an idea before moving forward," described one roundtable participant. Implementing technologies such as sensors to support predictive analytics and create digital twins, help operators to mitigate risk, increase asset productivity, and enhance their reliability and performance.

Decarbonising existing operations is typically more challenging than integrating digital solutions into new-build infrastructure. Not only does digitising existing infrastructure play a meaningful role in reducing the industry's existing

CO_2 footprint, but it also improves profitability. Overall, this makes assets more commercially valuable and in turn, reduces the risk of stranded assets (estimated at $1trn in the effort to reach Paris Agreement goals1). This translates into less material waste and more efficient use of talent. Other more substantial digital initiatives could include data management centres for processing, storing and analysing information from power systems. This could also be valuable amid the rise of decentralisation.

The Gulf Cooperation Council's (GCC) total distributed energy market is expected to generate $602mn in revenue by December 2021, rising by 25% on 2020. This includes solar PV, distributed wind power, hybrid systems, diesel gensets and gas gensets. This shift is expected to intensify during the 2020s, triggering a rethink in financing structures, transmission and distribution (T&D) methods and real-time supply and demand monitoring. For those involved, digital aids will be critical to ensuring energy security is sustained via streamlined and transparent channels of communication.

Strategic plans are also needed to improve data storage methods. Failing to do so means lessons are lost and efforts must be repeated. Less than 2% of the unusually high growth of data created and replicated worldwide in 2020 was saved and retained into 20213 – a colossal loss of intel. Energy stakeholders must take note and integrate smart storage into their digital roadmaps.

Whichever route energy stakeholders take, strategies should centre around product data management (PDM) that boosts safety, operational visibility and energy efficiency. Such a data-led approach applies to all aspects of sustainability, not just energy markets. From carbon targets and community investment, to inclusion and diversity and ethical partnerships – these too are building blocks in the Middle East's drive towards decarbonisation. In this vein, capital allocation must be discussed with a long-term view; the depth of the industry's upheaval cannot sustain a "dive-in-and-out" financing approach

Solar robot project - Shams Ibri

LET'S TALK

Energy stakeholders' knowledge is certainly evolving, with more asking technology providers: what is your toolbox, how can it help us fulfill our resource potential and decarbonisation goals, and what do you need from us? Similar questions are being asked within partnerships, which are becoming a coveted differentiator in the highly competitive industry.

One emerging risk is that some energy stakeholders expect a one-stop digital shop that can be bought "off the shelf" to drive low-carbon growth with immediate benefits. The reality is that there is great value in constructive back-and-forth conversations in energy-tech alliances. These helps both parties pin down nuances in the digital offering, making sure the solution fits the exact needs of the energy company. Such tailoring will only become more valued as digitalisation becomes increasingly embedded in companies' competitive edge.

This Blue Paper highlights and explores the key takeaways made by high-level energy executives at a roundtable hosted by Wood in Abu Dhabi. Leaders across national oil companies (NOCs), international energy companies and their partners openly discussed the critical question: How can the Middle East leverage its natural resources to spur global decarbonisation?' This White Paper has been written and produced by Gulf Intelligence.

Climate Resilience for Energy Transition in Oman

Further policy measures will be essential to achieve climate-resilient energy transitions in Oman, says the International Energy Agency (IEA) in a new report.

CLIMATE HAZARD ASSESSMENT

Temperature

Oman is characterised by a hot and arid climate. In the period 1980-2013 Oman experienced a mean temperature increase of around 0.4°C per decade. This increase has resulted in a current average annual temperature of between 12°C and 18°C in the country's mountainous region and around 26°C in most of Oman's territory, reaching 28°C along the northeast coastline. Although the rate of temperature increase slowed during 2011-2020 to around 0.14°C per decade (partly due to a comparatively cooler summer in 2013 and colder winter in 2014), it maintained its upward trend and lifted the average temperature to 27.8°C. With the rising mean temperature, heatwaves are becoming more intense in Oman. In recent years the country has experienced significant heatwaves. In June 2018 the minimum temperature did not drop below 41.9°C for 24 hours in the coastal city of Quriyat (60 km east of Oman's capital, Muscat). In June 2021 a heatwave continued for almost a month in some locations, reaching the country's highest recorded temperatures at over 50°C.

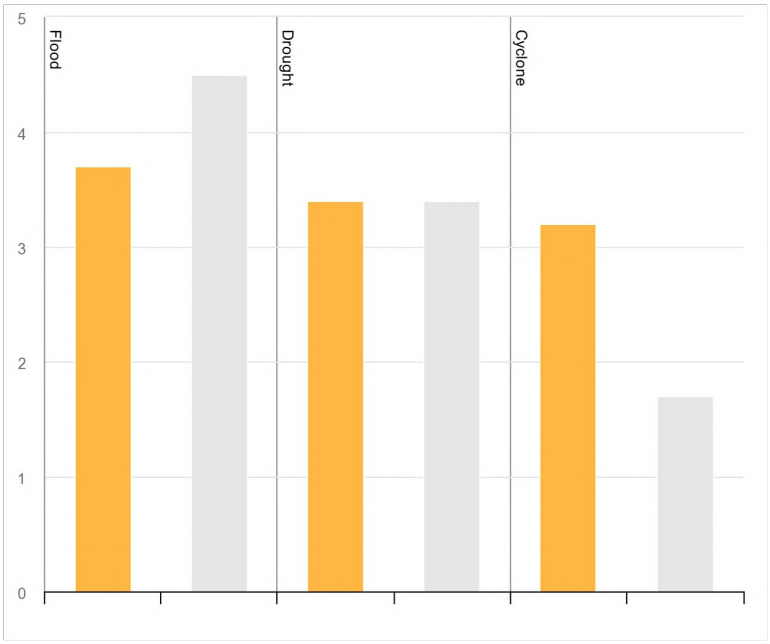
Climate projections indicate that Oman will experience higher temperatures in the coming decades, with more frequent heatwaves. Under a high-emissions scenario, the mean annual temperature is projected to rise by about 5°C on average from 1990 to 2100, and the number of days experiencing a warm spell (heatwave)2 is projected to increase from fewer than 15 in 1990 to about 280 days on average in 2100. Under a low-emissions scenario, the mean temperature rise could be limited to about 1.5°C and the number of days of heatwave to about 85 on average in 2100.

Increasing mean temperatures and the growing number of days with high maximum temperatures in Oman have resulted in the number of cooling degree days (CDD) rising rapidly, by an average of 6.7% per year, over the past two decades, while the number of

heating degree days (HDD) has remained very low since 2000. This is triggering a notable increase in peak electricity demand, which is closely related to the intensive use of air conditioning during summer (May-July). Peak electricity demand increased from 6 060 MW in 2015 to 7 081 MW in 2021, an average annual growth rate of about 3%, and it is projected to continue rising at around 4% per year until 2027. The planned increase in the installed capacity of solar and wind power plants and improvements in the energy efficiency of air conditioners and government buildings will help Oman respond to the rising peak demand in summer.

The projected rise in temperatures and more frequent and intense heatwaves could have negative impacts on gas-fired power plants, which accounted for 97% of electricity generation in Oman as of 2020. The performance of natural gas combined-cycle power plants depends on the air mass flow entering the gas turbine compressor, which is affected by air density and ambient temperature. A continuous increase in ambient temperature may reduce the electricity generation capacity of those power plants unless additional cooling technologies are added.

Climate projections show that around three-quarters of existing gas-fired power plants in Oman are likely to be exposed to over 2°C of warming in a low-emissions scenario (Below 2°C) and over 5°C in a high-emissions scenario (Above 4°C) during 2080-2100, compared with the pre-industrial period. If GHG emissions are not mitigated, over 80% of Oman's gas-fired power plants could experience at least 60 more days with a maximum temperature above 35°C. This share is almost double the world average, given that less than 40% of gas-fired power plants globally are projected to see the same level of increase.



Level of floods, droughts and tropical cyclones in Oman, 2000-2020

Precipitation

Low rainfall, combined with limited natural freshwater resources, has made Oman one of the most water-stressed countries in the world. Oman has less than 1 000 m3 of freshwater per capita per year, which is significantly less than the world average of around 5 500 m3. In recent decades the amount of annual rainfall has decreased, adding more stress to freshwater availability. In 2022 rainfall fell to an annual average of just 76.44 mm, one-sixteenth of the global average. It made Oman the country with the tenth lowest average rainfall in the world that year.

Future impacts of climate change may aggravate freshwater availability in Oman. Although there could be a slight increase of about 10 mm per year around the middle of the 21st century under a low-emissions scenario, a high-emissions scenario projects a decrease in annual average rainfall in most areas of up to 20 mm per year by 2061-2080. In addition, climate projections show that the year-to-year variability in rainfall patterns is likely to increase.

Diminishing precipitation in the long term could lead to an increase in energy demand. To cope with the reduction in rain-fed water sources and the decline in groundwater recharge, Oman has expanded water supply from desalination plants. Water supply from these sources grew significantly from 146 million m3 in 2010 to 315 million m3 in 2018.

Currently nearly 100 desalination plants are operational in Oman, and desalinated sea water and brackish water account for 15% of its annual water supply and over 80% of its potable water supply. Given that desalination is more energy-intensive than traditional water supply options, requiring up to almost 100 kWh per m3 of water, greater reliance on desalinated water could add strains to the energy sector unless there are significant improvements in energy efficiency.

Despite the overall decrease in annual mean precipitation, Oman is also experiencing more frequent flooding. In May 2020 heavy rainfall damaged energy infrastructure and disrupted the power supply in Salalah. Again, in May 2021 torrential rainfall caused flooding and prompted power cuts for several hours in certain towns in the Al Dakhliya and Al Batinah regions.

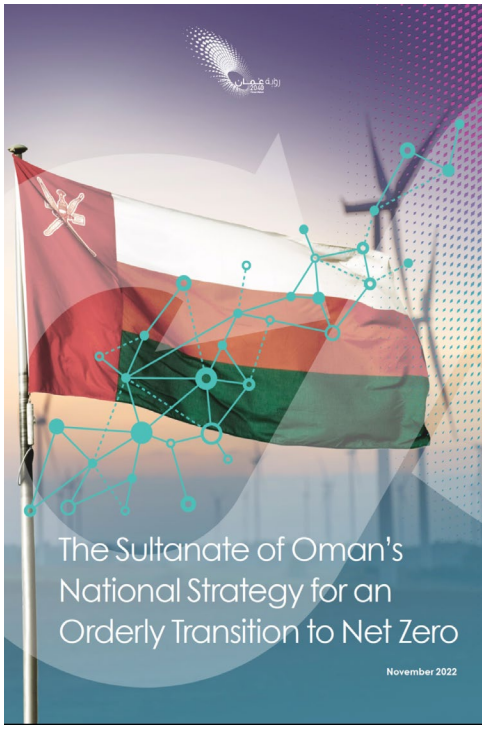
The increased frequency of heavy rainfall with a risk of flash flooding may affect gas-fired power plants. Although they are generally equipped with flood protection structures that work in most cases, severe floods could prompt disruption, including pre-emptive shutdown. Climate projections show that almost all gas-fired power plants in Oman will see an increase of more than 10% in one-day maximum precipitation during 2080-2100, even in a low-emissions scenario (Below 2°C). If emissions are not mitigated (Above 4°C), all plants could see an increase of over 40% in one-day maximum precipitation. The level of the increase is particularly notable given that only around 10% of gas-fired power plants around the world would experience an increase of over 40% in one-day maximum precipitation under the same scenario. Therefore, resilience measures against intense rainfall events and flash floods would become more important for the operation and maintenance of gas-fired power plants in Oman.

Sea level rise

Low-lying coastal areas are vulnerable to sea level rise. This could trigger saltwater intrusion and lead to a decrease in freshwater availability in coastal areas, where the majority of irrigated land (56%) is located. Indeed, by the middle of the 21st century 64% of cultivated land in the southern Al Batinah region will be unfit for groundwater irrigation owing to seawater intrusion into the Jamma aquifer from sea level rise. This could increase demand for desalination, which is generally more energy-intensive than other water supply options.

Tropical cyclones

Tropical cyclones and storms from the northern Indian Ocean and the Arabian Sea have increased in frequency and intensity. These storms usually occur during the pre-monsoon period in May and June, and during the post-monsoon period in October and November. In recent years, the areas at risk have increased almost tenfold in the Muscat area, while Al Wusta is expected to be the region most vulnerable to tropical cyclones in the future.



Cyclone Shaheen inundated large swathes of coastal Batinah in October 2021

The increase in tropical cyclones and storms in Oman could become a concern for the resilience of energy supply infrastructure. In 2021 tropical cyclone Shaheen hit Oman's northern coast, prompting floods and landslides. It damaged electricity substations, poles and transmission and distribution lines and caused power cuts to around 120 000 customers in the governorates of Muscat and Al Batinah. Restoration of electricity services took up to 192 hours in South Al Batinah and 384 hours in North Al Batinah. In addition, oil and LNG shipping was also suspended at several ports, including Port Sultan Qaboos, A'Suwaiq and Shinas, owing to tropical cyclone Shaheen. The government activated its Emergency Response Plan to prevent interruptions to oil and LNG supply.

Oman has directed its efforts to address climate change through diverse public policies, with an emphasis on clean energy transitions. One of the main policies that sets out the future path is the Oman Vision

2040. It focuses on four objectives: a society of creative individuals; a competitive economy; responsible state agencies; and an environment with sustainable components. Under the fourth pillar, it establishes a vision of a gradual transition to a low-carbon economy, putting the development of renewable energy sources and energy efficiency actions at the centre of its commitments. It sets a target of renewable energy consumption from 0% in 2015 to 20% by 2030 and 35-39% by 2040. Oman's National Energy Strategy, published in 2020, shows a more concrete plan for energy transitions, with a target of 20% renewables in total electricity generation and 63% efficiency at gas-fired plants by 2027 (from 55% in 2020).

This is further developed into Oman's National Strategy for an Orderly Transition to Net Zero, which aims to reach net zero by 2050 based on five principles: environmental sustainability; minimised energy system costs; optimisation of economic impacts; social implications; and security of supply. Electrification, energy efficiency improvement, transition to EVs and the deployment of renewable power generation are identified as key priority levers.

The planned increase in the share of renewables in power generation (from 0% in 2015 to 20% by 2030 and 35-39% by 2040) would require more attention being given to climate impacts, since renewables tend to be more sensitive to climate and weather conditions than gas-fired power plants. Solar PV generation relies on irradiance, which is determined by climate factors such as season, weather, clouds, water vapour, fires, temperature and daylight hours, while wind power plants are largely affected by wind speed and temperature. The projected increase in temperature and heatwaves could decrease the generation efficiency of solar PV and wind power plants. Increasing frequency of tropical cyclones may lead to physical damage to solar PV and wind turbines, and automatic shutdown of wind power plants. Climate risk and impact assessments from the early stage of project planning, and the adoption of more resilient technologies and designs, will help renewable energy penetration to be resilient and to maximise its contribution to energy security and adaptation.

As a country with high levels of vulnerability to several consequences of climate change, Oman has made notable progress in climate change adaptation and resilience. Oman approved its National Strategy for Adaptation and Mitigation to Climate Change in April 2019, focusing its vision on three themes, one of which is climate adaptation. Within this theme, Oman has identified five key vulnerable sectors to focus on: water resources; marine biodiversity; agriculture and fisheries; urban areas; and tourism, infrastructure and public health. Although the energy sector is not explicitly addressed through this, it is covered within the urban areas and infrastructure sector, which considers the impacts of flooding on infrastructure in urban areas, including electricity supply.

Advancing the National Strategy for Adaptation and Mitigation to Climate Change, Oman developed a National Spatial Strategy 2020-2040 to anticipate the impact of climate change on urban areas and infrastructure, and to incorporate adaptation and mitigation measures into new developments to ensure adequate response to climate change. The strategy foresees a national framework to guide Oman's sustainable development and facilitate the implementation of the Oman Vision 2040. It includes seven categories, the seventh pillar being about building an efficient infrastructure system and making sustainable use of resources for the energy transition to achieve sustainable and resilient growth. Using this approach, Oman aims to identify its needs for renewable energy (solar plants and onshore and offshore wind farms), energy storage and electricity transmission, while improving the stability and flexibility of its energy supply.

Reflecting the increasing importance of climate change adaptation to better manage climate risks, Oman assessed the barriers to and gaps in its adaptation objectives in its second nationally determined contribution in 2021. The barriers and gaps include

limitations on the data, information and knowledge available to address vulnerability; limited experience with methods and tools to support climate risk-informed decision-making in the critical sectors; insufficient national budgets to address the scope and magnitude of climate change impacts effectively; and insufficient national regulatory frameworks in place to support effective adaptation planning.

To address the gaps, Oman has been preparing its National Adaptation Plan (NAP). This aims to integrate adaptation into the country's development planning for low-carbon and climate-resilient development priorities, projects and transition pathways. It will identify the medium- and long-term climate adaptation needs, strategies and programmes that need to be developed and implemented. The development of Oman's NAP is still in progress, with support from international organisations, including the Green Climate Fund's report, Enhancing the national adaptation plan process for the Sultanate of Oman, published in late December 2022.

In addition to the establishment of the NAP, further policy measures could also enhance the climate resilience of the energy sector in Oman. Measures to improve the dissemination of climate data and to develop useful tools for climate risk and impact assessment in the energy sector can be the first step. Despite notable progress in climate data and projections in recent decades, energy suppliers and consumers continue to have difficulty using them in their planning, due to the limited accessibility of downscaled data. Even when energy suppliers and consumers have access to such information, it remains challenging to link the complex probabilistic information to industry-specific applications. Government support to enhance access to more accurate climate information and data translation (e.g. providing assessment tools and capacity building programmes) would help address the knowledge gap.

Government efforts to bring climate resilience considerations into the core of decision-making on energy projects,

by integrating them into guidelines, regulations and project approval processes, could catalyse action on resilience. For instance, the government can recommend or mandate that energy project developers: assess climate risks and impacts from the early stage of project planning; adopt more resilient technologies (e.g. adopt dry or hybrid cooling technologies for gas power plants in areas of water scarcity; use more energy-efficient technologies for desalination); and enhance the resilience of power plants and grids in the face of the physical impacts of climate-related disasters (e.g. stronger flood protection measures in flood-prone areas).

The government's continuing efforts to diversify Oman's range of energy technologies by increasing renewable energy penetration can also significantly enhance climate resilience. A diversified energy system tends to cope better with climate-related shocks than a system that is heavily reliant on a single energy technology. For instance, the penetration of wind and solar generators, which generally have low water requirements, can make a power system more resilient against droughts than a system dominated by traditional thermal power plants. Such resilience measures led by the government can facilitate action by energy suppliers and consumers, sending strong signals to investors ■

‘Pioneering The Production Of Clean Fuel From Waste’

Wakud was a decade in the making! Maher and I met over 10 years ago and we came together when we found out what was happening with the waste cooking oil here in Oman. Unfortunately, it was being dumped in the desert and destroying nature in the process, but sometimes it was reused in restaurants resulting in carcinogens and thus bad for human health.

Maher and I felt that we had to tackle this important challenge. We started with recycling the waste cooking oil and sending it to Europe to be converted into biodiesel. But as the years went on, we decided that we wanted to take the next step by creating a biofuels ecosystem and keeping the value within the Sultanate of Oman. this is how we came up with the concept of WAKUD to refine and recycle the waste cooking oil here in Oman, so that the nation benefits not only financially and economically, but also in creating jobs, attracting expertise, and supporting decarbonization,making sure that this clean fuel is used in-country.

We started construction of the plant in 2020, and from start to finish, the construction took eight months, right at the height of COVID when it was very difficult to get things done. It was challenging, but somehow we managed to pull this off in less than a year.

I still remember the first batch of biofuel that came out of the factory in 2021. Until today we have some of it bottled and we’ve kept it here in the office as a demonstration of what time, patience and perseverance can lead to.

Talal Hasan
Wakud Co-Founder

“There’s no single silver bullet when it comes to decarbonization. Yet biodiesel provides a solution, its ease of use and the fact it can be blended with standard diesel makes it a good option for existing diesel engines

Driving the future with Oman's greenest fuel

Omani circular economy start-up Wakud is emblematic of a project that exemplifies Oman's Nationally Determined Contributions under the Paris Agreement

The mood at Wakud has been decidedly upbeat in recent months. Indeed, during a recent visit to Wakud's state-of-the-art plant at Khazaen Economic City on the outskirts of Muscat, Energy Oman found the company's Omani staff in buoyant spirits, far removed from the persistent challenges that the start-up has faced from the outset in 2020 by introducing a new sector to the Sultanate.

For CEO Maher bin Mohammed Al Habsi, a feisty entrepreneur and pioneer in waste oil recycling and reuse, recent events have been transformative for the beleaguered company. X2E, a Muscat-based investor with a shared passion for the circular economy and the energy transition, recently acquired a sizable stake in Wakud. But in addition to bringing in generous funding support, X2E has also pledged to make available a slew of leading-edge technological solutions and innovations with the potential to position Wakud on a strong growth trajectory. At the same time, X2E left the incumbent leadership team intact in a tacit recognition of founder Maher's caliber and commitment to the growth of this fledgling industry

"We have never felt this excited and energetic in a long time," said Maher exultantly. "As we speak, we are embarking on a phase of growth that will take us beyond Oman's borders and into the wider Gulf region and potentially even further. At the same time, we will be tapping new waste streams and resources as feedstock, creating in the process a wider national ecosystem that will support the growth of Omani-owned SMEs to help with the collection and supply of the feedstock. The potential for employment generation and livelihood sustenance is significant, in addition to the enormous benefits accruing to the environment and Oman's Net Zero goals."

Maher Al Habsi
Co-founder and CEO

> *We are proud to support Oman. Wakud's clean fuel is supporting local companies to decarbonize, and all while creating a new value chain and jobs for Omanis. Keeping value in the Sultanate, it's a win*

Modest beginnings

When he first went public – three years ago - with his plans to set up Oman's first biodiesel plant in partnership with the well-known climate-tech entrepreneur Talal Hasan, Maher was making local history of sorts. It marked the first time that locally produced Used Cooking Oil (UCO) was to be processed into commercially valuable and environmental-friendly biodiesel in Oman.

A passionate recycler for the entirety of his professional life, Maher began collecting waste oil in 2005. He recalls: "It was a pretty small market then; recoverable quantities were very modest, but we began with a collection facility in Muscat and later branched out to Salalah. As volumes grew, we shipped them initially to India and Pakistan, until we discovered that the European market, with its strict environmental laws, offered a premium for biodiesel from waste oil and other sources."

Just as Maher and Talal began work on their dream project, the pandemic hit. But the duo pressed ahead doggedly with the construction of the project at Barka, undeterred by the global lockdowns that hampered the movement of plant equipment and expert personnel to the factory site. Incredibly, and despite the odds, it was completed in eight months – a testament to the founding team's resolve to get their landmark venture off the ground.

The underlying objective is multifold, says Maher. "For one, we saw the potential to convert a waste stream into an environmentally-friendly fuel and thereby earn carbon credits from the project. Another goal was to put in place a sound system for the collection of used cooking oil from hotels, restaurants and other generators, instead of this waste often ending up in the drainage

X2E co-founders Eyhab Al Haj and John Jones

Omani nationals account for the majority of the company's workforce

system or the garbage dump, potentially contributing to health and environmental hazards. In the process, restaurants were also encouraged to stop reusing their cook ing oil to the detriment of their patrons. Multiple reuse of cooking oil can be can cerous for consumers of that food. That was the initial spark behind our project: Let's clean-up our country of UCO by recycling it and slowly journey onward towards other decarbonization goals."

Circular economy

Over the three years since it was launched, Wakud has spawned an ecosystem of Omani SMEs that are assisting in the collection of UCO from local generators – hotels, restau rants and catering companies. So far, seven SMEs are in the collection business, incen tivized by reasonably attractive margins, as well as Wakud's technical assistance in managing what is essentially a messy busi ness. The longer term goal, says Maher, is to support the establishment of a nationwide network of around 50 Omani SMEs covering every major city in the country.

Boding well for recyclers like Wakud are new laws that restrict the export of waste commodities that can be reprocessing into higher value products in support of the growth of a circular economy in Oman. That list includes used lead acid batteries, lead moulds, end-of-life tyres, all types of used oil (industrial, car lubricants, cooking oil, etc.), electronic waste, scrap cans, alumin ium, scrap metals, all types of plastic and paper waste, in addition to cardboards. The measure has since unlocked investment opportunities for mainly SMEs eager to tap into this nascent market.

But to Wakud's misfortune however, sig nificant quantities of waste cooking oil that should have been retained in-country under these regulations, continue to be siphoned out by a handful of bad players, ostensibly by deliberately misdeclaring it as anything but UCO. This leakage is stymieing the efforts of domestic recyclers like Wakud towards achieving the economies of scale necessary to be commercially viable. By offering a higher margin to the waste generators, these shady operators manage to steer sizable volumes of UCO away from the local market and divert them to overseas recyclers. For legitimate recyclers like Wakud, which are vested in the operation of a bio-refinery to world-class standards, the project's econom ics preclude the payment of a premium on waste oil as feedstock.

Nevertheless, with Omani SMEs com ing into the picture as collectors, there is optimism that the regulatory authorities are rapidly upping their game to detect and

crackdown on unauthorized outflows of recyclable waste. Moreover, with the Omani government actively championing the growth of a circular economy around waste, commercially promising waste streams, including UCO, will be covered by better reg- ulatory safeguards designed to ensure they are processed in-country.

Green fuel

Wakud's longer-term goal is to produce enough biodiesel to sustain the operation of a network of fuel stations dispensing a blend of the green fuel and conventional diesel. In Europe, for example, filling sta tions are mandated to dispense a B7 blend (%7 biodiesel blended with %93 diesel). In Oman, however, Wakud aims to start with a B5 blend given the challenges of producing adequate quantities of biodiesel to supply the market.

But with UCO-based feedstock barely enough to cover the bio-refinery's cur- rent capacity of 20,000 tonnes per annum, Wakud is now exploring the feasibility of tapping other types of biomass and biowaste in the production of biodiesel.

"We are working to diversify our feedstock requirements by targeting, for example, fish waste, date seeds and Jetropha seeds, as well as the cultivation of a species of grass that can be harvested for its oil content. In sup port of this strategy, we have signed up with Sultan Qaboos University and the German University of Technology (GUtech) to study the potential for a mix of feedstocks." Wakud's bio-refinery at Khazaen Econom ic City is state-of-the-art, with the main plant machinery coming from UK-based Green Fuels, the world's leading provider of biodiesel equipment, and a partner in the Oman project.

An onsite lab run by Omanis helps ensure that the waste oil is suitable for processing at the plant. A sample is tested for its free fatty acid (FFA) content and water, among other ingredients. Once it meets the min imum specs, the consignment is brought to the factory where it is left to stand for a couple of days for any water to separate out. The waste oil is then heated to about 65 deg C to separate out its glycerin content a commercially valuable by-product. The remaining feedstock is blended with some quantities of methanol and other chemicals before it is processed into European-stan dard biodiesel.

But in a market awash with relatively cheap conventional diesel, finding corporate buyers – Oil & Gas companies, fleet opera tors, transport and logistics firms, etc – to patronize Wakud's green fuel has not been easy. With few local offtakers for its environ ment-friendly product, Wakud has had little choice but to export the bulk of its output to Europe.

Green fuel marketing agreement reached with Oman Oil Marketing Company

According to Maher, corporate hesitation towards the uptake of Wakud's indigenously produced biodiesel is driven by two factors: (i) Price, which will be rectified once the local recycling regulations taxing the export of UCO is enforced, and (i) Concerns around engine compatibility which are due to misunderstandings of how biofuels work and more more education is required.

"As raw material costs are quite high, the only recourse is for the government to intervene and ensure we can access feedstocks at reasonable prices. In fact, we are currently in discussion with authorities on this issue."

Promising outlook

In recent months, however, Wakud has made some headway in introducing its bio diesel to the local market, notably through a partnership with leading fuel marketing company Oman Oil Marketing (part of OQ Group). At the same time, a number of leading energy companies and oilfield contractors have begun trialling the use of biodiesel to operate their fleets and heavy machinery. Among the companies that have signed contracts with Wakud are: ARA Petroleum, BP, Alshawamikh Petroleum, OARC Sohar, Sohar Port, Nakheel Oman, Schlumberger, Masirah International Marine and 44.01.

State- owned public transport company Mwasalat has also operated a few routes using a blend of biodiesel.

Wakud is also banking on the government to level the playing field for biodiesel producers who find themselves competing with state-subsidized diesel. As a sustainable, low-carbon alternative to emission-intensive fossil-fuel based diesel, biodiesel should instead benefit from subsidy, and not the other way around, Maher argues.

Discussions with Oman's authorities, particularly the Ministry of Transport, Communications and Informational Technology, are set to finally pay off, according to the entrepreneur. Following the successful trial operation of a handful of buses on a B20 blend of biodiesel, the Ministry recently announced that the uptake of locally produced biodiesel by state-owned buses will be ramped up over the next seven years through to 2030. Other government ministries, including the Ministry of Commerce, Industry and Investment Promotion and the Environment Authority are expected to announce measures advocating the use of greener fuels as part of their energy transition strategies.

Wakud Site, 149, Khazaen Economic City Barka OM, 116, Oman

Wakud, the first biodiesel plant run by solar power

In-Country Value

As the only biodiesel refinery utilizes locally produced waste resources, Wakud also exemplifies value creation in-country, says Maher. "Beyond the environmental benefits, Wakud's value proposition is based in ICV. This extends not only to the feedstock, but our staffing as well. Around 90% of our current workforce comprise Omanis. We have 22 engineers, who are all Omani, while our lab staff are nationals as well. And we creating jobs as well in the small scale sector by mentoring Omani SMEs to get involved in the UCO collection ecosystem. So far, seven such SMEs are in operation, but our goal is to reach a target of 50 SMEs by the end of 2024, potentially creating hundreds of new jobs."

But it is Omani environmental services start-up X2E, with its financial muscle, technological prowess and penchant for innovative, that is poised to take Wakud to the next level. Co-founded by Omani oilfield entrepreneur Eyhab Al Hajj and environmental technologies specialist John Jones, Muscat-headquartered X2E recently acquired a majority stake in Wakud with a commitment to driving its exponential growth.

X2E's investment has been greeted by Wakud as transformative. "Eyhab and John not only share Wakud's vision for a low-carbon future, but to achieve that vision by leveraging the right technologies cost-competitively and sustainably. Thus, in addition to the funding that they bring in, X2E will also give us access to technologies and innovations to drive our business growth. And to their credit as upright and broadminded investors, they have left undisturbed the management team at Wakud, demonstrating their confidence in the company's leadership."

As to its ambitions for growth, Wakud has plans to establish a network of biodiesel plants in various parts of Oman and potential in the wider Middle East region in the future. Also envisioned is an international-class laboratory – the first of its kind in Oman – to support the testing of waste commodities for biodiesel production. A local testing and certification lab will do away with the need for local players like Wakud to ship their samples to Europe at significant cost.

"We are excited about the future of our industry and see the potential for partnerships with universities, researchers and other stakeholders to help unlock value from waste. I'm also grateful that the regulatory authorities in Oman, as well as the stakeholder bodies, are extending all support to our initiatives, particularly in light of the contribution our activities will make to Oman's Net Zero goal," Maher added. .

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> **Up next from the Wakud pipeline: 'Wakud Max' - A world - class venture - slated for implementation in the Sultanate of Oman.**

Conrad Prabhu

Dr. Lamya joins Wakud board

Award-winning Omani scientist, TEDx motivational speaker, executive coach and luminary of the STEM ecosystem in the Arab region, Dr. Lamya Al Haj, has been appointed to the Board of Directors of Wakud. Well-known for her ground-break- ing research on biodiesel alternatives to oil, Dr. Lamya will leverage her unmatched technical expertise and innovative insights to drive Wakud's growth ambitions over the coming decades.

Holding a PhD in Structural and Molecular Biology from UCL and an MSc degree in Environmental Science and Technology from UNSW (Australia), Dr. Lamya is an as sociate professor at Sultan Qaboos University, and founder of the speakers' platform 'Jalasat Mulhimoon', which showcased inspiration role models to young Arabs in the region.

During an illustrious career as a researcher and motivational speaker, Dr. Lamya has delivered addresses, speeches, keynote talks and workshops at conferences and associations on science, technology, youth empowerment and leadership. The list of venues includes Harvard, IMD Middle East Alumni conferences and more recently the World Economic Forum in Davos. Recently, she was nominated to be part of the World Economic Forum - Young Global Leader Advisory group after being selected as a 'Young Global Leader' by WEF in 2020.

Dr. Lamya has been bestowed with numerous awards and citations throughout her academic career and professional life. In 2020, she was honoured by the First Lady of Oman, Her Majesty Sayyida Ahad Bint Abdallah Al Busaidi. Earlier, in 2018, she was presented with the prestigious L'Oréal UNESCO award for women in science (Middle East Fellowship Award and a member of The World Academy of Science - TWAS)


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World Energy Transition: Outlook For 2023

Current pledges and plans fall well short of the 1.5°C pathway

The recent Synthesis Report of the IPCC Sixth Assessment has delivered a sobering message – one that leaves little ambiguity as to the need for immediate action. This decade, our success in reducing greenhouse gas emissions will determine whether global temperature rise can be limited to 1.5°C or even 2°C. Within this timeframe, the only realistic option available is a considerable scale-up of renewable energy andefficiency solutions.

Francesco La Camera
Director-General – IRENA

The International Renewable Energy Agency's 1.5°C pathway positions electrification and efficiency as key transition drivers, enabled by renewable energy, clean hydrogen and sustainable biomass. This preview of the World Energy Transitions Outlook provides an overview of the progress achieved in developing and implementing these technological avenues. It shows that the scale and extent of the change achieved in all sectors to date fall far short of what is required to stay on the 1.5°C pathway.

Most of the progress so far has been made in the power sector, where advances in technology, policy and innovation have taken us a long way.

Current energy structures were designed to support fossil fuels and must be re-designed to support renewable energy systems. The emphasis must shift from supply to demand, toward overcoming the structural obstacles that impede progress. This preview outlines three priority pillars – physical infrastructure; policy and regulatory enablers; and a well-skilled workforce - that must be addressed simultaneously, requiring significant investment and a new paradigm for international co-operation in which all actors can engage in the transition and play an optimal role.

There is no time for a new energy system to evolve gradually over more than a century - as was the case for the fossil fuel-based system. We simply cannot continue with incremental changes if we are to achieve the necessary reductions in carbon emissions to meet climate goals. The Global Stocktake concluding at COP28 in the United Arab Emirates presents the opportunity to assess requirements and determine the best path to rapid, lasting change. To this end, the forthcoming World Energy Transitions Outlook will provide a comprehensive assessment of the energy transition and propose effective ways to accelerate progress following this important climate action milestone.

> **We simply cannot continue with incremental changes if we are to achieve the necessary reductions in carbon emissions to meet climate goals, warns Francesco La Camera**
>
> **Director General - IRENA,**
> In a foreword on the outlook for the global energy transition in 2023

KEY MESSAGES

The energy transition is off-track.

The aftermath of the COVID-19pandemic and the ripple effects of the Ukraine crisis have further compounded the challenges facing the transition. The stakes could not be higher - every fraction of a degree in global temperature change can trigger significant and far-reaching consequences on natural systems, human societies and economies. Achieving the necessary course correction in the energy transition will require bold, transformative measures that reflect the urgency of the present situation.

Current pledges and plans fall well short of IRENA's 1.5°C pathway and will result in an emissions gap of 16 gigatonnes (Gt) in 2050.

Nationally Determined Contributions (NDCs), long-term low greenhouse gas emission development strategies (LT-LEDs) and net-zero targets, if fully implemented, could reduce carbon dioxide (CO2) emissions by 6% by 2030 and 56% by 2050, compared to 2022 levels. However, most climate pledges are yet to be translated into detailed national strategies and plans, implemented through policies and regulations, or supported with sufficient funding. According to IRENA's Planned Energy Scenario,1 the emissions gap is projected to reach 35 Gt by 2050, underscoring the urgent need for comprehensive action to accelerate the transition.

Although global investment across all energy transition technologies reached a record high of USD 1.3 trillion in 2022, annual investment must more than quadruple to remain on the 1.5°C pathway.

A cumulative USD 150 trillion is required to realise the 1.5°C target by 2050, averaging over USD 5 trillion in annual terms. Compared with the Planned Energy Scenario - under which a cumulative investment of USD 103 trillion is required - an additional USD 47 trillion in cumulative investment is required by 2050 to remain on the 1.5°C pathway. Around USD 1 trillion of annual investments in fossil fuel based technologies currently envisaged in the Planned Energy Scenario must therefore be redirected towards energy transition technologies and infrastructure.

Cumulative investments between now and 2030 need to total USD 44 trillion, with energy transition technologies representing 80% of the investment, or USD 35 trillion.

Total cumulative energy sector investments in the Planned Energy Scenario until 2030 are USD 29 trillion. An additional cumulative investment of USD 15 trillion - or an annual average investment of USD 1.9 trillion - would be needed in the 1.5°C Scenario until 2030. Furthermore, a change in the volume and type of investments is required under the 1.5°C Scenario to prioritise the energy transition and set the stage for a dramatic decrease in the fossil fuel share by 2050.

THE WAY FORWARD

Net-zero commitments must be embedded in legislation and translated into implementation plans that are adequately resourced.

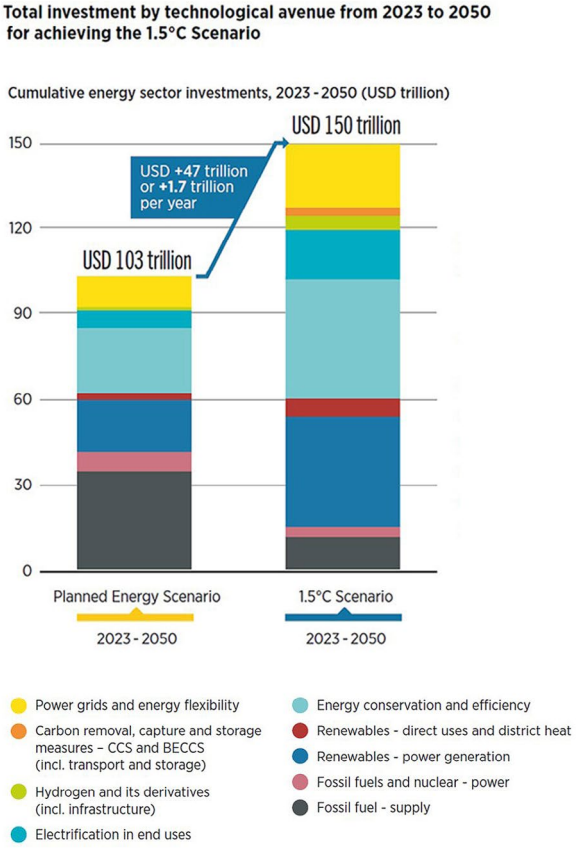
Without this crucial step, climate announcements remain aspirational, and the necessary progress out of reach. The current energy system is deeply woven into socio-economic structures that have evolved over centuries. This means significant structural change must occur in a condensed timeframe of less than three decades to successfully deliver on the goals of the Paris Agreement.

Energy infrastructure is long-lived, so investment in fixed infrastructure should consider the long term.

Every investment and planning decision around energy infrastructure today should consider the structure and geography of the low-carbon economy of the future. Electrification of end uses will reshape demand. Renewable power will require existing infrastructure to be modernised, with grid reinforcement and expansion on both land and sea. Green hydrogen production will also occur in locations other than today's oil and gas fields. The technical challenges and economic costs of redesigning infrastructure should be accounted for, and the environmental and social aspects adequately addressed from the outset.

Energy investment decisions should simultaneously drive the transition and reduce the risk of stranded assets.

The Planned Energy Scenario foresees cumulative energy sector-wide investments of USD 103 trillion between 2023 and 2050, or USD 3.7 trillion annually, on average, to 2050. Around 59% of this investment is intended for energy transition technologies - mostly for renewables, energy efficiency, electrification, hydrogen, and carbon removals. However, some 41% of planned energy investment remains aimed at fossil fuels; therefore, a combination of scale-up and re-allocation of investment in energy transition technologies is needed to keep the 1.5°C target within reach.



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How investment in renewables needs to grow by 2050 for a faster energy transition. Image: IRENA

The 1.5°C Scenario envisages electricity becoming the main energy carrier, accounting for over 50% of total final energy consumption.

Renewable energy deployment, improvements in energy efficiency and the electrification of end-use sectors contribute to this shift. In addition, modern biomass and hydrogen are projected to play more significant roles, with 16% and 14% of total final energy consumption by 2050, respectively. Notably, 94% of hydrogen consumption is expected to come from renewables, indicating a growing reliance on clean energy sources. The pathway also suggests that total final energy consumption could decrease by 15% from 2020 to 2050, potentially indicating a trend towards decarbonisation and a more sustainable energy future.

The share of renewable energy in the world's primary energy supply grows from 16% in 2020 to 77% in 2050 under the 1.5°C Scenario, requiring an annual growth rate thirteen times the current rate.

This growth is expected to stabilise primary energy supply due to increased energy efficiency and the growth of renewables. The energy mix will change drastically in the process, with a net gain of 61 percentage points of renewable energy share, driven by a mix of end-use electrification, renewable fuels and direct use. Achieving this level of renewable energy penetration is critical to meeting global climate goals and will require significant investment and policy support, as well as continued innovation.

Electricity generation will more than triple from 2020 to 2050, with 91% of the total electricity supply coming from renewable sources, compared to 28% in 2020.

Coal- and oil-based power generation will experience a sharp decline over the decade before being phased out entirely by mid-century. By 2050, natural gas will provide 5% of total electricity needs, with the remainder being met by nuclear power plants. The transition features an important synergy between increasingly affordable renewable power technologies and the wider adoption of electric technologies for end-use applications, especially in transport and heat.

Public investment strategies play a critical role in accelerating the speed of the energy transition.

Such investments need to not only increase in volume, but also be allocated strategically to guide private investment decisions and serve as an effective instrument to shape the energy transition in ways that maximise benefits in the public interest. In addition, public procurement programmes are best placed to set standards so that energy projects adhere to labour standards and environmental safeguards.

Stronger public sector intervention is required to channel investments towards countries and technologies in a more equitable way.

Some 75% of global investment in renewables from 2013 to 2020 came from the private sector; but private capital tends to flow to the technologies and countries with the least associated risks, be they real or perceived. In 2020, 83% of commitments in solar PV came from private finance, whereas geothermal and hydropower relied primarily on public finance - only 32% and 3% of investments in these technologies, respectively, came from private investors in

2020 (IRENA & CPI, 2023).

The greater need for public finance in hydropower is linked to large upfront investments, high construction risks, the need for long-tenor loans (as projects can take over a decade to complete), complex and lengthy permitting procedures, and high social and environmental risks, all of which can significantly hamper the ability of the private sector to finance large hydropower projects (IRENA, 2023b). For geothermal, meanwhile, the high costs of surface exploration and drilling represent the main obstacles to private sector financing.

Public finance and policy should continue to be used to crowd in private capital, but greater geographical and technological diversity of investment requires targeted and scaled-up public contributions.

For many years, policy has focused on mobilising private capital. Public funding is urgently needed to invest in basic energy infrastructure in the developing world, as well as to drive deployment in less mature technologies (especially in end uses such as heating and transport, or synthetic fuel production) and in areas where private investors seldom venture. Otherwise, the gap in investment between the Global North and the Global South will continue to widen. In 2015, renewable energy investment per capita in North America (excluding Mexico) and Europe was around 22 times higher than in Sub-Saharan Africa. But by 2021, investment per capita in Europe had risen to 41 times that in Sub-Saharan Africa, and in North America it was 57 times more. This is partly explained by the fact that Sub-Saharan Africa investment per capita in 2021 had fallen to almost half its 2015 value of USD 6 per person (IRENA and CPI, 2023) ■

Upgrading industrial energy policies in the GCC: The imperative

Mandatory policies have proven to be an effective tool to increase industrial energy efficiency, as evidenced by their successful implementation in many countries worldwide.

Mariya Al-Tobi
Independent Industrial Analyst

Dr. Abdullah Al-Abri
Consultant at the International Energy Agency

Economic diversification has been a critical developmental objective for the Gulf Cooperation Council region since the 1970s.

In one way or the other, this objective has been translated into three overarching development strategies: the export or import of new products, the international trade of existing products for new markets and the qualitative upgrade of the exported or imported products.

These strategies extend beyond energy but historically relied on a functioning energy system in the GCC. Within the context of energy, the region could successfully extend the hydrocarbon value chain upstream through the development of manufacturing and service capabilities and expand it downstream through the establishment of industries such as chemical and petrochemical, iron and steel, cement and aluminum. Such extension on either side of the mainstream hydrocarbon portfolio has brought socioeconomic benefits, including greater trade opportunities, foreign investments and jobs.

However, the energy sector in the GCC now faces three fundamental challenges: overwhelming sector subsidies, high energy consumption in the industrial sector that could ultimately outpace the available resources in some instances and shifting international trade scenario with the emerging carbon tax adjustments and emission caps. These challenges collectively suggest one thing — and one thing only — that the current industrial energy policies in the GCC require a revamp.

The update of industrial energy policies is not a new concept, as many governments worldwide have already been adopting various practices to help their industries actively embrace the consumption reduction agenda through industrial programs with mandates, performance-benchmarked targets, loans, grants and financial instruments.

In order to gain insights into the efficacy of these efforts, we have looked into the annual average improvement in energy intensity of major industrial sub-sectors, including chemical and petrochemical, iron

and steel, cement and aluminum across six countries as well as the outcome from the analysis of International Energy Agency.

We found out that the spectrum of average annual sectoral improvement — thus energy consumption reduction — between 1 and 2 percent from 2010 to 2020. Therefore, we believe it's crucial for GCC countries to upgrade their industrial energy efficiency policies and set mandatory energy intensity improvement targets to stimulate industries to self-assess their operational procedures, processes and energy efficiency practices.

Mandatory policies have proven to be an effective tool to increase industrial energy efficiency, as evidenced by their successful implementation in many countries worldwide.

For instance, a policy for the chemical and petrochemical sectors could focus on improving efficiency in process heating and motor-driven systems. In the iron and steel sector, a policy could prioritize increasing the recycling of scrap metal to produce new metals.

The cement sector could benefit from policies that reduce the clinker-to-cement ratio and install heat recovery facilities. The aluminum sector could focus on promoting the use of recycled scrap in the production process. Aluminum recycling is significantly

less energy-intensive than primary production, and utilizing recycled scrap as feedstock can contribute to a significant opportunity for energy efficiency.

By actively engaging industry stakeholders in tailoring realistic policies, the GCC countries could realize potential efficiency gains such as significant energy savings, cost-effectiveness, and accelerated progress toward emission reduction targets while promoting sustainable economic growth ■

Country	Chemical & Petro-chemical	Iron & Steel	Cement	Aluminium
Poland	0.7	2.6	2.6	2.6
Germany	0.7	0.4	0.5	1.3
Italy	2.5	1.1	0.5	0.8
Spain	0.42	2.53	2.66	1.67
France	2	0.5	-	2.3
Japan	1.2	1.6	0.7	-
IEA	0.9	1.65	1.7	1.65

Exploring the Energy Transition and Net-zero Strategies of Gulf Oil Producers

Osamah Alsayegh
Visiting
Research Scholar

Kristian Coates Ulrichsen
Fellow for
the Middle East

Jim Krane
Wallace S. Wilson Fellow for
Energy Studies

Ana Martín Gil
Program
Coordinator

Center for Energy Studies | Edward P. Djerejian Center for the Middle East

This is a summary of discussions that took place at a roundtable gathering that was held recently at Rice University's Baker Institute for Public Policy as part of a collaboration between the Center for Energy Studies and the Edward P. Djerejian Center for the Middle East. The Middle East Energy Roundtable brought together industry leaders, academic experts, research analysts, and participants from Kuwait to discuss key trends shaping the Gulf's energy transition politics.

The Current Energy Landscape in the Gulf

To understand the energy transition in the Gulf, it is important to highlight its current energy landscape. The total installed power generation capacity in the GCC as of 2022 was 170 gigawatts (GW), with a production injected to the grid that reached about 667 terawatt hours (TWh). Most GCC electricity is generated by combusting natural gas and oil products. Power demand is growing at different rates in each country, which in part reflects the differences in size and populations across the six states. A Kuwaiti consultancy projects electricity demand in the GCC to reach 900 TWh in 2030 from 618 TWh in 2020, highlighting the need for urgent action. To fulfill the growing demand,

Key points that emerged from the meeting included:

- Member countries of the Gulf Cooperation Council (GCC) have different terms and perspectives on the energy transition compared to non-oil states. In GCC countries, monetizing hydrocarbon assets to maintain national security is a top priority. Thus, from the GCC perspective, the energy transition should involve adopting a balanced approach through a gradual transition toward more sustainable energy sources and emissions mitigation. In doing this, Gulf nations hope to avoid exacerbating inflation and social and security problems. They also hope to continue investing in fossil fuels while encouraging the development of clean energy technologies in the next two decades.
- There is, however, a political will to engage in energy diversification and maintain development growth with less reliance on hydrocarbon revenues. The GCC countries emphasize the need for partnership and collaboration with the rest of the world to address key challenges, primarily related to technology advancements.
- The GCC's energy transition faces major challenges, including access to funds for infrastructure, technology limitations, and, in the smaller states, land availability for renewables.
- National goals espousing high levels of renewable energy penetration by 2030 appear unrealistically ambitious and are unlikely to be met in full. Even a 50% goal attainment would be a positive outcome.
- Overall, participants agreed that the energy transition presents distinct challenges for hydrocarbon exporters like those in the Gulf, and that a more gradual pace of change is preferred to maintain political and economic stability while still addressing the need for climate solutions.

around 280 TWh will have to be added over the next seven years. In terms of required installed capacity, Saudi Arabia and the UAE lead with a projected required installed capacity of 28 GW and 17 GW, respectively.

As of 2022, a participant stated that renewable electricity provided up to 4% of the total GCC demand, from an installed capacity of 5 GW, mainly in Saudi Arabia and the UAE. Each country in the region has announced its own separate target for increasing the renewable share in the energy mix. Bahrain originally announced a target of 5% by 2025 and 10% by 2035, but made an amendment recently, increasing its targets to 10% by 2025 and 20% by 2035. Kuwait announced a 15% target by 2030; Oman announced a 10% target by 2025 and 30% by 2030; and Qatar announced a 6% target by 2020 and 20% by 2030. Saudi Arabia set the most aggressive target in the Gulf, with the aim of having renewable energy generate 50% of electricity by 2030, followed by the UAE, which set a 27% clean energy target by 2021 and a 44% target by 2050.

Will GCC Countries Reach their Renewable Energy Targets?

A study presented at the roundtable looked at three scenarios whereby GCC countries achieve their renewable energy targets by 50%, 100%, and 150% by 2030. It highlighted that a mix of technology — including photovoltaic, solar, wind, and geothermal — will be necessary to meet these targets as no single technology

can attain this. The second scenario, whereby GCC countries simply fulfill their announced targets without under- or over-shooting, would entail adding 147 GW of renewable energy, from 5 GW today to 152 GW in 2030, as well as an investment of around $181 billion over the next eight to 10 years. Most of this investment will be allocated to hardware, which is usually imported from foreign markets, mostly from China. Failure to localize the majority of the supply chain within the GCC market will result in missed opportunities to further industrialize and diversify regional economies.

Bearing these challenges in mind, even reaching 50% of the target production of renewable energy would be considered a success given the fact that the raw materials used to build hardware are not directed to or reserved for the GCC but rather the entire world, which is competing for the same materials for the energy transition. Despite the challenges outlined, investing in the energy transition will also yield benefits, such as hydrocarbon fuel savings of 200 million barrels of oil equivalent per year, representing an opportunity cost of $10 billion per year at $50/barrel if the transition investments are not made, as well as substantial reductions in greenhouse gas emissions, providing both economic and climate action benefits to GCC states.

Energy Efficiency and the Importance of the GCC Interconnection Grid

Another issue examined was the importance of energy efficiency and the possibility of bringing consumer demand down by making changes to energy prices. Electricity in the Gulf is heavily subsidized by the state. For instance, in Kuwait, electricity is subsidized by approximately 95%, leading to lower prices and increased consumption. A possible solution would be to redefine the tariffs on electricity and water in order to adjust consumer behavior, but this has potential political implications. Other models being discussed are setting tariffs at market price and providing cash assistance instead, or setting a threshold on subsidized electricity and water per household.

The discussion then turned to the importance of the GCC Interconnection Grid, which connects the six GCC countries, from Oman to Kuwait, and could be used to exchange electricity during peak periods. More projects like this one that send electricity to a high-demand location from another location would be beneficial. The company that owns the GCC grid has, in fact, recently agreed to a project that will connect the same grid to Iraq, a country that is deeply affected by electricity shortages. Such regional cooperation can be an example of the benefits that accrue when countries work together and pool resources in pursuit of a common objective.

OTHER OPTIONS

Nuclear Power and Carbon Capture and Storage

Participants also considered the potential of nuclear energy. The UAE completed the first nuclear plant in the GCC in 2020, and Saudi Arabia has its own separate plans for nuclear energy that have not yet gone beyond the drawing board.

A GCC-wide nuclear energy initiative, which was proposed in 2007, similarly went nowhere. The use of small modular reactors (SMRs), which could transform the energy landscape into a more environmentally friendly one, are being discussed in some GCC countries. SMRs are not yet commercially feasible, but they will likely be by 2050 or 2060 and could be used in applications beyond traditional power plants, such as on-site power for petrochemicals.

In terms of decarbonization plans in the region, participants discussed the prospects for carbon capture and storage (CCS). The challenge with carbon capture is the need for infrastructure, transportation, and storage. For the GCC to secure a position in the future market of clean technologies, such as blue hydrogen, there needs to be an investment in carbon capture, whether in its gas phase or solid phase.

A promising technology called methane pyrolysis separates carbon from oxygen and turns it into a solid phase, making it easier to store. There is also ongoing materials research into using carbon nanotubes made from methane pyrolysis as a replacement for metal in structural applications. GCC states enjoy many advantages in CCS, including expertise, clustered emissions, and viable storage opportunities nearby in depleting oilfields.

The Case of Kuwait

Looking at the particular case of Kuwait, participants emphasized the need for investments in small-scale clean energy projects and the importance of remaining a responsible hydrocarbon supplier. Participants also stressed the country's commitment to the energy transition. In August 2022, Kuwait's oil sector developed a strategy for the energy transition and is now in the process of creating roadmaps toward it. It is estimated that the cost will be $20 billion by 2040.

Some of the challenges that Kuwait will face are the availability of land for solar energy and the need for funding and technology. Bilateral partnerships with governments and private sector investment will be critical for the latter. Despite these challenges, Kuwait has committed to achieving net-zero greenhouse gas emissions in the oil and gas sector by 2050 (Scope 1 and 2 emissions) and to increasing renewable energy production to meet 15% of electricity demand by 2030. Collaboration across sectors and among states is necessary to achieve this goal and can be both a responsibility and an opportunity for the GCC to take the regional lead.

Credit: Rice University's Baker Institute for Public Policy.

CONCLUSION

A Gradual Transition

GCC states are pursuing a gradual strategy toward the energy transition to avoid inflation, instability in global energy markets, and political uncertainty in the region. Achieving net-zero emissions will be challenging and require sustained levels of funding well beyond the national capacities of many countries if announced 2050 targets are to be met. Viewed from a regional perspective, the energy transition is two-fold: a transition of technology but also an evolution of behavior and collective mindset toward sustainable, clean energy. A question that remains to be answered is whether GCC states will work collectively toward common energy transition objectives or instead focus on separate country-specific initiatives ■

Energy transition in alignment with Vision 2040

Oman is one of the first Gulf countries to realise the importance of aligning climate policies with economic development ambitions.

Achieving climate mitigation and resilience ambitions should not come at the expense of a country's economic growth and vice versa. Oman is one of the first Gulf countries, with lowest oil and gas reserves compared to its neighbouring Gulf states, to realise the importance of aligning climate policies with economic development ambitions.

In November 2022, ahead of COP27, Oman committed to reach carbon neutrality by 2050, defining a new direction for Oman's energy policy and economic growth, one that is an orderly transition from a hydrocarbon-based to a carbon-neutral economy. Oman's National Strategy for an Orderly Transition to Net Zero, released in November 2022, sets a pathway for unlocking investments in alternative energy sources including renewable energy and hydrogen while simultaneously decarbonizing existing hydrocarbon resources. This new energy policy direction aligns with the goals set in Oman's Vision 2040, launched in 2019, aiming to diversify economic activities and establish an economic environment where dependence on hydrocarbons is kept at a very limited level.

Dr Aisha Al-Sarihi
Research Fellow,
Middle East Institute, National University of Singapore

While the Omani government's interest in protecting its natural environment and wildlife goes back to 1974, Vision 2040 is the first economic development document that places the protection of natural environment and sustainable use of natural resources at the heart of national economic priorities:

"While identifying the national priorities, the vision focuses on reshaping the roles of and relation between the public, private and civil sectors to ensure effective economic management; achieve a developed, diversified and sustainable national economy; ensure fair distribution of development gains among governorates; and protect the nation's natural resources and unique environment." – From Vision 2040 address of His Majesty Sultan Haitham bin Tarik.

Vision 2040 makes a reference to renewable energy, setting a goal to increase renewable energy consumption to 20% of total use by 2030 and to 35% - 39% by 2040. It aims to put Oman in the top 20 countries globally in the Environmental Performance Index, linking its national priorities with UN 17 Sustainable Development Goals (SDGs). Aiming to diversify the country's economy and shift to a low carbon economy, Oman Vision 2040 includes benchmarks and key performance indicators to reduce the oil share of its GDP to 16% in 2030 and 8.4% by 2040, and to increase the non-oil share of its GDP to 91.6% by 2040. Furthermore, Vision 2040 sets a target to raise energy productivity (GDP per unit of energy) from 6.92 in 2014 to 14.57 in 2030 and 17.3 in 2040.

Simultaneously, the Omani government has ensured that its climate and energy transition policies are in alignment with Vision 2040. In its second nationally determined contribution (NDC), Oman pledges to reduce its greenhouse gas (GHG) emissions by 7% relative to a business-as-usual (BAU) scenario by 2030. Oman's NDC makes an explicit link to its national economic vision, Vision 2040, and its National Energy Strategy. Both Vision 2040 and the National Energy Strategy include targets that align with Oman's second NDC's 7% emissions reduction target.

Amongst others, the national green hydrogen strategy, launched in October 2022, aims to build a hydrogen-centric economy, setting a target of 1 Mt to 1.25 Mt of green hydrogen production by 2030, rising to 3.25 Mt to 3.75 Mt per year by 2040 and further to 7.5 Mt to 8.5 Mt per year by 2050 ■

Solar farm at Sur Desalination

FLARE TO POWER

Solid Oxide Fuel Cells (SOFCs) are a promising technology for the recovery of flared gas. They are efficient, low-emitting, and reliable, and they can be used to generate electricity from a wide range of fuels.

Global warming refers to the increase in the Earth's average temperature, which profoundly negatively impacts the global climate. The effects of global climate changes encompass rising sea levels, alterations in precipitation patterns, variations in climate conditions, and elevated temperatures. These transformations will lead to more frequent occurrences of severe weather events such as storms and cyclones. As a result, the urgency to decarbonize and shift the world towards cleaner energy has reached unparalleled levels. Under His Majesty Sultan Haitham bin Tarik's leadership, Oman has committed to achieving net zero emissions by 2050. This positions the nation as a global leader in pursuing a sustainable future, in line with the Paris Climate Agreement's objectives.

Human activities are the primary drivers of these global climatic changes, with gas flaring from oil-producing companies being one notable factor. Flaring is a procedure in which natural gas is burnt off in a controlled way to extract oil from the ground. It is common to see a flaring stack burning flammable gas components in hydrocarbon processing plants and refineries. This unavoidable process is necessary to maintain safety on-site and allow the operation to continue. However, flaring-associated gas, which is a byproduct of oil production, is a major source of greenhouse gas emissions. Apart from the environmental consequences, It is also a waste of a valuable energy source, due to its substantial heating value. Flaring-associated gas results in both environmental and economic losses.

Maryam Al Lawatiya

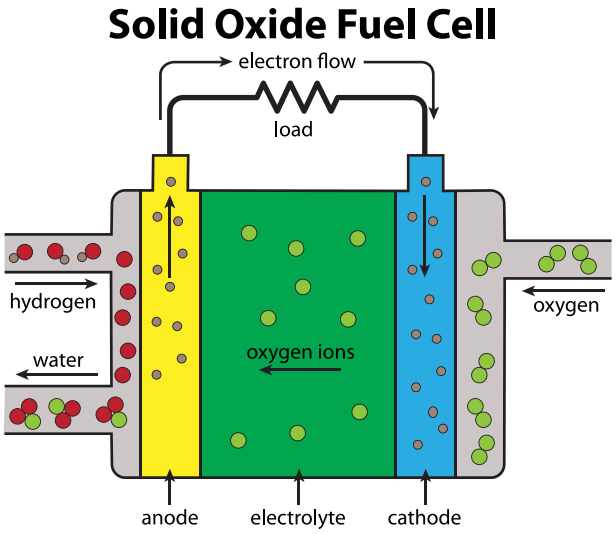
As mentioned above flares are commonly regarded as an indication of consistent production; however, the combustion of these components generates undesirable emissions, including nitrogen oxides (NOx), sulfur oxides (SOx), greenhouse gases (such as carbon monoxide and carbon dioxide), and various hydrocarbons. Based on the findings of the Global Gas Flaring Reduction (GGFR) partnership, an initiative led by the World Bank, it has been determined that approximately 150 billion cubic meters of natural gas are flared annually worldwide. As a result of this gas flaring, an estimated 400 million tons of CO2 are released into the atmosphere each year, as documented by Elvidge et al. (2009) and The World Bank (2012). Gas flaring stands as one of the most formidable energy and environmental challenges confronting the global community in the present era.

From an economic perspective, flares result in significant losses, often being the largest loss in various industrial operations. This is due to the wasted energy that could have been harnessed from the flaring process, considering the considerable heating value of the components found in flaring gas. Depending on the specific composition of the flaring gas, a substantial amount of energy suitable for various operations in petroleum fields could be generated. It is worth noting that the composition of flared gas closely resembles that of natural gas, making it a cleaner energy source compared to other commercially available fossil fuels.

In order to prevent financial losses and address the environmental implications associated with gas flaring, it is crucial to prioritize the implementation of flare gas recovery methods. Various technologies have been explored thus far for the recovery of flare gas. These include injecting the gas into oil wells for enhanced oil recovery (EOR) or pipelines, utilizing it in natural gas liquid (NGL) refineries, separating the methane content and compressing it to produce compressed natural gas (CNG) or liquefied natural gas (LNG), employing the gas-to-liquid (GTL) process to generate fuels or chemicals, and producing other petrochemical products such as methanol, ethylene, dimethyl-ether (DME), ammonia, among others. Additionally, power generation is another viable option to consider for the recovery of flare gas.

A literature review found that generating power is one such method, as it is flexible and can be applied to a variety of situations. The simple gas turbine cycle, combined cycle, gas engine cycle, and solid oxide fuel cell (SOFC) are all methods for generating power from flare gas. SOFCs are particularly promising due to their high efficiency and ability to operate at high temperatures, which can improve performance and reduce costs.

THE ADVANTAGES OF A SOFC



High Energy Efficiency

- Solid oxide fuel cells (SOFCs) have a high conversion efficiency, which means they can generate more electricity from the same amount of flared gas.
- The theoretical efficiency of SOFCs can reach up to 60%, which is significantly higher than other types of fuel cells.
- This high efficiency is due to the fact that SOFCs operate at high temperatures, which allows them to extract more energy from the fuel.

High-Temperature Operation

- SOFCs can operate at high temperatures, which allows them to use a wider range of flared gases as a fuel source.
- This is because high temperatures help to break down the complex molecules in flared gases, making them easier to burn.
- Some of the flared gases that can be used in SOFCs include methane, propane, butane, and even coal.

Low Emissions

- SOFCs produce very low emissions, making them a clean and environmentally friendly option for flare gas systems.
- The main emissions from SOFCs are water vapor and heat.
- There is a small amount of carbon dioxide produced, but this can be captured using a membrane.

High Reliability

- SOFCs have a long lifespan and low maintenance requirements, making them a reliable option for flare gas recovery.
- The solid electrolyte in SOFCs is very stable, which helps to prevent them from corroding or breaking down.
- This means that SOFCs can operate for many years without the need for major repairs.

Zero Flaring

- By adding a membrane to SOFCs, a small amount of carbon dioxide produced can be captured.
- This means that the SOFC can achieve zero flaring, which is a major environmental benefit.

SOFCs are a promising technology for the recovery of flared gas. They are efficient, low-emitting, and reliable, and they can be used to generate electricity from a wide range of fuels. The addition of a membrane to SOFCs can even achieve zero flaring, which is a major environmental benefit.

Meanwhile, SOFC systems are more expensive to install and maintain than flare gas recovery systems, however, they are more efficient at converting flare gases. As technology advances and economies of scale are achieved, SOFC systems become more cost-effective over time, especially as their cost continues to decrease. Furthermore, the price of natural gas plays a significant role in determining the cost-effectiveness of SOFC systems. In the event that natural gas prices rise, the cost advantage of employing SOFC systems becomes even more pronounced. Additionally, government incentives and regulations can greatly impact the cost-effectiveness of SOFC systems. Measures such as tax credits or rebates for the acquisition of SOFC systems can make them more financially accessible and attractive to potential users. These factors collectively influence the overall affordability and viability of SOFC systems in various applications.

In conclusion, the rising environmental awareness and widespread adoption of the Kyoto Protocol and lately the Paris Agreement by numerous countries have led to an expectation that gas flaring will be prohibited in the foreseeable future. Consequently, substantial transformations in the existing practices of oil and gas extraction and processing are imperative. Encouragingly, in recent years, oil companies have shown increasing interest in exploring alternatives to minimize the amount of flared gas.

In Oman, all major operators have committed to reducing their flared volumes within specific timelines, aiming to achieve zero flaring by 2050 in alignment with Oman's Net Zero target. This motivation stems from a combination of environmental and sustainability policies as well as business-related factors. Such developments reflect a positive shift toward more responsible and efficient approaches within the oil and gas industry ■

[Maryam Al Lawatiya holds a Master's degree in Sustainable Energy from the University of Glasgow, along with a Bachelor's degree in Chemical Engineering. She is currently working part-time as a research assistant at Sultan Qaboos University (SQU) in the Flare-to-Power project.

(Email: maryamallawatia143@gmail.com)]

Electrical Vehicle Regulatory Development in Oman

Zero-emission vehicles such as EVs have an important role in achieving the aspirations of Oman Vision 2040, especially the priority of the environment and natural resources as well as supporting the drive to achieve net-zero and sustainability in the transportation sector.

The Regulation of Electrical Vehicle Charging Activity was issued in May 2023 by the Authority for Public Services Regulation as part of the national effort to support the deployment of EV in Oman. Zero-emission vehicles such as EVs have an important role in achieving the aspirations of Oman Vision 2040, especially the priority of the environment and natural resources as well as supporting the drive to achieve net-zero and sustainability in the transportation sector.

The Authority is the regulator for the electricity, water, wastewater, and gas transmission and its role is to control, monitor, and evaluate these markets to ensure fair competition and that services are provided at reasonable prices and high quality. The Authority started exploring the regulatory frameworks required for EVs in 2018 by conducting a market study that concluded that the existing market and market size in Oman at that time did not compel any regulatory actions to be taken, however; it would be a matter for consideration in the future.

The Authority continued to monitor the market and in 2022 formed the National Team for Electric Vehicles to provide general guidance and unify national effort.

Members of the national team represent the Ministry of Energy and Minerals, the Ministry of Commerce, Industry, and Investment Promotion, the Ministry of Housing and Urban Planning, the Ministry of Interior, the Ministry of Transport,

Zainab Al Lawati
Authority for
Public Services Regulation

The Authority continued to monitor the market and in 2022 formed the National Team for Electric Vehicles to provide general guidance and unify national effort.

Members of the national team represent the Ministry of Energy and Minerals, the Ministry of Commerce, Industry, and Investment Promotion, the Ministry of Housing and Urban Planning, the Ministry of Interior, the Ministry of Transport, Communication, and Information Technology, Royal Oman Police, and Muscat Municipality. The team led by the Authority studied a number of regulatory and technical requirements that can be used to achieve economic, environmental and social goals such as enabling the market, attracting investment, supporting the transition from fossil fuel vehicles to new and sustainable mobility technologies, and protection of drivers and users of EV equipment through safety specifications. The team focused on three key enablers: (1) EV technical Standard, (2) incentives, and (3) EV Infrastructure.

As an outcome of this national effort, the Ministry of Commerce, Industry and Investment Promotion issued the Ministerial Resolution No. (45/2023), considering the Gulf standard specification of technical requirements for electric vehicles as a binding Omani standard specification. This will ensure that vehicles coming to Oman are compliant with the technical regulation especially with regards to safety requirements. In addition, the Government

approved incentives to encourage uptake of EVs. The incentives are 100% exemption from customs tax and car registration fees as well as setting the value-added tax rate to zero percent. The incentives will reduce the initial cost of purchasing and will drive the EV and EV charging sector by encouraging suppliers to offer more models at a range of prices. It will also attract investment to develop the infrastructure in terms of charging technologies and owning and operating EV charging stations. The issued regulation is another key outcome and aims to govern EV infrastructure and sets the legal foundation for the operation of EV charging sector.

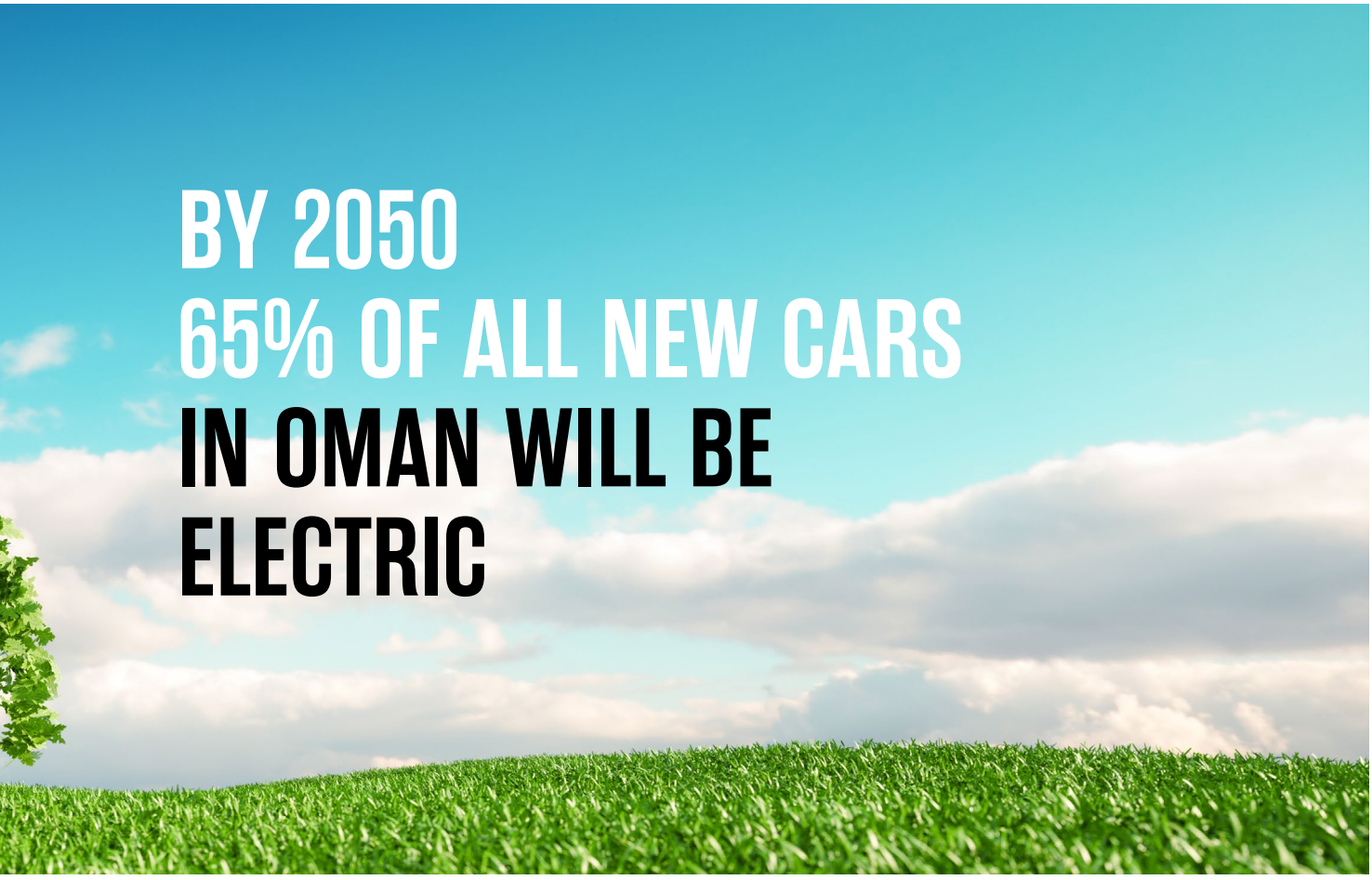
The regulation sets requirements for installing and operating electric charging points, tariffs, as well as specific requirements for private and public charging points, in addition to the obligations, and procedures for connecting charging points to the network. Therefore any individual or entity that wants to own and operate EV charging points will be clear on the process, the procedures, and their obligations. Safety is also a key requirement in the regulation as it stipulates the need to carry out maintenance work, to not expose the public to danger, and to disconnect charging points in the event that it was found to be dangerous to the public safety, or if the charging equipment are not conforming to the technical requirements and specifications.

Installing and operating EV points:

Individuals or entities that want to own EV charging points must obtain the approval of the electricity distribution company and provide the required information. The construction and installment of the charging point must adhere to the technical requirements set by the distribution company and carried by a qualified electrical contractor approved by the Distribution Code Review Panel. During the operation, owners or operators of the charging point must comply with the regulatory and technical requirements issued by relevant authorities and carry necessary maintenance according to the instructions of the manufacturer of charging equipment.

Private Charging Points:

These points are owned for non-commercial purposes such as charging points installed at homes or for entities that want to charge their own fleet. The electricity tariff applied will be in accordance with the provisions of the regulation of the permitted tariff for electricity connection and supply and according to consumption category for the customer



account. For example, the residential tariff will apply for charging point installed at home. The property owner is responsible for installing and operating the private electric charging point, and if the property is leased, the tenant must obtain the written consent of the property owner before installing the private charging point. The property owner remains responsible for the tenant's obligations if the electricity account is not updated under the tenant's name in the distribution company's system.

Public Charging Points:

These points can be owned for commercial use and are accessed by the general public, for example, points located in public parking spaces, fuel stations and commercial centers. The electricity tariff applied will be in accordance with the provisions of Cost-reflective tariff and the connection must be through a separate and dedicated meter. The owner or operator of the charging point will bear the costs of installing the charging point and meter and any other costs required for the connection process.Aligned with these recent developments in EV landscape in the country, the Ministry of Transport, Communications and Information Technology have announced EV targets in the sector's Decarbonization plan to have a share of 35% of all new cars by 2030 and 65% by 2050. The Ministry have also set a plan for the charging infrastructure through the distribution of 90 charging points across different governorates to ensure national coverage of charging points. Globally, EVs are growing in popularity and according to the global outlook of EV, a report published by the International Energy Agency, more than 10 million EVs were sold worldwide in 2022 and it is expected that sales will grow by 35% in 2023. EVs are becoming competitive in terms of prices and they are exceeding the targets for their expected share in the market. That shows that the equation has changed and EVs are becoming the pillar of sustainable mobility ■

Compliant Carbon Market Trading takes off in GCC

Leading bank takes the lead in offering carbon trading ahead of COP28 in the UAE.

Emirates NBD, a leading banking group in the MENAT (Middle East, North Africa and Türkiye) region, has taken the lead in the region in offering carbon future contracts trading, fulfilling growing demand from corporations to manage their carbon emissions offsetting and align with the UAE's Net Zero action plan.

The Group aims to continue being at the forefront of the rapidly evolving carbon trading landscape in the region, providing clients with the flexibility to deal in carbon credits as they reach their sustainability goals. The 28th United Nations Climate Change Conference, also known as the Conference of the Parties of the UNFCCC, or COP28, will be held in the UAE. Ahead of COP28, the Bank's carbon future contracts trading facility also gives clients access to a rapidly growing asset class with an estimated value of USD 850 billion across six global emission trading schemes.

Emirates NBD's carbon contract trading is aligned with the guidelines set by the European Union's Emission Trading System (ETS) and the United Kingdom's Emission Trading Scheme, providing full transparency, credibility, and accountability. The ETS's follow the 'cap and trade' system whereby companies are given a limit, or "cap," on the amount of greenhouse gases they can emit. If a company exceeds its limit, it is required to buy permits, called allowances, from others who have emitted less. This approach incentivises companies to reduce their emissions and promotes a shift towards cleaner technologies and practices to combat climate change.

The UAE government is supporting the growth of carbon trading markets with plans to launch regulated carbon credit trading exchanges and clearing houses ahead of COP28. Also, the year 2023 is dedicated to sustainability in the UAE, under the theme 'Today for Tomorrow' and includes initiatives, activities and events that draw upon the UAE's values of sustainability.

The launch of trading capability in compliance carbon markets will also enhance corporate access to sustainability-linked finance amid a growing demand in ESG-related financing. Green and sustainable financing in the UAE increased 32% year-on-year in 2022, according to the consulting firm Arthur D. Little. Meanwhile,

> We are proud to be taking the lead in facilitating client access to global compliance carbon markets ahead of the UAE's hosting of COP28 in November

green debt instruments from the Middle East and Africa are outpacing the segment's global growth, with USD 24.55 billion in green and sustainable issued in 2021, a 532% increase compared to USD 3.8 billion in 2020.

Ahmed Al Qassim, Group Head of Wholesale Banking at Emirates NBD, said "We are proud to be taking the lead in facilitating client access to global compliance carbon markets ahead of the UAE's hosting of COP28 in November. Through our Global Markets team, clients will be able to seamlessly tap global carbon credit markets to support their net zero ambitions and sustainability goals. Our clients' engagement will also aid the growth of the region's fast growing capital markets, attracting more global ESG investors as the UAE becomes a hub for climate change financing. Ahead of COP28, we will continue to provide a robust range of innovative green financing solutions to our regional and global clients as we collectively work to make the global energy transition a reality."

Vijay Bains, Chief Sustainability Officer, Group Head of ESG at Emirates NBD said: "The launch of Emirates NBD's carbon trading facility marks a significant achievement in granting access to the world's most regulated carbon markets, in line with the 2023 Year of Sustainability, and the United Arab Emirates revised Nationally Determined Goal of a 31% reduction of business-as-usual emissions by 2030. Access to carbon markets in the form of credits and offsets will become increasingly crucial for organisations to meet their net zero ambitions and goals in a structured manner. The Group's development of a carbon trading facility is also in line with the COP28's goal of climate change mitigation, and the United Nation's Sustainable Development Goal 13" ■

IS TECHNOLOGY OUR BEST BET TO REBALANCE THE ENERGY TRILEMMA?

By **Dr. Paige Marie Morse**
Sustainability Advisor,
Aspen Technology

As we move deeper into 2023, we find the road ahead is more uncertain than ever. A year ago the world had just become optimistic about its cheerful recovery from the pandemic when the outburst of the conflict in Europe overturned markets just as recovery seemed possible.

The energy markets have been exceptionally turbulent, and new emphasis has been put on the Energy Trilemma – a framework that balances a nation's energy security and affordability with environmental sustainability in mind. The World Energy Council (WEC) discussed this index in 2010; since then, they have documented this for 127 countries.

This difficult trilemma balance can be evidenced by the disappointing number of countries that set more ambitious targets for COP27 in November 2022. Only 27 countries strengthened their pledges to the UN climate agreement in 2022. However, with UAE as the host of COP28 this November 2023 and the first in the region to set a 2050 net zero goal, there is a greater urgency for a sustainable Middle East.

Energy Security

Diversity of supply is a vital deliberation for energy users, both in terms of types of energy and sources of supply. Many countries and organisations are shifting towards expanding the use of renewable sources like solar and wind, particularly as rapid innovation has aided in lowering the cost and increasing the availability of alternative energy sources.

Oil and gas companies, chemicals, and mining industries focus on electrifying energy production and processing heat to lower the carbon intensity of existing operations to support and meet the net zero targets. By adopting a digital grid management platform that delivers robust microgrid and distributed grid solutions needed, asset-intensive companies can reliably integrate these expanding renewable networks.

Energy Affordability

Process optimisation is considered a long-established approach to lower the costs of energy productions and make fuels more affordable. Continuously improving operational efficiency with software solutions can enable improvements in feedstock selection and reliability, process control and prioritised revamp projects to minimise energy and resource use.

Digitally-enabled data management helps operators track and optimise resource use and make better decisions when processes falter, or market conditions shift with new supply/demand scenarios. Digital twins, which are digital simulations of existing assets, are valuable when evaluating multiple scenarios in parallel to test options and target new levels of operational excellence.

With newer technologies like hydrogen emerging, modeling is an important tool to accelerate research efforts and to cost-effectively scale production capabilities to meet the continuously growing demand. Developing hydrogen as a new energy source demands an expansive redesign of the entire value chain and often the addition of new logistics networks. Digital technologies aiding in each step – from the simulation of new electrolysis processes to collaborative workflows to scale new projects to integrated supply chain planning and distribution.

Sustainability

Digital tools have targeted sustainability-related objectives for many years, focusing on energy efficiency, pollution control, and value chain optimisation. Traditionally, cost savings have driven much of the efficiency efforts. However, companies are starting to move towards sustainability-targeted metrics, such as the integration of renewable or reprocessed feedstocks, to reflect on the environmental impact of operations. Visibility of both financial and environmental metrics helps companies better balance operations to meet company goals beyond profitability.

A vital first step is to gather current data to identify the largest emitters. Digital processes are essential to data recording and collection from sensors and unit operations, combining isolated systems to provide an enterprise understanding. The data collected can be leveraged to make informed decisions about how operational actions impact CO2 emissions and waste generation.

With the increase in environmental, social, and governance (ESG) reporting requirements across the regions, the value of data is shifting from general external communications to forming the basis for reliable external reporting. For example, entities in the UAE are starting to address ESG standards, with greater inflows focusing on renewable and clean energy initiatives. Operational data systems must capture the appropriate detail and ensure it is easily retrievable and understood, and ready for auditing as needed by government agencies.

As the new year moves ahead, we see that the process industry globally is working with technology providers to address and discuss the impact of the Energy Trilemma on businesses and communities. Their focus rightfully remains on the key pathways to reduce resource demand and develop and implement newer technologies to meet sustainability goals. With the use of digitalisation solutions, they could improve existing assets by a substantial level of efficiency and therefore help balance the Energy Trilemma ■

Importance of logistics behind the Middle East's offshore energy projects

Offshore oil and gas (O&G) projects are on the up across the Middle East. To ensure they remain on schedule and budget, developers are turning to service providers for support meeting the urgent and complex logistics requirements of such projects.

By **Gopalakrishnan Srinivasan**
Group General Manager,
Special Projects,
Energy Division, GAC Group

To meet rising oil demand, global offshore developments will make up half of all approved projects in the next two years, up from just 29% in 2018.

Offshore upstream spending in the Middle East is set to overtake other regions with investments set to increase from US$33 billion in 2023 to US$41 billion in 2025, according to a report by Norwegian energy market research firm Rystad Energy.

This renewed investment has resulted in a marked increase in the size, scale and number O&G projects, especially as Saudi Arabia, Oman, Qatar and the United Arab Emirates (UAE) go full steam ahead with major offshore drilling extraction and production projects.

Complexity

Offshore projects are expensive, involve multiple moving pieces and can take several years to materialise. Crucially, they must be 24-hour operations as the Middle East looks to maintain its position as one of the leading hydrocarbon producers.

As with any long-term projects, any seemingly small-scale or one-off tasks that are not well-managed can create a domino effect, impacting overall project costs and causing hold-ups. To complicate matters further, ongoing supply chain challenges and inflationary woes add to the challenges of keeping these projects on time and on budget. To minimise risks, developers are increasingly outsourcing smaller, complex and urgent tasks to third-party services providers.

Supply chain spending for offshore services market is expected to grow 16% over the next two years, a decade-high

year-on-year increase of US$21 billion. This is an opportune time for the region's logistics players to demonstrate how their experience, knowledge, infrastructure and resources can help developers stay focused and on track.

On the road

There are recent examples showcasing the value of third-party support service providers in the Middle East's offshore development sector.

The first was in Oman where a 55-tonne hydraulic power unit and spooler completed a five-day, 916 km journey from Duqm to Sharjah in the UAE, crossing four borders following the completion of work at an offshore location for a major Omani energy provider.

Full end-to-end logistics services were provided for the operation, including liaison with UAE and Omani authorities for heavy-load permits, customs clearance and inspection at Sharjah, Mezyad, Hafeet and Duqm, and coordination with local police authorities that escorted the vehicles. Due to night restrictions, the trailers could only be moved during daytime, adding to the time pressure.

In another instance in the UAE, multiple out-of-gauge structures worth US$4 million had to be transported urgently from Ras Al Khaimah, Jebel Ali, to dry docks in Dubai using a combination of heavy load trucks, barges and tugs. Some of the structures were up to 14.5 metres in length, 9.2 metres in width, 6.2 metres in height and 80 tonnes in weight.

The size of the structures meant overhead power cables that ran across the road had to be disconnected to allow the trucks to pass safely. That meant working with various parties including the local electricity company, transportation authorities and a special police unit to secure approvals, road barriers and escorts. As a result, like the Omani project, the operation was conducted at night to minimise the impact on the public.

Both projects had similar success factors: specialised transportation vehicles, good relationships with and support from local authorities, experienced agents with intricate understanding of operational requirements including strict timelines, as well as meticulous planning with time-definite execution.

Trust

Trust remains an important aspect of a support service provider, especially when it comes to moving parts and equipment worth millions of dollars on the road and at sea. This trust brings reassurance amid global instability and supply chain headaches.

The impact of contractual freight rates is one example of how a trusted agent can support energy project developers. During the Covid-19 pandemic, freight rates from China to Houston shot up from $2,000 to $15,000, resulting in a major backlog of the supply chain.

During that period, logistics service providers proved crucial as they monitored freight rates and suggested alternative transportation methods or operational workflows that either ensured the cargo arrived on time or cut unnecessary costs.

While not as severe as during the pandemic era, fluctuating freight rates remain an ongoing challenge for the entire logistics sector – and it's one that is beyond the control of agents and developers. However, having the reassurance of a trusted agent in their back pocket can be the financially sensible solution for developers seeking to minimise such risks.

That is why logistical service providers are seen as a developer's 'third arm' as they keep a close eye on the smaller yet just as important elements of major energy projects to ensure the project runs smoothly as planned.

O&G remain a cornerstone of the region's economic status and the presence and development of offshore energy projects will continue in the near future. The role of logistics service providers will be more critical than ever in keeping projects on schedule, on budget and on target to maintain the Middle East's position as one of the top hydrocarbon producers ■

CRITICAL INSIGHTS TO EMPOWER YOUR BUSINESS GROWTH

Energy

OMAN

The Energy Oman Student Initiative (EOSI) aims to provide a platform for students interested in the energy sector to gain knowledge, engage with industry professionals, and contribute to Energy Oman Magazine. The program aims to foster learning, networking, and career development opportunities for students.

EOSI

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EUROPEAN LE MANS SERIES

Barcelona, 22nd of April 2023