

Diversification, Transition and
Innovation in the Energy Sector:

A Sustainable Future for Oman

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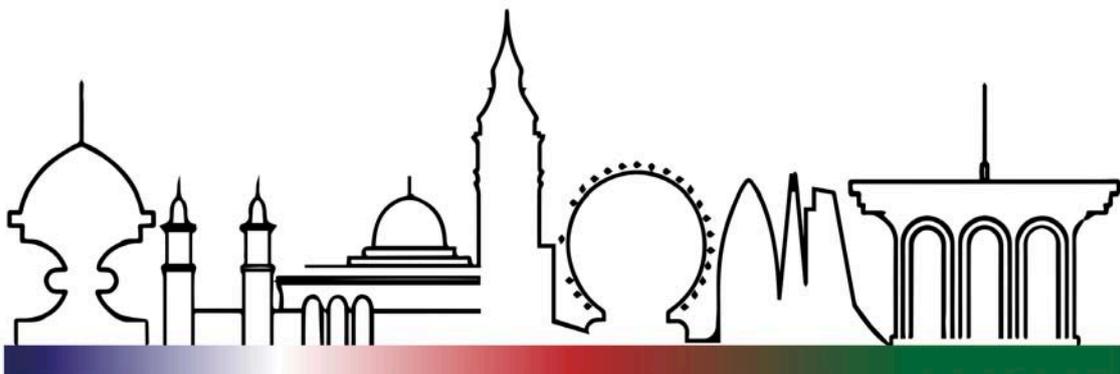
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INSIGHTS

Block 61

bp



bp's relationship with Oman stretches back to 1927 when the company's founder William Knox D'Arcy was granted a two-year exploration license. Today, the jewel in this relationship's crown is Block 61. Located around 350km southwest of Muscat, deep in the Omani desert where summer temperatures regularly hit 50°C, the block is home to the giant Khazzan and Ghazeer gas fields.



With an estimated 10.5 trillion cubic feet of recoverable reserves, Khazzan and Ghazeer are some of the largest tight gas fields in the Middle East. They are also the most complex, thanks to five kilometers of millennia baked rock that sits above the reservoirs. Indeed, when Khazzan was first discovered in the 1990s, the economics were simply too prohibitive to develop this 'tight' gas.

Breakthroughs in seismic and drilling techniques changed all of that and, by 2007, bp had become a leader in developing tight gas projects, thanks to its work in the US. The company signed a production sharing agreement for Block 61 and shared the lessons it had learned to help Oman assess and later develop the field.

bp quickly set to work, conducting what would become the largest onshore seismic survey of its kind, gathering vital reservoir data from a 2,800 square kilometer area in just five months.

The study was followed by a three-year extended well test, in which gas and condensate were recovered rather than flared, which proved that Khazzan was indeed a viable reservoir. By 2013, bp and Oman had signed an agreement to proceed to full-field development, on the promise of first gas by the end of 2017.

To meet this challenging deadline, some 13,500 people (at the peak of construction) helped drill dozens of new wells, lay hundreds of kilometers of pipeline and build some of the most efficient gas processing facilities anywhere in the world.

Khazzan started production ahead of schedule in September 2017.

In 2018, the second phase of field development, Ghazeer was sanctioned. As with Khazzan, thousands of people were brought to site to construct the new facilities.

In October 2020, four months ahead of schedule, bp announced the start-up of Ghazeer.

“THE START-UP OF GHAZEER IS AN IMPORTANT MILESTONE IN OUR STRATEGIC PARTNERSHIP WITH OMAN, DELIVERING CRITICAL NATIONAL INFRASTRUCTURE FOR THE SULTANATE.” SAID BP CHIEF EXECUTIVE BERNARD LOONEY. “WE APPRECIATE THE COLLABORATIVE SUPPORT WE HAVE RECEIVED FROM THE GOVERNMENT OF OMAN AND OUR PARTNERS IN DELIVERING THIS SIGNIFICANT START-UP SAFELY AND AHEAD OF SCHEDULE.”

BERNARD LOONEY, bp Chief Executive

A three-train gas central processing facility; 400km of gas and condensate export pipelines; almost 500km of roads and over 60km of water pipelines have been installed. 132 wells were drilled, with more planned over the lifetime of the two projects.

Total production capacity from Block 61, comprising both Khazzan and Ghazeer, is expected to rise to 1.5 billion cubic feet of gas a day and more than 65,000 barrels a day of associated condensate.

Block 61 ownership comprises bp as operator (60%), OQ (30%) and Petronas (10%)

Gas from Block 61 is distributed for domestic consumption via Oman’s national gas grid, while also boosting availability of feedstock supply for Oman LNG. bp Trading and Shipping purchases

1.1 million tonnes a year of LNG from Oman LNG under a seven-year deal that started in 2018.

Combined, Khazzan and Ghazeer have the capacity to deliver approximately 35% of Oman’s total gas demand.

A new town blossoms

bp’s partnership with Oman didn’t just build a gas plant out in the desert, it helped an entire town blossom, with new roads, a water treatment plant, waste facilities, accommodation blocks, kitchens and a clinic that in 2019, won the Ministry of Health’s Excellence Award for the Best Private First Aid Clinic.

The site is now larger than Greater London and takes about 90 minutes to drive from one side to the other.





ADOPTING EXPERIENCE FROM BP'S ONSHORE OPERATIONS IN THE US, GHAZEER'S WELLS WERE TESTED AND COMPLETED USING THE 'GREEN COMPLETIONS' CONCEPT.

Reducing sustainable emissions

Khazzan is pursuing methane reductions by using gas cloud imaging cameras that continuously monitor and identify new leaks – known in the industry as fugitive emissions. The cameras send an alert to the control room whenever emissions are detected, meaning bp can respond and fix the problem more quickly.

Adopting experience from bp's onshore operations in the US, Ghazeer's wells were tested and completed using the 'green completions' concept. Historically, hydrocarbons produced during well testing for new completions would be flared. In green completions, the hydrocarbons are routed to the production facility instead, reducing greenhouse gas emissions. Since adopting this approach in 2019, 201,000 tonnes of CO_{2e} emissions were saved – equivalent to removing 44,000 cars from the road for a year.

Committed to Oman Vision 2040

The Sultanate's vision, established by the late Sultan Qaboos, sets out the intention of using energy supplies to boost investment in areas such as health, education and enterprise to raise living standards.

That commitment has since evolved into the Oman Vision 2040, spearheaded by Oman's new leader, His Majesty Sultan Haitham bin Tariq,

with the aim of turning the country into one of the most 'developed nations' in the world.

"We know how important energy, especially gas, is to a country's economic and social development," says bp Oman president Yousuf Al Ojaili. "bp is proud to be able to play a part in delivering new resources that can help continue this important work."

bp supports this Vision in several ways, including a firm commitment to work with – and help develop – local supply chains.

In 2019, the company spent around US\$1 billion with Omani registered companies, while Ghazeer awarded six construction programmes worth US\$300 million to Omani companies.

Employment is another way in which bp supports the Vision. Over the past decade, it has invested in its local team, with Omani nationals now representing over 80 per cent of its workforce and half of its leadership team. The company intends to reach 90 per cent 'Omanisation' of its whole team by 2025.

Graduates have always been key to this success, with bp Oman recruiting the first four into its global 'Challenge Programme' for fresh graduates back in 2010. Today, there are 80 Omani Challengers.

Meanwhile, in 2012, the company set up its Technicians Development Programme, with



IN 2020, A ROYAL DECREE PERMITTED EXPLORATION ACTIVITIES IN BLOCK 77 TO PROGRESS, INCLUDING SEISMIC DATA PROCESSING AND THE DRILLING OF ONE EXPLORATION WELL WITHIN THE NEXT THREE YEARS.



candidates coming in from technical colleges and universities across the Sultanate to complete a four-year programme, including 18 months working towards an NVQ (National Vocational Qualification). More than 100 technicians were trained, many of whom now work at Block 61 as mechanical, electrical and production engineers.

What's more, around 20 Omanis are currently working in other bp businesses around the world, with the intention that they will eventually bring the skills they learn back home.

"We're passionate about developing our people," says Al Ojaili. "So, it's really pleasing to see our graduates out at Khazzan and to be able to share best practices with our partners. It's testament to the depth of our relationship with Oman that we can create opportunities like this."

The depth of that commitment to the Omani people can also be seen in bp's long-standing social investment programme. Since its launch in 2014, bp has invested US\$13.3 million in more than 70 initiatives that have reached more than 55,000 people. The programmes it supports fall into one of three areas: enterprise development, education and energy sustainability – all of which are close to bp's heart and align with the Vision's goals.

New horizons

In January 2019, bp and ENI signed an agreement with the Government to work jointly towards a significant exploration opportunity in Block 77. Six months later an EPSA was signed.

In 2020, a royal decree permitted exploration activities in Block 77 to progress, including seismic data processing and the drilling of an exploration well within the next three years.

"Our portfolio in Oman is growing," says Al Ojaili. These new agreements are important for bp because they represent the next stage in our long-standing commitment to the country and His Majesty's Oman Vision 2040. We've always been proud to help Oman secure the energy supplies that drive its Vision and we are excited to be working together on new projects that will continue to make those ambitions a reality." ■

INSIGHTS

Renewable Energy Development in the Sultanate of Oman

Brian Wood

Senior Advisor, Oman Power and Water Procurement



The story behind renewable energy development in the Sultanate of Oman is an interesting one, demonstrating a readiness to commit whole-heartedly to opportunity subject to prudence in timing, given an over-riding responsibility to nurture economic growth and the well-being of citizens.



It is no secret that sunshine is formidable year-round throughout the country, nor that the wind is stiff and constant in the southern region for much of the year. Yet harnessing these resources has come quite recently as the cost to develop them has dropped to a point that is competitive with hydrocarbon-based fuels. Some context is needed to understand why.

The electricity sector in Oman was wholly owned and operated by the Government until a restructuring initiative launched a regulatory regime in 2005. Before that, the focus was on nation-building, to develop an infrastructure rapidly that would support an improved standard of living and economic growth. In 2005, Oman Power and Water Procurement Co. (OPWP) was established to be responsible for procurement of electricity generation and related water desalination, along with a separate transmission company, four distribution companies, the regulatory agency, and a vertically integrated entity responsible for electricity supply in rural, off-grid areas. Under their operating licenses, these companies were focused squarely on the assurance of stable and reliable supply at economic prices.

Most electricity generation has been fuelled by indigenous natural gas, apart from rural areas that lack access to electricity grids or gas pipelines,

requiring diesel-fired generators. The nation's domestic gas supply has thankfully been available to support OPWP's obligation to develop generation resources in response to demand growth. From 2005 to 2015, electricity demand grew at an astonishing annual rate of 10%. OPWP procured generation capacity from a base of formerly government assets of 2,600 MW in 2005, to 11,000 MW in 2020, all under the Public-Private Partnership (PPP) model in which assets are developed, owned and operated privately with no government stake, under Power Purchase Agreements with OPWP.

During this period, from 2005 to 2015, government entities supported studies of the potential for solar and wind energy development. OPWP operated solar monitoring stations at two sites for five years, to collect ground-sourced data that would support bankable solar energy projects. Yet at this time, even as the cost of solar photovoltaic (PV) projects was falling fast, they were still not competitive with the full economic cost of gas-fired generation. Despite a strong interest in renewable energy development, OPWP was constrained by its license obligation of economic purchase.

That condition turned a corner in 2016, as large-scale solar PV projects within the Gulf Cooperation Council (GCC) region set new records for low-cost solar PV. Furthermore, in 2017 the Government

launched a Fuel Diversification Policy, in which one of the principal elements was a renewable energy target of 10% production share of electricity supply by 2025. This helped to accelerate OPWP's regulatory and government approval processes, and to open interest to other promising renewable energy technologies such as wind (requiring transmission access), waste-to-energy and others.

The tendering process for the first large-scale solar PV project by Oman was launched in 2017 and awarded the following year. That project set a global record for the lowest cost in levelized terms at the time of award. At 500 MW, the Ibri II Solar IPP is currently under construction and expected to begin operation in the second half of 2021. Two further 500 MW projects are in the tendering stage. By 2025, OPWP expects to have 2,000 MW of solar PV capacity in operation.

As with development of thermal generation resources, the Government has no capital or loan guarantees at risk in the project companies developing these renewable energy projects. The tariff for generation from the Ibri II Solar IPP is less than OPWP's average generation cost, such that consumers benefit from every unit of electricity produced. Solar PV costs have continued to fall since 2017, and OPWP expects the upcoming projects similarly to yield lower costs and greater consumer benefits.

OPWP's renewable energy development journey has not stopped with solar PV. There is an abundant wind resource in the eastern and southern governorates. The first utility-scale plant, at 50 MW, started commercial operation in 2018. It supplies electricity to the Dhofar region, an islanded grid having average demand of about 360 MW. OPWP aims to develop another plant with capacity of 100 to 150 MW on an adjacent site by 2025. Further wind development needs completion of a transmission line to connect to the main demand centres to the north, which is expected in 2024. OPWP plans to procure a further 300 MW of wind power by 2025. The development schedules for these projects are constrained by the transmission connection schedule and collection of bankable wind data from the project sites, which OPWP is managing.

Waste-to-energy is another promising technology for renewable energy development in Oman. Both waste-to-energy and bio-gas projects have been promoted by the Sultanate's main waste management company, be'ah. When it was determined to explore tendering via the PPP model, the first project came to OPWP to develop a feasibility study and tendering approach. It is intended for a site near the Barka landfill, with electricity generation capacity of 100 to 140 MW. However, waste-to-energy is primarily a waste management technology, where commercial

DO WE ANTICIPATE CHALLENGES? CERTAINLY. ACCESS TO LAND FOR LARGE PROJECTS IS A FIRST CONCERN. EVEN IN THE MOST SEEMINGLY REMOTE DESERT AREAS, LAND ACCESS MAY ALREADY BE COMMITTED TO GOVERNMENT ENTITIES.



OMAN HAS AMBITIOUS PLANS TO DEVELOP ITS ABUNDANT RESOURCES IN THE EMERGING RENEWABLE ENERGY ECONOMY.



electricity sales will support only a portion of project costs. Under the current adverse economic conditions, the project has been put on temporary hold.

By 2025, OPWP plans to have installed renewable energy capacity of more than 2,400 MW in operation, compared to 50 MW today. That would contribute about 13% of generation requirements in the grid-connected areas supplied by OPWP. We expect that the renewable energy share of generation may reach 30% by 2030, purely on economic terms without government subsidies. That may require as much as 3,000 MW of additional renewable energy capacity by 2030. This is a period when we do not expect significant net additions of new thermal capacity.

And OPWP's activity is only part of the story. The Rural Areas Electricity Company has an ongoing tender for eleven wind and solar projects to displace diesel generation. Oman's oil and gas sector has developed a 100 MW solar PV project, along with a 4.5 MW rooftop solar carpark, and has near-term plans for a wind farm. Industries are looking at private solar farms, of which the first is under construction at 25 MW. The Government also has a program underway for the development of rooftop solar projects in homes.

Do we anticipate challenges? Certainly. Access to land for large projects is a first concern. Even in the most seemingly remote desert areas, land access may already be committed to government

entities, or if uncommitted, it may be disputed for access by livestock herders or others. In the sparsely vegetated desert environment, livestock require a large range. In more accessible areas, it is more challenging to find a contiguous plot of land available for a utility-scale project. Yet the Government has pledged to support access to land to meet the ambitious renewable energy development targets.

For power system planners, an important concern is how we can assure that the grid can be managed securely and reliably with the advancing penetration of renewable energy technologies. By 2025, we may expect occasional relatively rapid changes in power output at wind and solar plants due to weather developments, which must be compensated by other generators. OPWP and Oman Electricity Transmission Company (OETC) are working together to anticipate technical issues in time to offer effective solutions. Before 2025, we do not expect the need for energy storage solutions to support renewable energy integration into the grid. Studies are currently underway to assess when the need would arise under anticipated development plans.

Oman has ambitious plans to develop its abundant resources in the emerging renewable energy economy. A study is underway to assess the developing market for green hydrogen: a future fuel and industrial feedstock that may be supplied entirely by renewable energy. That may soon be an exciting topic for Spotlight On. ■

INSIGHTS

Creating a Biofuels Ecosystem in Oman

Tala Hasan
Chairman, Wakud



It was a typical English rainy day in 2009, a friend of mine had offered to show me around a biodiesel company which he worked for in central London. As we toured their small facility, I had to ask the same question again; “So, you take used cooking oil from restaurants and you convert it into a sustainable diesel which can be used in a vehicle’s engine and it burns cleaner than petro-diesel?”. “Yes, that’s correct!” was the answer (again). I was dumbfounded at the simplicity of the concept and a little surprised that this was the first I had heard of biofuels.

WAKUD

The following year, I moved back to Oman and immediately looked at what restaurants were doing with their used cooking oil and noticed that it was being collected and dumped, or worse, put back into the food chain (which is a carcinogenic). I then set up a logistics company with two friends which focused on the collection of used cooking oil for conversion to biodiesel and we started with our first customer in Oman, McDonald’s. Since 2011 we’ve been sending all of our used cooking oil to biodiesel plants in Europe, as there is no facility in Oman. We are proud to say that today, all used cooking oils collected from restaurants and commercial establishments in Oman are being recycled into biofuels, albeit outside of the country.

In 2018, Oman announced that its subsidy on fuel was to be removed and a formula-based pricing system would be adopted. This was a pivotal moment for us as finally it made commercial sense to build a refining plant and use biodiesel in Oman to create a textbook circular economy. This is when we reached out to the team at Green Fuels in the UK, a pioneer in sustainable fuels since 2003.

Earlier this year, we incorporated Wakud with a mission of creating a biofuels ecosystem in Oman. Wakud,

SINCE 2011 McDONALD’S IN OMAN HAVE BEEN SENDING ALL USED COOKING OIL TO BIODIESEL PLANTS IN EUROPE.





is a joint venture between Omani entrepreneur Maher Al Habsi, Green Fuels, and my business 44.01, a company focused on decarbonising Oman and the world. Maher is the CEO of Wakud and brings over 14 years of used oil recycling experience with him. Wakud will play a leading role in the energy transition in Oman and the Arabian Gulf. We shortly will ship a state-of-the-art FuelMatic GSX20 biorefinery from the UK for installation and commissioning at its site in Khazaen Economic City, about 70 kilometres west of Muscat. The plant has the capacity to process 20 tonnes per day of used cooking oil (UCO), collected from restaurants and food processing establishments, into European EN14214 standard biodiesel for local consumption as road fuel.

SELECTING GREEN FUELS AS OUR REFINING TECHNOLOGY PARTNER WAS AN EASY DECISION GIVEN OUR SIMILAR BELIEF THAT BIODIESEL HAS POTENTIAL BEYOND ROAD FUEL WITH SUSTAINABLE AVIATION AND MARINE FUEL AS FUTURE AREAS FOR GROWTH.

Selecting Green Fuels as our refining technology partner was an easy decision given our similar belief that biodiesel has potential beyond road fuel with sustainable aviation and marine fuel as future areas for



OUR PLANT IN OMAN IS THE FIRST STEP TOWARDS BUILDING AN INTEGRATED BIODIESEL AND SUSTAINABLE AVIATION/MARINE FUEL VALUE CHAIN IN OMAN, AND EVENTUALLY THROUGHOUT THE GULF, AND WILL THUS ESTABLISH THE SULTANATE AS THE STANDARD BEARER IN SUSTAINABLE DEVELOPMENT, ADVANCED BIOFUELS PRODUCTION AND TECHNOLOGICAL INNOVATION IN THE REGION.

growth. Green Fuels have developed a strategy accordingly, starting with the founding of its sister company, Green Fuels Research (GFR).

Among several proprietary advanced biofuels processes that GFR has developed is SABR (sustainable aviation through biofuels refining), which converts biodiesel into biokerosene (jet fuel) and sustainable marine fuel, both drop-in blend fuels which require no modification to aero or marine engines. These waste-derived fuels, apart from being verifiably sustainable, are the shortest, least costly route to decarbonisation of air and marine transport, which together account for 5% of global carbon emissions.

Moving goods by sea is efficient on a purely commercial, tonne-per-kilometre basis, but the volume of marine traffic means that this sector accounts for around 3% of CO₂ emissions. Efficiencies in vessel design are possible but ships are expensive, long-lived assets therefore it will take a long time to upgrade the world's fleet. Electrification is presently not a viable option for large ships on long routes and other alternative propulsion systems are prohibitively costly. Most ships today use marine diesel or heavy fuel oil and substituting these with sustainable, liquid alternatives will make an important contribution to decarbonisation.

As for aviation, the sector generates around 2% of global carbon emissions and consumed 360 million tons of fuel in 2019, with only a miniscule amount of sustainable fuel used. There is, therefore, a pressing need to transition and decarbonise this sector. Aviation is a key application for sustainable fuels because the energy needed to move a large airliner long distances can only be supplied by liquid fuel. As with ships, no battery or alternative propulsion system comes close to delivering the required energy density, and will require billions in R&D investment and take years, possibly decades, to become commercially viable, which itself is not guaranteed in two understandably risk-averse sectors. Thus, proven, drop-in, liquid sustainable fuels are demonstrably the shortest route to decarbonisation.

Our plant in Oman is the first step towards building an integrated biodiesel and sustainable aviation/marine fuel value chain in Oman, and eventually throughout the Gulf, and will establish the Sultanate as the standard bearer in sustainable development, advanced biofuels production and technological innovation in the region. We want to create a biofuel ecosystem in Oman and will achieve this via knowledge transfer (we will host internships at our plant and at Green Fuels), and by collaborating with Omani SMEs to explore other avenues of feedstock for biofuels such as fish oils, fruits oils, algae and more.



The last decade has seen unprecedented disruption in the energy sector and a profound energy transformation as the global trend shifts from fossil fuels to renewable energy. The recent oil price crash has accelerated the need for increased diversification in the energy sector, in alignment with key themes of Oman's Vision 2040. Biofuels will play a role in Oman's energy transition and Wakud aims to lead the way on biofuels and to catalyse the sector in Oman. ■

SPOTLIGHT ON



Diversification, Transition and Innovation in the Energy Sector:

A Sustainable Future for Oman

The last decade has seen unprecedented disruption in the energy sector and a profound energy transformation as the global trend shifts from fossil fuels to renewable energy. The 2020 Oil Price Crisis has accelerated the requirement for increased diversification in the energy sector, in alignment with one of the four key themes of Oman's 2040 Economic Vision: Environment and Natural Resources. It has been a pleasure to bring you some of the most exciting and pioneering developments, projects and initiatives across the sustainability landscape in the Sultanate.



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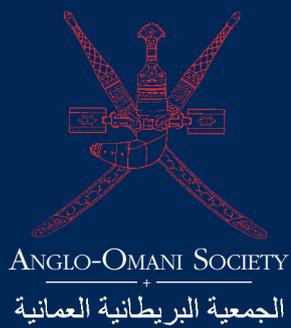
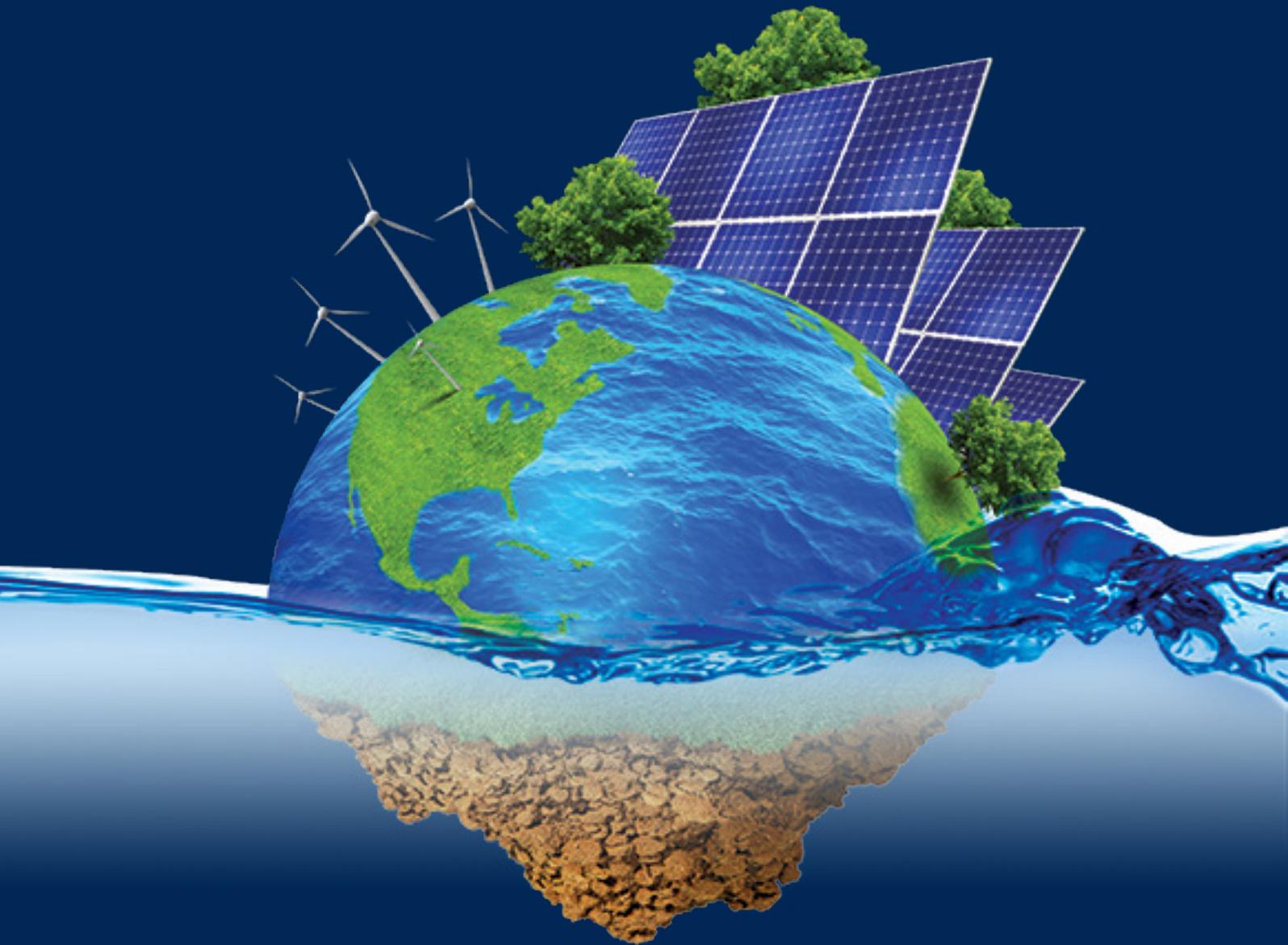
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Dr Abdullah Al Abri is the Director of EJAAD. EJAAD is a membership-based virtual collaborative platform where industry, academia and government can interact and engage in energy related research and innovation activities to help solve Oman's most pressing sustainability challenges.



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