MARKET REPORT

Used as a primary fuel resource in power generation, water production and downstream hydrocarbons activities, natural gas is central to Oman's economy. The sultanate has always run at a natural gas capacity shortage and has historically relied on partially state-owned Petroleum Development Oman (PDO) to produce 70% of the country's gas requirements with the rest imported via pipeline from Qatar. Advancements in 2017 has significantly changed Oman's resource profile, bringing on-stream enough domestic facilities to delay any future supply deficit for years.

Planned investment in megaprojects across the tourism, transportation and infrastructure sectors have led to pressing new demand on Oman's utility sector.

Already boasting a dynamic, liberalised and open market that has witnessed a number of successful power projects built and owned by private companies, Oman is now set to launch a series of new projects that will add generation and desalination capacity. At the same time, increasing consumption of natural gas has led the government to embrace renewable energy projects, in line with the economic diversification plan to target Oman's solar and wind power resources to help meet the country's growing electricity demand.

SECTOR STRUCTURE

Nama Group, formerly the Electricity Holding Group, holds shares in nine state-owned companies involved in the generation, transmission, distribution and supply of power. The group is wholly owned by the Ministry of Finance and in turn owns shares in Oman Power and Water Procurement Company (OPWP), which is tasked with purchasing required power and desalinated water in bulk from privately operated generation and production facilities connected to power and water transmission systems. In order to insure that sufficient generation resources are available to meet future power demands, OPWP contracts generation capacity through competitive tenders that are open to international bidding.

The terms of the Power Purchase Agreement (PPA) permit foreign investors to own 100% of power generation plants on a build, own and operate (BOO) basis. Whenever beneficial, OPWP seeks to co-locate power and water projects to benefit from co-procurement savings associated with pairing power generation and thermal desalination.

OPWP also procures standalone desalinated water facilities under a bulk supply agreement with DIAM, the Public Authority for Electricity and Water, who acts as the water department, developing and extending networks to pipe water to customers in its service areas.

The government heavily subsidises potable water distribution in the country, and domestic users pay less than half of the true cost of water they consume.

POWER GERNERATION

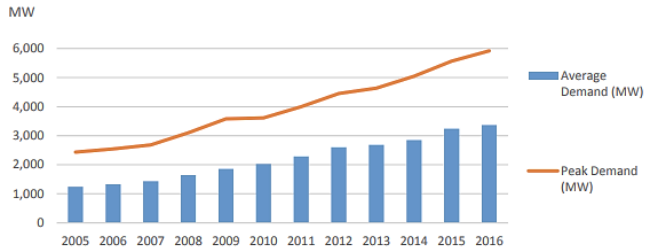
Oman's power sector is expected to attract $7bn in new investments in the near to medium term into new power generation and water desalination capacities, the expansion of power transmission and distribution networks. Owing to the sultanate's size and varying population density, Oman's power sector consists of three separate networks. The largest part of the system, known as the Main Interconnected System (MIS) covers the northern part of the Sultanate. A smaller system owned by the Dhofar Power Company serves the Salalah area in the south.

The rest of the country is supplied by the Rural Areas Electricity Company. Petroleum Development Oman (PDO), responsible for oil and gas exploration and production, also owns and operates its own power system, which is interconnected with the MIS and Salalah systems.

Transmission within the MIS is the responsibility of the Oman Electricity Transmission Company (OETC), which is owned by the Omani government through the Electricity Holding Company (EHC). The OETC currently operates transmission systems at 220kV and 132kV, although works are under way to introduce a 400kV system as a backbone to the main central power plants.

This network transmits power generated by licensed generation or desalination companies, both publicly and privately owned and sells it to OPWP through long-term power purchase agreements (PPAs). Power in the MIS is then supplied to consumers through three EHC-owned distributors: the Muscat Electricity Distribution Company, and the Majan and Mazoon electricity companies. The peak power demand is to increase substantially, by 10% annually, from 4455MW in 2013 to 9133MW in 2020.

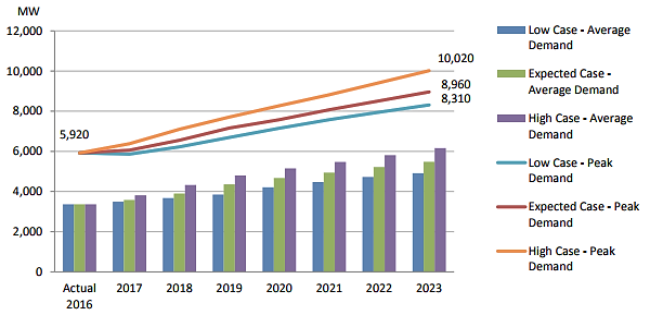
Historical electricity demand (MIS)



Source: OPWP

The growing personal income, housing starts, and continuing government investment in infrastructure projects are major contributors to continued high growth in electricity and water demand.

Electricity demand projections



Source: OPWP

New plans for power transmission infrastructure aimed at meeting the rapidly escalating energy needs of the country involve new grid stations, high voltage transmission lines and other networks are being added to the grid.

OPWP signed a number of agreements worth $2.3bn to establish two Independent Power Plants (IPP) to be connected to the MIS in 2019; OETC has awarded six contracts worth $225m for several infrastructure projects related to the new grid stations in the sultanate. A number of tenders for new megaprojects are expected before 2019.

The $2bn Duqm Integrated Power & Water Plant project consists of a natural gas-fired 300MW combined cycle power plant integrated with a seawater reverse osmosis (RO) desalination plant located at Duqm Special Economic Zone. The project includes a marine intake structure, seawater pumping station, seawater supply, return channels and beach well system.

Oman's Government started an ambitious initiative to introduce Automated Meter Reading (AMR) services for large industrial and commercial customers. CESI Middle East, a Dubai subsidiary of the Italian technical consulting and engineering company is implementing the project which will serve the distribution companies in Oman.

Companies specialising in power plant construction, power generation equipment, and power plant operations and processes should find opportunities in Oman: power transformation and networking, power generation equipment, gas-fired turbines, dispatch and transmission equipment, related software and control systems are among the best prospects for suppliers in this sector.

SOLAR AND WIND POWER

The only country in the GCC with a ministry dedicated to climate affairs and renewable energy development, Oman is targeting 90MW of renewables by 2019.

The focus on renewables builds on the National Programme for Enhancing Diversification (Tanfeedh), which was launched in 2016. The programme set a target of having renewable energy projects contribute 10% to the total power mix within 10 years. To support the government's objectives in next-generation power capacity development, OPWP is planning for a more rapid transition to power supply from solar plants, wind farms and coal-fired generation.

The sultanate has long looked to solar power to achieve energy independence while maintaining steady hydrocarbon exports. With a pilot solar project in Dhofar, the renewables sector could soon enjoy a period of strong private expansion. Solar energy has become an attractive option for water desalination following a steep drop in the cost of photo-voltaic (PV) based systems for electricity generation and is particularly competitive in rural areas where diesel is the primary fuel for electricity generation.

Oman's experiment with new models and methods in partnership with the private sector are unique in the region. The shift towards solar makes sense: Oman's high ratio of "sky clearness" allows solar collectors to receive daily radiation ranging 2500-6000Wh per square metre depending on the season, thus giving the sultanate one of the highest solar energy densities in the world. The country also has sufficient land available for large-scale solar projects: it is theoretically possible for Oman to power itself entirely on solar energy, by utilising 110 square miles, or about 0.1% of the country's total land area, for solar collection.

Oman's first commercial renewable power project is set to go operational at Al Mazyunah in Dhofar. The 303kW solar power plant is the first such commercial venture linked to the electricity network. The technology used in the project

includes PV thin films and polycrystalline system and is spread over 8,000m^2.

More solar power projects as pilot ventures have been proposed by Rural Areas Electricity Company in a move to efficiently utilise renewable energy, which will reduce use of fossil fuels, planned in different parts of the country: Ibri (2000kW), Mudhaibi (2000kW), Sharqiya (2000kW) and Dhofar (500kW).

The $94m solar panel manufacturing project run by Oman Investment Fund is expected to start operation in 2019 in Duqm Special Economic zone.

The first industrial-scale wind power project, the 50MW Harweel Plant in Dhofar ($125m) is being jointly developed by RAECO and UAE-based renewable clean energy company Masdar. They will also build a 132kV transmission line to connect the plant, which will consist of up to 25 turbines. The plant will power 16,000 households. RAECO also plans to roll out a further seven small-scale power projects based on solar and wind energy resources in order to reduce diesel-based generation by around 25% and replace this capacity with solar and wind capacity within five years.

As Oman's only vertically integrated utility, RAECO has the licence to generate, transmit, distribute and supply electricity in areas that fall outside of the country's two main grids — the Main Interconnected System (MIS) covering much of the northern half of the Sultanate, and the Salalah System, serving Dhofar Governorate.

SOLAR ENHANCED OIL RECOVERY

Solar enhanced oil recovery (EOR) can also become a major market for concentrated solar power systems (CSP) as oil producers are looking for ways to reduce their carbon footprints and to save production costs and natural resources.

With many of the sultanate's hydrocarbons resources contained in challenging or depleting formations, Oman has become a global leader in the commercial usage of EOR techniques. The main EOR techniques currently used in Oman are miscible flooding, which involves pumping natural gas into the reservoir to maintain pressure; polymer flooding, which involves mixing a polymer with water to improve its viscosity; and steam injection, which reduces the viscosity of heavy crude deposits and the permeability of rock formations. More recently, the sultanate has been leading the world in the adoption of solar EOR technology, which uses solar thermal energy to drive steam injection.

A prime example of the versatile approach of Oman's oil industry to EOR can be found in Block 6, operated by PDO. Its Amal reservoir is the home to one of the most ambitious EOR projects currently under way in the world.

Since 2010 PDO has been working with US technology company GlassPoint Solar on a trial project for solar EOR. The project involves using glasshouses to protect parabolic mirrors, which are used to generate thermal energy, from the violent sandstorms that hit Oman's deserts. The glasshouses are kept clean through an automated system which reduces water usage. The trial project, which was able to produce 7MW of thermal energy, generated 50 tonnes of steam for use in EOR.

The success of the trial unit has encouraged PDO to invest serious sums in rolling out the technology on a large scale. The project, which is called Miraah (mirror), will involve the investment of an estimated $600m in the construction of 36 glasshouses, covering a total area of 3 square km – 100 times the size of the pilot trial. The completed facility will eventually generate 1GW of thermal energy, enough to produce 6,000 tonnes of steam per day and save 157 million square metres of natural gas per year. At peak capacity the finished project will produce the largest amount of energy of any solar plant currently operating in the world.

An eventual switch to solar-based steam generation could dramatically cut the consumption of gas for oil production in the Sultanate. The upshot is a potential windfall in conserved natural gas that can be diverted for higher value applications, such as fuel for power generation, water desalination, and industry, and as feedstock for petrochemical processing and downstream value addition. Another operator, Occidental Petroleum, is using a giant steam project at the Oman's Mukhaizna field.

These projects create new opportunities in supply chain development, manufacturing capability and employment and training. Plans to localise the supply chain are currently under development, including establishing a local manufacturing centre in Oman.

WATER

Demand for water in Oman is primarily driven by population growth and tourism projects. With demand growth projections for potable water in Oman steady at 7% through to 2021, the Public Authority for Electricity and Water (PAEW), in cooperation with OPWP are implementing strategies aimed at increasing capacity to meet the existing shortfalls. Projected capital expenditure in developing new water infrastructure and financing the cost of renewing aging transmission and distribution infrastructure has been estimated at $6.5bn until 2040. This

includes projects that support the development of distribution networks, new reservoirs to improve consistency of supply and reverse osmosis (RO) water plant projects to expand water production capacity.

PAEW is committed to providing potable water to all residents, with the objective of supplying piped water to more than 95% of the population within the next two decades. With the rapid and continuous growth of water demand (almost 15% increase on average per year), as a result of the robust economic and demographic growth in Oman, $390m is forecasted to be spent every year on development projects.

Most of Sultanate's land is in dry and semi-dry areas. Water scarcity, increase in population and improvement of the living standards has put strain on water resources and their use in the country. Hence, finding new unconventional water resources such as treated wastewater (TWW) has become highly important in the country. The importance of wastewater as a potential source of water is apparent in countries that suffer from shortage of water especially to those in the arid zone such as the Sultanate of Oman. The non-conventional sources are desalination of seawater, storage dams and recharge dams, and treated wastewater.

Oman holds significantly higher groundwater reserves than its GCC neighbours, but desalination still supplies some 44% of the total water needed. Together with the regular demand, the EOR techniques used to extract its heavy oil require substantial water treatment. Overall, Oman uses 8-9 barrels of water for every barrel of heavy oil extracted.

OPWP is also reviewing plans to build a mobile desalination project to meet temporary shortages for potable water in different parts of the country. The project can be mounted either on land transport vehicles or sea-faring barges, providing mobility to various sites depending on water demand.

Almost universally across new projects tendered in Oman, bidders have favoured reverse osmosis (RO) technology over multi-stage flash (MSF) in the seawater desalination process due to its economic advantage.

WATER LOSS REDUCTIONS

The scarcity of water and the need to transport it over long distances makes it important to reduce losses to an economical and operationally manageable level. In 2016 the PAEW reported an increase of unaccounted for water (UFW) lost in distribution from desalination plants and wells to customers via pipe or tanker. UFW across Oman spiked to 39% causing the authorities to look for better technologies in active leak detection, as well as establish a network replacement refurbishment programme.

Further development will require up-to-date solutions in waterproofing, tank and reservoir lining, micro tunnelling equipment, leak detection and sealing techniques.

ENERGY EFFICIENT DESALINATION

Oman plans to develop a number of seawater desalination facilities to meet growing water demand in the Sultanate. Some parts of Oman face the prospect of their desalination capacity not meeting consumption needs, adding to the urgency of progressing with its planned projects.

Planned desalination facilities in Oman

Facility	Capacity (m3/day)	Year
Aseelah IWP	80,000	2017
Mobile WD Facility	100,000	2017
Khasab IWP	16,000	2017
Qurayyat	200,000	2018
As Suwayq	230,000	2018
Barka 4 IWP	280,000	2018
Sohar 3 IWP	250,000	2018
Duqm RAECO expansion	4,000	2018
Sharqiyah IWP	100,000	2019
Duqm IWP	60,000	2019
Aseelah IWP	80,000	2020
Salalah 3 IWP	100,000	2020
Khasab IWP	20,000	2021
Ghubrah 3 IWP	300,000	2022
Salalah 4 IWP	100,000	2022
North Batinah IWP	200,000	2022

Source: OPWP, RAEC

Project agreements have been signed for the establishment of a number of desalination stations, which are currently at different stages of development and expected to come on-line beginning in 2019. The largest of these plants is the Barka Desalination Plant 4 ($298.7m). The high-efficiency RO desalination facility will be Oman's largest when it goes into service, equipped to produce a total of 281,000 m^3/day of potable water output, enough to cover nearly 30% of demand around Muscat.

The project will be structured as an independent water project (IWP), with the OPWP purchasing potable water produced by the project under a water purchase agreement that has a term of 20 years.

Another major independent desalination plant is scheduled to come on-line at Sohar Port: the $259.7m RO project with production capacity of 250,000 m^3/day will meet about 80% of local water demand in the area.

Oman is heavily reliant on small-scale RO plants to produce potable water, in combination with its larger IWPP and independent water production (IWP) facilities. To meet demand, Oman has approximately 1.9 million m^3/day of new capacity under construction, planned, or under study, with the emphasis on RO technology under its Seven-Year Plan, issued by the Oman Power and Water Procurement Company in May 2017. There is also about 100,000 m^3/day of mobile desalination capacity planned. Moreover, alongside these projects, Oman Environmental Services Holding Company (Be'ah) is investigating the possibility of building the sultanate's first waste-to-energy plants for desalination.

WATER NETWORK DEVELOPMENT

Oman is investing $2.8 billion for new wastewater projects across the country. During its 9th Five-Year Plan (2016-2020), Haya Water is mandated to manage, operate and maintain all wastewater networks, desalination facilities, pumping stations and sewage treatment plants in Oman, as well as the development of a national master plan for the management of the wastewater and sewage network in Muscat.

Current and upcoming projects

Project	Estimate Value
Wadi Dayqah Water Treatment Project	$1bn
Al Ghubra Seawater Desalination Project	$378m
Quriyat Desalination Project	$250m
Barka Desalination Extension Project	TBA
Al Dakhiliyah Water Network Project	$87.9m
Al Ghubra Pipeline Project	$78m
Muscat Water Desalination Project	$33.8m

Source: Omanexpo

Companies that can provide equipment for small-scale irrigation should find a ready market among the large number of small farms in the country. Firms with expertise in desalination, sewage, and wastewater treatment may also find opportunities, particularly with ongoing work on wastewater treatment systems, led by Haya Water. The agreement will see Haya take responsibility for the ministry's 57 sewage treatment plants (with a total capacity of 56,130 m3/day), 900 km of network, 21 contracts relating to ongoing construction projects, and 11 operation and management contracts.

The overall goal of Haya's Muscat strategy is to connect the city's residents to six major treatment plants at Seeb, Bawshar, Muscat, Muttrah, Amerat and Quriyat. These plants will then in turn be linked to the world's largest submerged membrane bio-reactor treatment plant at Al Ansab, which began initial operations in 2011, with a daily processing capacity of 54,000 cubic metres of effluent per day. This figure is expected to eventually reach 110,000 cubic metres, with the treated water going on to be used to irrigate public parks and green spaces.

As well as limiting the amount of desalinated water previously required for such purposes, the canalisation project also has the benefit of severely curtailing the need for septic tanks within the capital – helping to reduce the pollution of groundwater aquifers and the erosion of foundations through seepage.

The sewerage network construction includes new gravity networks, vacuum and treated effluent systems, with the requirement of UPVC, GRP and HDPE pipes, concrete, HDPE and Polycrete manholes and submersible pumps, vacuum valves, valve chambers and measuring equipment, storage and balancing tanks, double suction split case centrifugal pumps. The sewage treatment plants, operated by Haya Water, typically run on conventional extended aeration activated sludge process, sequential batch and membrane bioreactor technologies. At the same time, the Haya's network is not equipped to accept industrial wastes, such as oil and grease, especially those from industrial estates, garages, restaurants and hospitals, so they are encouraged to have their own plants for industrial and clinical waste before being linked to Haya's network. Membrane Bioreactor (MBR) technology, used for municipal and industrial wastewater treatment, was selected by Haya Water to produce high quality treated effluent for irrigation and coastal discharge.

Sequential Batch Reactor (SBR) flowed by ultra-filtration is one of the approved technology for sewage treatment plants in Haya Water to produce high quality TSE.

Haya Water supplies treated effluent for a wide range of irrigation purposes across the Muscat area, including parks, public green areas and golf courses to keep them green and pleasant for the public. Haya officials have appealed for assistance and expertise for the process of registering its sewage treatment networks for UN carbon credits, increasing local awareness and acceptance of recycled water, and finding other uses for the treated water (only 60-70% of the recycled water is currently used, mostly for irrigation, gardening, and golf courses, the rest is discarded into the sea or used to supply a nature lagoon which is being developed as a bird breeding sanctuary).

The Kala Plant is the first composting project in the Middle East, operated by Haya Water in order to reuse sewage bio solids and green waste and to convert them to compost for agriculture, landscaping and for individual gardens,

enabling a reduction in the overall production of harmful greenhouse gases. As a result, all sewage bio solids generated by the company's water reuse treatment project are treated and converted to compost – instead of being dumped into a landfill site.

Haya would also like to look at ways to recover methane as a source of energy and further develop its effluent fertilizer product. Finally, the company is seeking solutions for odour management around its treatment plants, thus remaining a lucrative source of business for contractors and vendors for several years to come.

The best prospects for suppliers in this sector are: water recycling, wastewater and desalination equipment, waste management solutions, weather monitors, advanced irrigation equipment, water quality monitoring systems, oil drilling wastewater recycling systems, chlorination units, online water quality analysers, water quality equipment, groundwater recharge, aquifer management, automated meter readers.

PRODUCED WATER IN OIL AND GAS

Produced water is water trapped in underground formations that is brought to the surface during oil and gas exploration and production. According to PDO, the amount of produced water used for re-injection needs to grow by 58% in 10 years and to almost double in 20 years.

Around two-thirds of produced water in Oman's oil and gas exploration is currently utilised (45% is re-injected for reservoir pressure maintenance, 13% is treated by Reed beds). The water which cannot be utilised and is therefore needs to be disposed of, is either hyper saline or comes from chemical enhanced oil recovery processes. Only some of the disposed water can be used in agriculture, for example, in date palm-tree cultivation projects.

The best prospects for suppliers in this sector are solutions and equipment for the online monitoring of produced water quality, downhole oil water separation (DOWS), hypersaline water treatment for steam injection and frack operations, decontamination of produced water from polymers, minimising RO reject and maximising RO recovery, Reed beds outlet produced water treatment for agricultural use.

WASTE MANAGEMENT

Oman is close to completing the transfer of waste management operations in each of its 11 governorates to international operators. The move is part of a waste management plan that aims to modernise and restructure the handling, treatment and disposal of municipal solid waste (MSW) and expand the country's capacity for recycling and waste-based energy generation. This is a key step to transform the country's waste into an economic and environmental benefit by diverting 60% of waste away from landfills as part of its diversion strategy, which includes converting waste to energy, biogas and other sustainable alternatives by 2022, and 80% by 2040.

MARKET ENTRY

As demand in products and technologies for the sultanate's utilities sector continues to grow, *Oman Energy & Water* is staged in Muscat, as a direct gateway to the opportunities in this sector, on April 22-24, 2019.

OMAN ENERGY & WATER Exhibition & Conference

This initiative is supported by Department for International Trade and British Water, in association with Intec Export Intelligence, who are responsible for selecting appropriate participants.

THE PACKAGE

To ensure that appointed suppliers maximise potential benefit, a comprehensive package has been put together, which includes:

- Provision of interactive contact list support facility;
- Return flight from UK to Oman;
- Four star hotel accommodation;
- Transport to and from airport to the hotel and venue;
- Exhibition site complete with purpose built shell scheme, facia board and furniture (9 m2);
- All necessary badges, passes, security, cleaning and catalogue entry.

CONTACT LIST SUPPORT FACILITY

- The allocation of the end-user contact details in Oman;
- The specific customer, partner, agent, and distributor information relevant to each appointed supplier.

Department for International Trade

BRITISH WATER expertise worldwide

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Sources: DIT, British Water, OBG, PDO, OPWP, Omanexpo.