OMAN POWER AND WATER PROCUREMENT CO. (SAOC)

Member of Nama Group

الشركة العمانية لشراء الطاقة والمياه (ش.م.ع.م)

إحدى شركات مجموعة نماء

OPWP's 7-YEAR STATEMENT

(2019 – 2025)

(Issue 13)

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GLOSSARY

AER	Authority for Electricity Regulation, Oman
BTU/scf	British thermal units per standard cubic foot
CCGT	Combined-cycle gas turbine
CSP	Concentrated Solar Power
DGW	Directorate General of Water (Office of the Minister of State and Governor of Dhofar)
DR	Demand Response
DPC	Dhofar Power Company (SAOC)
DPS	Dhofar Power System
GJ	Gigajoule(s)
GCCIA	Gulf Cooperation Council Interconnection Authority
HHV	Higher Heating Value
IPP	Independent power project
IWP	Independent water project
IWPP	Independent water and power project
kWh	Kilowatt hour(s)
LOLH	Loss of load hours
m^3	Cubic metre(s)
m^3/d	Cubic metres per day
MEDC	Muscat Electricity Distribution Company (SAOC)
MIGD	Million imperial gallons per day
MIS	Main Interconnected System
MISC	Majis Industrial Services Company (SAOC)
MJEC	Majan Electricity Company (SAOC)
MOG	Ministry of Oil and Gas
MSF	Multi-stage flash (desalination technology)
MW	Megawatt(s)
MZEC	Mazoon Electricity Company (SAOC)
OCGT	Open-cycle gas turbine
OETC	Oman Electricity Transmission Company (SAOC)
OPWP	Oman Power and Water Procurement Company (SAOC)
PAW	Public Authority for Water
PDO	Petroleum Development Oman (LLC)
PPA	Power purchase agreement
PWPA	Power and water purchase agreement
PV	Photovoltaic
RAECO	Rural Areas Electricity Company (SAOC)
RE	Renewable Energy
RO	Reverse osmosis (desalination technology)
SAC	Sohar Aluminium Company
Sm^3	Standard cubic metre(s)
Sm^3/d	Standard cubic metres per day
TWh	Terawatt hour(s)

OVERVIEW

Introduction

This statement provides a 7-year outlook for power in the main power systems of Oman, the Main Interconnected System (MIS), the Duqm Power System, the Dhofar Power System (DPS), and the Musandam Power System. The 7-Year Statement also provides an outlook for desalinated water supply in the Main Interconnected System, the Sharqiyah Water Network, the Dhofar Water Network, and the Massirah Zone.

Over the next seven years, OPWP is committed to achieve ambitious goals to diversify the sources of electricity generation. New solar, wind, and waste-to-energy projects will contribute 16% of electricity production by 2025, and gas consumption by conventional power plants will be less than today. In 2020, OPWP plans to launch the region's first wholesale electricity spot market. It will drive further efficiency improvements and provide a means for generation capacity that is not contracted to OPWP to sell power into the national grid.

OPWP prepares the 7-Year Statement annually in accordance with Condition 5 of its license. This is Issue 13, for the period 2019 to 2025; previous issues and additional information are available on the OPWP website at www.omanpwp.com.

Demand for Electricity

In the MIS, peak demand is expected to continue to grow at a brisk rate, about 5% per year, from 6,168 MW from 2018 to 8,600 MW in 2025. Peak demand growth continues to show the impact of consumer responses to the time-of-use tariffs (Cost-Reflect Tariff or CRT) that were introduced in 2017. Energy consumption is expected to parallel the growth in peak demand requirements, at an annual average of 5% per year.

High and Low Case scenarios are also considered. The Low Case projects 3% annual growth in peak demand, reaching 7,590 MW in 2025, almost 1,000 MW below the Expected Case. The High Case projects 8% annual growth in peak demand at 10,240 MW by 2025, exceeding the Expected Case by almost 1,600 MW.

In the Dhofar Power System, peak demand is expected to grow at 6% per year, from 539 MW in 2018 to 827 MW in 2025. The Low Case projects 5% growth, reaching 747 MW by 2025, about 90 MW below the Expected Case. The High Case, on the other hand, projects 9% growth in peak demand, reaching 981 MW by 2025, exceeding the Expected Case by almost 150 MW.

Power Generation Requirements

In the Main Interconnected System, the major developments include the start of the Spot Market in 2020, completion of the 400 kV North-South Interconnect to the Duqm Power System in 2023, the continuing push for RE projects driven by economics, and a focus on Demand Response. The North-South Interconnect will stimulate development of the Special Economic Zone of Ad Duqm and development of RE projects in Al Wusta.

Project developments in the MIS are expected to include: (1) completion of Ibri IPP (1,509 MW) and Sohar III IPP[1] (1,710 MW) in 2019; (2) extension of Manah PPA under new ownership in 2020; (3) launch of a Demand Response program to contribute capacity of 30 MW in 2021 and expanding to 100 MW by 2025; (4) completion of Ibri II Solar IPP in 2021; (5) around 600 MW of capacity contracted via the Power 2022 procurement process; (6) additional solar IPPs will begin operation in 2022, 2023, and 2024; (7) Barka WTE IPP[2] of around 100 MW to begin operation in 2023; (8) a Wind IPP of around 100 MW in the Sharqiyah region for completion in 2023; and (9) around 700 MW to be contracted via the Power 2024 procurement process.

In the Dhofar Power System, the first Dhofar Wind IPP is currently under construction and expects to achieve COD in 2019.

In the Duqm Power System, OPWP plans several projects to be completed in the forecast period, including (1) wind IPPs of around 200 MW to be potentially located across multiple sites, for completion in 2023; and (2) the Duqm IPP, to provide about 600 MW of baseload supply by 2025. These plans are subject to approval.

Fuel Requirements

The new projects under the fuel diversification initiative will contribute 16% of total electricity production by 2025, enabling total gas consumption to decline by 7.4% compared to 2018.

In the MIS, efficiency improvements in the MIS generation fleet and the contributions of RE are expected to reduce fuel requirements by 1% per year on average through 2025, despite the 5% annual growth in electrical energy requirements. Average gas utilization by the generation fleet (sm^3 per MWh produced) is projected to improve by 36% from 2019 to 2025. Much of the improvements will occur starting in 2019 with the introduction of new high-efficiency power plants (Ibri IPP and Sohar III IPP) and large RO water desalination plants that will enable less energy-efficient MSF plants to shift to standby operation. After 2020, the main improvements will be due to the introduction of solar and wind IPPs.

In the Dhofar Power System, gas requirements are projected to increase at 6% per year, which follows the 7% growth of electrical energy requirements. The projections include the impact of the Harweel Wind IPP, which has a positive impact on gas savings.

Desalinated Water Requirements

Peak water demand in the Main Interconnected System (MIS) is projected to increase at 7% per year, from 967 thousand m^3/d in 2018 to around 1,567 thousand m^3/d in 2025. In the Sharqiyah Zone, water demand is expected to increase at 5%, from 121 thousand m^3/d in 2018 to 175 thousand m^3/d in 2025.

In the MIS, developments include: (1) addition of Qurayyat IWP (200,000 m^3/d, 44 MIGD) in Q2, 2019; (2) addition of Sohar IV IWP[3] (250,000 m^3/d, 55 MIGD) in Q3, 2019; (5) addition of Ghubrah III IWP (300,000 m^3/d, 66 MIGD) in 2023; (6) addition of Wadi Dayqah IWP, up to (125,000 m^3/d, 27.5 MIGD)

[1] Sohar IV IPP will be referred to as Sohar III IPP in this (and future) publication(s) to ensure consistency across other documents and contracts.
[2] This project was previously referred to Waste-To-Energy IPP in former OPWP publications.
[3] Sohar III IWP will be referred to as Sohar IV IWP in this (and future) publication(s) to due to the updated name for Sohar III IPP and in line with OPWP's Project Naming Methodology.

in 2023; (7) addition of Barka V IWP (100,000 m^3/d, 22 MIGD) in Q2, 2022; (8) Sohar IWPP contract expiration in 2022; (9) new desalination capacity (150,000 m^3/d, 33 MIGD) in the North Batinah region, in 2023; and (10) extension of the (P)WPA of Barka II IWPP, or addition of new capacity, of 120,000 m^3/d (26 MIGD) in 2022.

In the Sharqiyah Zone, addition of Asilah IWP (80,000 m^3/d, 18 MIGD) in 2021.

In Massirah Zone, procurement of Massirah IWP (10,000 m^3/d, 2.2 MIGD) for operation in 2023 on Massirah Island.

In Dhofar, DGW projects water demand to grow at 14%, and peak water demand to increase from 154,000 m^3/d in 2018 to 380,000 m^3/d in 2025, including network demand as well as water requirements in the Jabal areas where DGW aims to expand its network. Developments include (1) addition of the Salalah III IWP (114,000 m^3/d, 25 MIGD) in 2020, and (2) addition of the Dhofar Water 2023 IWP (150,000 m^3/d, 22 MIGD) in 2023.

In Musandam, PAW plans to provide sufficient resources to meet Musandam area demand for the next five years, and requested OPWP to terminate procurement of Khasab IWP.

Procurement Activities

The main procurement activities for power projects in 2019 include: (1) Sale of Manah IPP asset and Power 2022 (RFP in Q2); (3) Barka WTE IPP (RFQ in Q3 and RFP in Q4); (4) Solar IPP 2022 (RFQ Q3 and RFP in Q4); (5) Solar IPP 2023 (RFQ Q4); and (6) Duqm Clean Coal IPP, if approved (RFP in Q2). Beyond 2019, future procurement initiatives include additional RE IPPs, and Power 2024.

The main procurement activities for water projects in 2019 include: (1) Wadi Dayqah IWP (RFQ in Q2); (2) Dhofar Water 2023 (RFQ in Q3), and (3) Massirah IWP (RFQ in Q3). Beyond 2019, future procurement initiatives include extension of the Barka II IWPP water purchase contract or procurement of equivalent new capacity.

SECTION 1
POWER

1.1 MAIN INTERCONNECTED SYSTEM

The Main Interconnected System (MIS) extends throughout the Governorates of Muscat and Buraymi, and most of the Governorates of Al Batinah North, Al Batinah South, Ad Dakhiliyah, Ash Sharqiyah North, Ash Sharqiyah South and Ad Dhahirah, serving around 999,825[4] electricity customers.

The MIS comprises eleven power generation facilities, owned and operated by separate companies; the 400/220/132 kV transmission grid, owned and operated by Oman Electricity Transmission Co. (OETC); and three distribution networks, owned and operated by Muscat Electricity Distribution Co. (MEDC), Mazoon Electricity Co. (MZEC) and Majan Electricity Co. (MJEC). The three distribution network operators also act as licensed electricity suppliers, supplying existing and new electricity customers in their respective service areas. The MIS is interconnected with the power system of Petroleum Development Oman (PDO), and with the power system of the Emirate of Abu Dhabi and other Member States of the GCC Interconnection Authority via the Abu Dhabi Interconnect.

OPWP's role is to aggregate the power and desalinated water requirements of licensed electricity suppliers and water departments, and to economically procure the required power and desalinated water in bulk from generation/production facilities connected to the MIS and water transmission systems. OPWP is required to ensure that sufficient power generation resources are available to meet licensed electricity suppliers' demands. Wherever beneficial, OPWP co-procures desalinated water to meet the needs of water departments in joint power-water facilities, and procures stand-alone desalinated water facilities upon the direction of PAW in accordance with Article 78 of the Sector Law.

1.1.A Demand for Electricity

OPWP evaluates electricity demand at the system level, including transmission and distribution system losses with consumer-level loads. This must be secured by the total output capacity of power generation plants at the power system delivery points, excluding the internal power consumption of auxiliary systems.[5]

Historical Demand

In 2018, electricity demand grew at a relatively slow pace compared to the historical average, and was lower than what was expected under OPWP's previous forecast. Peak demand increased by about 1% to 6,168 MW, while average demand increased by nearly 5% to 3,748 MW (corresponding to 32.8 TWh of energy). This reflects the continued impact of the reduced economic growth that began in 2015. The lower growth rate of peak demand also reflects the impact of Cost Reflective Tariffs (CRT) that were introduced to large industrial, commercial and government consumers in 2017. The CRT is time-

[4] AER Annual Report 2017

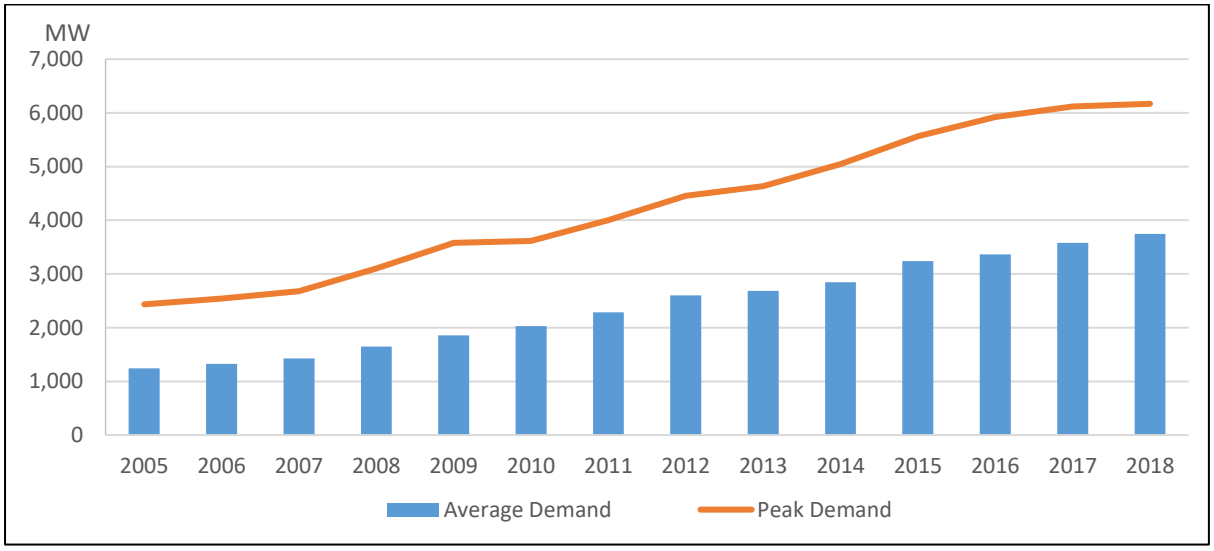
[5] This approach assures equivalence toward planning the generation supply required to meet consumer demand. However, from the perspective of power system operations, electricity demand and output are monitored at available metering points located at substations and power plants. The system "gross demand" at any point in time is the sum of the metered output at all power generators, although a portion of that generator output must be consumed by plant auxiliary systems. System peak demand is considered as net of plant auxiliaries and any exports to other power systems. The hourly consumption of plant auxiliary systems is not measured directly at some plants and in these cases must be estimated. Consequently, there may be differences in peak demand reports, depending on how auxiliary consumption at each plant is estimated.

differentiated, and reflects the cost of supply by season and time of day: higher costs during peak and summer periods, and lower costs during off-peak and winter periods.

Over the last 7 year period (2011-2018), peak electricity demand in the MIS grew at an average annual rate of about 6.4%, from 4,000 MW in 2011 to 6,168 MW in 2018. Energy consumption and average demand grew by about 7.3% annually during the same period. Single year growth rates have fluctuated widely, influenced strongly by weather and economic growth: annual peak demand growth has ranged from a low of 0.9% to a high of 15.6% since 2006.

Figure 1 illustrates the growth in peak and average demand in the MIS from 2005 to 2018.

Figure 1 Historical Electricity Demand – MIS



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Average Growth (%)
Historical Demand															
Average Demand (MW)	1,240	1,329	1,430	1,646	1,859	2,028	2,285	2,599	2,684	2,845	3,237	3,364	3,578	3,748	
Growth (%)		*7.2%*	*7.6%*	*15.1%*	*12.9%*	*9.1%*	*12.7%*	*13.8%*	*3.3%*	*6.0%*	*13.8%*	*3.9%*	*6.4%*	*4.8%*	*9.0%*
Peak Demand (MW)	2,435	2,544	2,682	3,100	3,581	3,613	4,000	4,455	4,634	5,047	5,565	5,920	6,116	6,168	
Growth (%)		*4.5%*	*5.4%*	*15.6%*	*15.5%*	*0.9%*	*10.7%*	*11.4%*	*4.0%*	*8.9%*	*10.3%*	*6.4%*	*3.3%*	*0.9%*	*7.5%*

Demand Projections

OPWP's 7-year electricity demand projections cover energy, average demand, and peak demand requirements. Peak demand is the most relevant parameter for purposes of assessing capacity expansion requirements. The projections of energy demand are necessary to identify fuel requirements over the forecast period, which is illustrated further in the Fuel section.

The demand projections for the MIS have been developed on the basis of: (1) quantitative analyses of weather and macroeconomic demand drivers; (2) consultations with the electricity distribution companies and other relevant entities such as large industries; (3) historical growth trends; and (4) assessment of past forecasts against out-turns.

The projections are derived principally from scenarios of economic growth in the Sultanate, specifically to the growth trend in Gross Domestic Product (GDP). Economic growth slowed following the fall in oil prices in 2014 and 2015, and is yet to fully recover. In 2017, GDP declined in real terms by 0.9%. The most recent growth estimates for 2018 and 2019 are 1.9% and 3.4% respectively.[6] OPWP demand scenarios reflect forecasts of Oman economic growth published by the World Bank and International Monetary Fund (IMF). OPWP assumes a long-term range for annual GDP growth from 1.8% to 3.5%, as determinants for the Low, Expected, and High Case scenarios for electricity demand projections.

The projections are then aligned with analyses of distribution system demands, which are assessed on a "macro" basis by distribution company zone, and certain bulk loads that are assessed on a specific customer basis. Distribution system demand is comprised mainly of residential, service sector (including government and commercial buildings, tourism facilities), and small- to medium- scale industrial demand in all MIS regions.

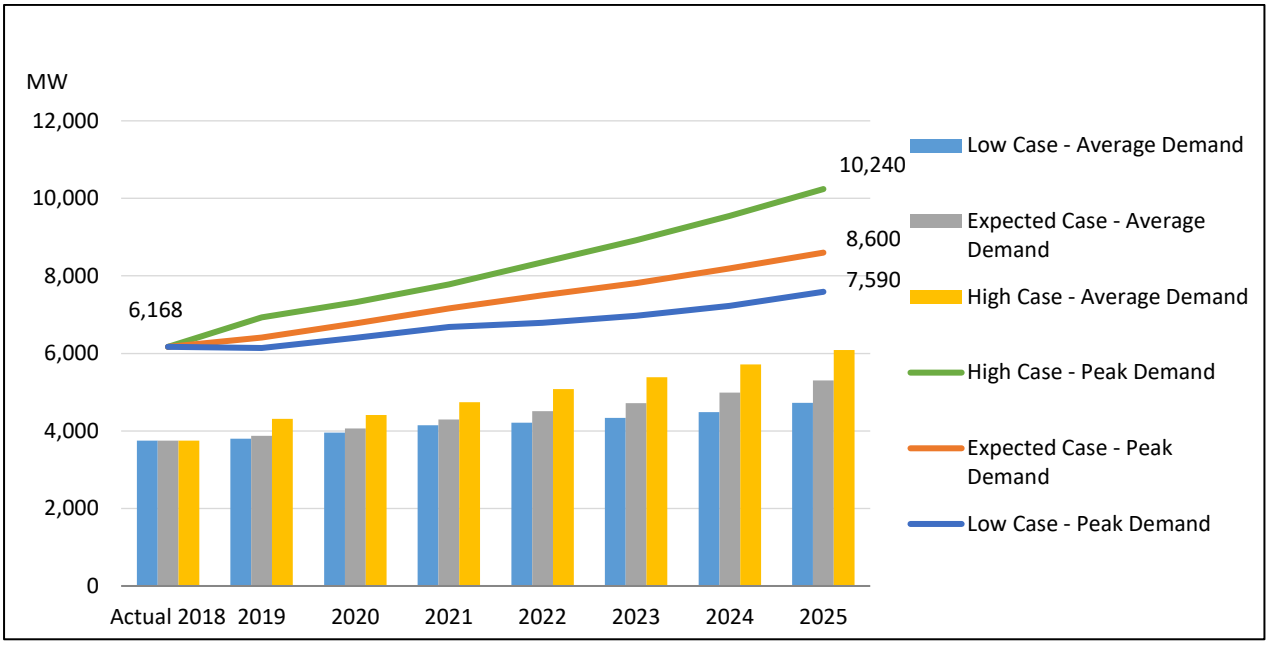
The growth in demand from very large loads (generally large industries and infrastructure projects) comprises both new projects and expansion of existing industrial plants. Industrial projects are located mainly in the Sohar Industrial Port and Sohar Free Zone. Infrastructure projects include, for example, the desalination plants and airports.

With the introduction of the CRT, it is observed that some large customers have shifted their demand in response to the new tariff. We have studied the impact of CRT since 2017 for grid-connected customers and estimated a reduction of about 130 MW in peak demand. We have identified that the majority of large industrial customers that have the ability to make behavioral, or short-term, changes in response to the time-differentiated CRT have already responded. We expect more CRT impacts to develop over the coming years as consumers make further investments in systems/capabilities to control and/or shift consumption to periods of lower cost. The Expected Case scenario includes a CRT impact of about 400 MW by 2025. Policy development will also affect the pace and extent of consumer response to CRT, such as whether tariff reform is extended to other consumer categories, and whether energy efficiency promotion or standards programs are implemented. It is noted that the AER has begun activities to carry out energy audits in the majority of government buildings – OPWP will continue to monitor the overall impact of these activities and account for them in future forecasts.

The projections are presented as a range bounded by Low Case and High Case scenarios, and a central Expected Case forecast. These are summarized in Figure 2.

[6] World Bank, Global Economic Prospects, January 2019.

Figure 2 Electricity Demand Projections – MIS



	Actual 2018	2019	2020	2021	2022	2023	2024	2025	Average Growth (%)
Expected Case Demand									
Average Demand (MW)	**3,748**	**3,871**	**4,065**	**4,295**	**4,508**	**4,719**	**4,987**	**5,304**	**5%**
Distribution Loads	3,164	3,161	3,235	3,305	3,438	3,609	3,857	4,164	4%
Directly-Connected Loads	584	710	830	990	1,070	1,110	1,130	1,140	10%
Annual Energy (TWh)	**33**	**34**	**36**	**38**	**39**	**41**	**44**	**46**	**5%**
Peak Demand (MW)	**6,168**	**6,410**	**6,770**	**7,160**	**7,500**	**7,810**	**8,190**	**8,600**	**5%**
Change from 2018-2024 Statement (MW)	*-352*	*-590*	*-660*	*-670*	*-800*	*-860*	*-820*	-	**-**
Low Case Demand									
Average Demand (MW)	**3,748**	**3,804**	**3,958**	**4,148**	**4,216**	**4,338**	**4,485**	**4,723**	**3%**
Distribution Loads	3,164	3,174	3,208	3,298	3,256	3,358	3,485	3,713	2%
Directly-Connected Loads	584	630	750	850	960	980	1,000	1,010	8%
Annual Energy (TWh)	**33**	**33**	**35**	**36**	**37**	**38**	**39**	**41**	**3%**
Peak Demand (MW)	**6,168**	**6,140**	**6,400**	**6,680**	**6,790**	**6,970**	**7,230**	**7,590**	**3%**
Change from 2018-2024 Statement (MW)	*-352*	*-590*	*-640*	*-690*	*-930*	*-950*	*-870*	-	**-**
High Case Demand									
Average Demand (MW)	**3,748**	**4,314**	**4,412**	**4,740**	**5,081**	**5,389**	**5,714**	**6,090**	**7%**
Distribution Loads	3,164	3,354	3,312	3,480	3,701	3,959	4,274	4,640	6%
Directly-Connected Loads	584	960	1,100	1,260	1,380	1,430	1,440	1,450	14%
Annual Energy (TWh)	**33**	**38**	**39**	**42**	**45**	**47**	**50**	**53**	**7%**
Peak Demand (MW)	**6,168**	**6,930**	**7,320**	**7,780**	**8,350**	**8,920**	**9,550**	**10,240**	**8%**
Change from 2018-2024 Statement (MW)	*-352*	*-720*	*-870*	*-940*	*-1,060*	*-1,030*	*-960*	-	**-**

The Expected Case scenario projects 5% annual growth in energy demand (i.e, average demand). Peak demand is also projected to increase at an annual average of 5% per year, from 6,168 MW in 2018 to 8,600 MW in 2025.

The Expected Case projections for both peak demand and total energy requirements are noticeably lower than that in the previous 7-Year Statement (Issue 12), due to current expectations of economic growth. This scenario assumes peak demand growth in the range of 4-6% from 2019 to 2021, settling to about 5% growth for the balance of the period to 2025. The GDP growth assumptions underlying the forecast are 3.4% in 2019, 2.8% in 2020, and an average of 2.8% growth per year for the remainder to 2025.

The Low Case scenario projects peak demand growth at an average of 3% per year, from 6,168 MW in 2018 to 7,590 MW in 2025. Annual average demand under this scenario is also expected to grow at around 3% per year. This follows an assumption of more modest economic growth than the Expected Case scenario and somewhat higher CRT impacts.

The High Case scenario projects peak demand to grow at 8% annually, to 10,240 MW in 2025. The total energy growth rate is projected to grow at a slightly lower rate, at 7% per year. These higher growth rates correspond to more robust GDP growth at about 3.4% on average for the forecast period. The High Case is not considered to be an extreme scenario: this 7-year economic growth trend would be lower than any previous 7-year period since that ending in 2008. Rather it is a plausible upper bound scenario for planning purposes, considering international expectations. The High Case also assumes a somewhat lower CRT impact compared to other scenarios.

The three demand projections are reference scenarios assuming normal weather conditions. Extreme weather may occur in any year, potentially increasing or decreasing peak demand up to 200 MW against the projected peak demand. These potential fluctuations are not shown in the demand forecast, as they do not affect the underlying multi-year trend. However, they are taken into account in the assessment of capacity requirements.

1.1.B Power Generation Resources

Sources of Power

OPWP purchases power from a number of sources via power purchase agreements (PPAs), power and water purchase agreements (PWPAs) and other similar agreements. The contractual arrangements for power delivery under these agreements may be differentiated as firm capacity, reserve-sharing, non-firm capacity, and energy-only. These terms are relevant for generation planning purposes.

All of the main power plants in the MIS are contractually committed to provide a specific generation capacity (in MW) upon demand, to be dispatched by the OETC, and to maintain specific availability levels. These are firm capacity contracts, also termed **“contracted capacity”**.

OPWP also purchases power from a number of sources where the contractual arrangements do not provide a guaranteed level of capacity upon demand. They may be termed collectively as **“non-firm resources”**. They currently include (1) reserve-sharing arrangements with other power systems via interconnection agreements, (2) capacity exchanges/energy purchases from industries with captive power generation facilities, where such industries use their embedded generators mainly for self-supply, and (3) renewable energy projects from intermittent sources, such as solar PV (without storage) and wind. In these cases no specific capacity is committed to OPWP. The availability of capacity for use by OPWP at any particular time may be subject to the other party’s first use, although reserve-sharing agreements with neighboring power systems commit support during emergencies for

specified periods of time. Collectively, non-firm resources provide reliability benefits to the MIS, in that capacity is generally available according to pre-arranged schedules or during contingency events, accordingly, a portion of this capacity can be considered to provide contributions towards meeting peak demand requirements.

The Government of Oman has recently adopted a fuel diversification policy. Whereas all the generators procured by OPWP currently use natural gas as their primary fuel, the fuel diversification policy requires that new renewable energy (RE) projects contribute 10% of generation output by 2025. A key objective of this policy is to release domestic gas committed to the power sector, to be available to stimulate industrial and economic development. OPWP has embraced this policy and is implementing a development plan to achieve the targets, as described below.

Solar and Wind projects, to be developed toward the RE target, are non-firm resources to the extent that their energy output is intermittent and non-dispatchable. However, OPWP has further refined the analyses made with respect to estimating the renewable energy contribution towards meeting peak demand requirement on the basis of their impact on the statutory loss-of-load (reliability) standard. These modelling activities were based on ground measurement data collected over a number of years, and correlation with satellite data where no such ground measured data is available. Once specific projects are under development, and later in operation, OPWP may adjust these estimates on the basis of specific locations, technology being deployed, and production out-turns.

Contracted Capacity

OPWP's present portfolio of contracted capacity for electricity generation in the MIS comprises of eleven P(W)PAs. A summary of these contracted capacities can be found in Table 1.

A summary of the generation capacity that is expected to be provided under these P(W)PAs over the 2019-2025 period is set out in Figure 3. This shows total contracted capacity of 9,764 MW in 2019, which then steadily decreases to 6,823 MW by 2024. The reduction in contracted capacity is due to a number of contract expirations during the period as detailed amongst the following main developments:

Al Kamil IPP: Contracted capacity of 291 MW at 45°C. The PPA is scheduled to expire on 31st December, 2021. Al Kamil IPP represents one of the projects that is able to compete under the Power 2022 procurement, potentially extending the PPA for a number of years.

Barka IWPP: PWPA is scheduled to expire on 31st December, 2021. The current agreement provides contracted capacity of 388 MW during normal operation in CCGT mode without MSF water production. Barka IWPP is another project that is expected to compete under the Power 2022 procurement.

Barka II IWPP: Contracted capacity of 688 MW at 45°C. The P(W)PA is scheduled to expire in 2024, where it will then be able to compete for a new long-term with OPWP under the Power 2024 procurement.

Ibri IPP: The plant is currently under construction and contracted to deliver full base-load capacity of 1,539 MW, utilizing CCGTs, which is expected to be fully operational by end of May 2019.

Manah IPP: Contracted capacity of 264 MW at 45°C. The PPA expires on 30 April 2020. Manah IPP is unique in that it was developed under a Build-Own-Operate-Transfer (BOOT) model, and transfers to

the Government upon contract expiry. OPWP is currently evaluating the prospects for a sale of the asset under a new PPA for an extended period.

Rusail IPP: Contracted capacity of 694 MW at 45°C. The PPA is scheduled to expire on 31st March 2022. Rusail IPP is another plant that is eligible to compete under the Power 2022 procurement.

Sohar IWPP: Contracted capacity of 597 MW at 45°C. The PWPA is scheduled to expire on 31st March 2022. Sohar IWPP is another project with CCGT units that is eligible to compete under the Power 2022 procurement cycle.

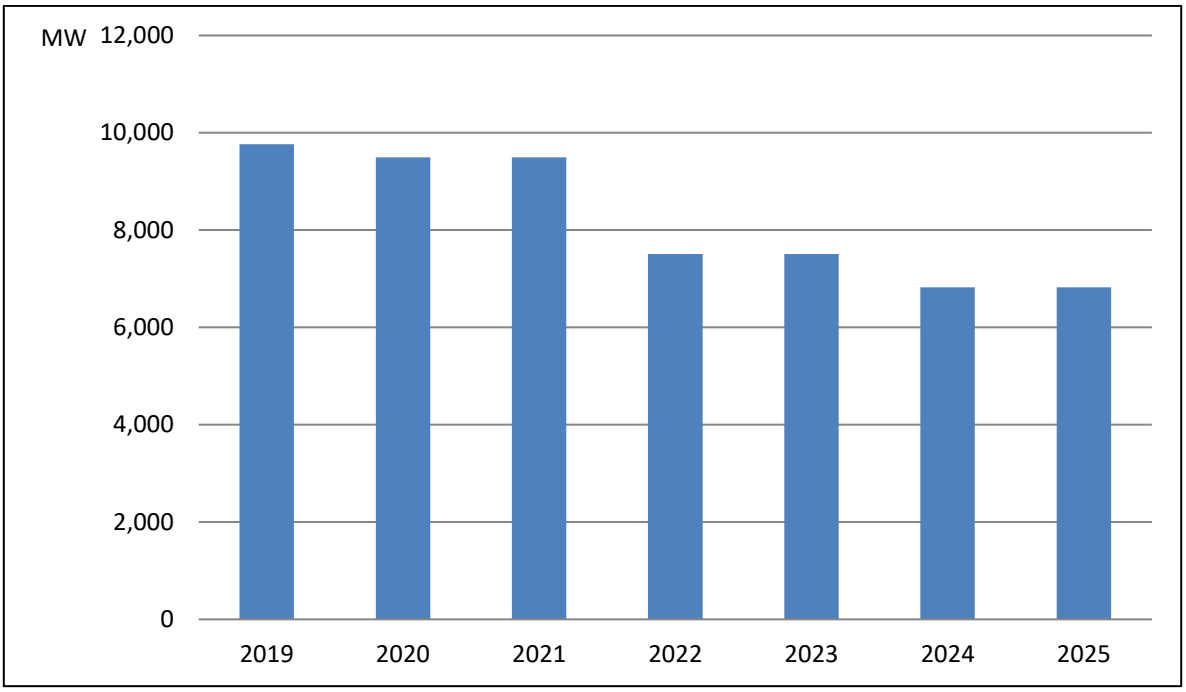
Sohar III IPP: The plant is under construction and contracted to deliver full base-load capacity of 1,744 MW, utilizing CCGTs, which is expected to be fully operational by end of May 2019.

Table 1 Contracted Capacities (PPAs/PWPAs) – MIS

Project Name	Contracted Capacity[a]	Contract Type	Project Company	Project Status	Technology	Contract Expiry
Al Kamil IPP	291 MW	PPA	Al Kamil Power Co. (SAOG)	Operational	OCGT Natural gas fired Fuel oil as back-up	2021
Barka IWPP	397 MW	PWPA	ACWA Power Barka (SAOG)	Operational	CCGT Natural gas fired Fuel oil as back-up	2021
Barka II IWPP	688 MW	PWPA	SMN Barka Power Co. (SAOC)	Operational	CCGT Natural gas fired Fuel oil as back-up	2024
Barka III IPP	766 MW	PPA	Al Suwadi Power Co. (SAOC)	Operational	CCGT Natural gas fired Fuel oil as back-up	2028
Ibri IPP	1,539 MW	PPA	AD'Dhahirah Generating Company	Under construction	CCGT Natural gas fired Fuel oil as back-up	2034
Manah IPP	264 MW	PPA	United Power Co. (SAOG)	Operational	OCGT Natural gas fired Fuel oil as back-up	2020[b]
Rusail IPP	694 MW	PPA	Rusail Power Co. (SAOC)	Operational	OCGT Natural gas fired Fuel oil as back-up	2022
Sohar IWPP	597 MW	PWPA	Sohar Power Co. (SAOG)	Operational	CCGT Natural gas fired Fuel oil as back-up	2022
Sohar II IPP	766 MW	PPA	Al Batinah Power Co. (SAOC)	Operational	CCGT Natural gas fired Fuel oil as secondary fuel and back-up	2028
Sohar III IPP	1,744 MW	PPA	Shinas Generating Co. (SAOC)	Under construction	CCGT Natural gas fired Fuel oil as back-up	2034
Sur IPP	2,018 MW	PPA	Phoenix Power Co. (SAOC)	Operational	CCGT Natural gas fired Fuel oil as back-up	2029

[a] Contracted capacities are shown as of summer 2018 at 45°C, adjusted from the reference condition of 50°C using contractually agreed upon correction factors and as reported as net of plant auxiliaries.
[b] Manah IPP follows a "Build-Own-Operate-Transfer" (BOOT) model.

Figure 3 Contracted Generation Capacity – MIS



	2019	2020	2021	2022	2023	2024	2025
Contracted Capacity			Net MW [a]				
Manah IPP[b]	264	-	-	-	-	-	-
Al Kamil IPP	291	291	291	-	-	-	-
Barka IWPP[c]	397	397	397	-	-	-	-
Rusail IPP	694	694	694	-	-	-	-
Sohar IWPP	597	597	597	-	-	-	-
Barka II IWPP	688	688	688	688	688	-	-
Sohar II IPP	766	766	766	766	766	766	766
Barka III IPP	766	766	766	766	766	766	766
Sur IPP	2,018	2,018	2,018	2,018	2,018	2,018	2,018
Ibri IPP	1,539	1,538	1,537	1,535	1,535	1,535	1,535
Sohar III IPP	1,744	1,742	1,741	1,738	1,738	1,738	1,738
TOTAL	**9,764**	**9,497**	**9,495**	**7,511**	**7,511**	**6,823**	**6,823**

[a] All capacities are rated on a net basis (i.e. after allowing for auxiliary consumption inside the plants) at 45°C ambient temperature.

[b] The contract with the current owner will expire in April 2020, as such, is not represented in the above table in 2020 as it shall not contribute to meeting peak demand requirements for that year.

[c] Barka IWPP's accessible contracted capacity is 439 MW. The plant is expected to be operated in open cycle configuration allowing the MSF unit to be available in standby mode. This configuration allows a dispatch of 397 MW only.

Non-Firm Resources under Contract

In addition to the contracted capacity described above, OPWP has contracts with a number of other generation sources, although these contracts are not for firm capacity commitments. They include the following and are summarized in Table 2:

- the 220 kV interconnect with the UAE (Abu Dhabi) power system at Mahadha; and
- the surplus generation of industries (and other parties) with captive power generation facilities.

Table 2 Non-Firm Resources under Contract - MIS

	2019	2020	2021	2022	2023	2024	2025
				MW			
SAC[a b]	180	180	180	180	180	180	180
GCC Interconnection[a]	200	200	200	200	200	200	200
Total Capacity	**380**	**380**	**380**	**380**	**380**	**380**	**380**

[a] Contributions from non-firm resources include the assessed capacity benefit of reserve-sharing arrangements with the GCCIA over the UAE interconnect (200 MW), and the power exchange with Sohar Aluminium (180 MW).
[b] Current agreement with SAC is scheduled to expire at the end of 2021. Following such, the agreement with SAC may be extended further, or SAC may opt to participate in the Spot Market.

MIS-UAE (Abu Dhabi) Interconnect. A 220 kV interconnection between the Oman (MIS) and UAE (Abu Dhabi) power systems has been commercially operational since 2012. Oman has been a member of the GCCIA since December 2014, and has access to the other five Member State power systems via this link. Benefits of the interconnection include firm support during emergencies, and opportunities to trade electricity and coordinate both planning reserves and operating reserves.

The interconnection is a double circuit link that supports reliable transfers of up to 400 MW and can carry up to 800 MW in emergencies. The link has provided emergency reserves on a number of occasions, preventing power failures in the MIS. In 2016, AER approved OPWP's recognition of the interconnects contribution to planning reserve requirements, based on its record of performance and the contractual obligations with the GCCIA to provide reserves support.

OPWP has completed energy exchanges with Abu Dhabi Transco in 2016 and 2018, for net fuel savings at no cost. Further trading opportunities with GCCIA neighbors are expected in coming years.

Surplus Generation. Several industries with captive power plants are connected with the MIS and have surplus power that may be purchased by OPWP. OPWP has an agreement with Sohar Aluminium Co. (LLC), whereby Sohar Aluminium exports up to 180 MW to the MIS during the summer, and imports a like amount of energy from OPWP during the winter on an annually determined schedule. The schedule and operations are managed to assure that energy exports balance with energy imports. This arrangement benefits both parties: Sohar Aluminium is better able to schedule the maintenance of its generating units and gains reliability of supply, while OPWP gains an efficient generating resource during the summer and improves the system Load Factor. The agreement with Sohar Aluminium (180 MW) was renewed in 2018 for an additional three years.

Resource Development Plan

OPWP continues to commit to the Fuel Diversification Policy issued by the Government by ensuring alignment with its' resource development plan such that this plan features rapid development of renewable energy (RE) resources and implementation of OPWP's new procurement methodology for gas-fired PPAs. The resource development plan comprises new capacity contracts, renewable energy contracts, demand response, and capacity contributions from other non-firm resources.

Planned Contracts for Guaranteed Capacity. OPWP anticipates three procurement initiatives for projects in the MIS that would provide guaranteed capacity during this 7-year period. Table 3 summarizes the capacity expectations from these projects.

Table 3 Planned Contracts for Guaranteed Capacity - MIS

	2019	2020	2021	2022	2023	2024	2025
				Net MW [a]			
Manah IPP Sale/ New PPA	-	264	264	264	264	264	264
Power 2022[a]	-	-	-	600	600	600	600
Power 2024	-	-	-	-	-	700	700
Duqm Power System - Export to MIS	-	-	-	-	-	-	497
TOTAL	**-**	**264**	**264**	**864**	**864**	**1,564**	**2,061**

[a] Subject to the outcome of the evaluation process, the awarded capacity under Power 2022 may be in a range around 600 MW.

These projects are described below in more detail:

- **Manah IPP Sale / New PPA.** The PPA expires in April 2020, and ownership of the plant transfers to the Government. OPWP is currently evaluating the prospects for a sale of the asset under a new PPA. Upon obtaining necessary approvals, OPWP expects to proceed with the asset sale in 2019. The current contracted capacity is 264 MW.

- **Power 2022.** The Power 2022 procurement initiative is ongoing: a competitive tender for long-term PPAs that commence in 2022. Dependent upon peak demand growth and assessment of the system security achieved PPAs may be awarded to a combination of bids with a total capacity in a range around 600 MW. Four I(W)PPs whose P(W)Pas are expiring in 2022 are participating as bidders for Power 2022. Bidders that are not awarded PPAs may participate in the new electricity Spot Market. They may later participate in future procurement cycles for long-term PPAs, such as Power 2024, if that is deemed to be necessary.

- **Power 2024.** OPWP plans to initiate the Power 2024 procurement in 2020 for new long-term PPAs that commence in 2024. It would follow a similar approach as that described above for Power 2022. Our current assessment for the capacity requirement is 700 MW. This is likely to change depending upon the outcome of Power 2022, demand growth, and assessments of capacity contributions from other resources, such as the spot market.

- **Duqm Power System – Export to MIS.** OPWP expects to develop several IPPs near Duqm which, by 2025, would have low-cost surplus capacity (over local Duqm demand) available to

export to the MIS via the North-South Interconnect. The projects are described below in section 1.2, Ad Duqm Power System. Table 3 shows the expected export capacity in 2025.

Renewable Energy (RE) Development. In December 2017, OPWP announced a tender for a 500 MW solar PV project to be located at Ibri. This is the first in a series of renewable energy (RE) IPP tenders that are planned to achieve the Government's target of 10% RE share of electricity generation by 2025.

OPWP's renewable energy development plan currently comprises solar, wind, and waste-to-energy (WTE) projects. OPWP plans to procure around 2,200 MW of RE IPPs in the MIS by 2025 (additional RE IPPs are also being planned for other systems, and are reported further in this publication). Table 4 summarizes the plan through 2025. The locations and type of RE projects will depend on approval of transmission projects and site allocations. OPWP expects to adapt the RE development plan as site acquisition and transmission development are approved and confirmed.

Table 4 Renewable Energy Development Plan – MIS

	2019	2020	2021	2022	2023	2024	2025
				MW[a]			
Ibri II Solar IPP	-	-	-	500	500	500	500
Solar IPP 2022[b]	-	-	-	-	500	500	500
Solar IPP 2023	-	-	-	-	-	500	500
Solar IPP 2024	-	-	-	-	-	-	500
Wind IPP 2023	-	-	-	-	-	100	100
Barka WTE IPP[c]	-	-	-	-	100	100	100
Total Capacity	**-**	**-**	**0**	**500**	**1,100**	**1,700**	**2,200**
Capacity Contribution	**-**	**-**	**0**	**100**	**295**	**430**	**530**

[a] The year in which capacities are reported represent the year in which the project is anticipated to contribute to peak demand requirements. The majority of these projects are anticipated to achieve COD in the year associated to the name of the project (for example, Solar IPP 2022 is expected to achieve COD in 2022), however, for the majority of the cases, is currently expected to be operational in Q3 or Q4 of that year, that is after the period of system peak demand. As such, they are offset by one year in the above table.
[b] Capacity of Solar IPP 2022 could be expanded to 1,000 MW by merging with Solar IPP 2023, subject to the outcome of market scoping, competition, and other studies.
[c] Feasibility study indicates a range of up to 160 MW depending on guarantees to be contracted via the Waste Supply Agreement. A minimum of 100 MW is reported here and will be adjusted in future publications based on the outcome of the Agreement.

OPWP plans for solar, wind, and WTE development are described as follows:

- **Solar Energy.** The current procurement of 500 MW solar PV (Ibri II Solar IPP) has scheduled COD in Q2 2021. We plan successive annual tenders of 500 MW, with the potential of targeting larger capacities. OPWP is assessing the value of different solar energy technologies to the system, and may specify the desired technology in future procurement cycles (PV vs CSP).

  OPWP plans that solar energy development will occur at multiple sites, and some tenders may involve multiple developer awards. OPWP has a process underway for site allocation and transmission access, with the full support of the relevant Government agencies.

  OPWP operated two solar monitoring stations at Adam and Manah during the years 2012-2016, collecting data in support of project development. The data is publicly available on the OPWP website. OPWP is assessing the need to relocate the measurement devices to other locations where data will support bankable projects.

OPWPs current expectation is that solar PV projects will contribute at least 20% of their peak installed capacity to the MIS peak demand. This was revised from last years' estimates of 30% following analysis of the impact of solar PV on meeting system reliability standards (24 LOLh). Specific projects may contribute somewhat more or less, depending on their location, configuration, supplementary systems such as energy storage, and any changes in system demand profile. Generally speaking, solar energy output peaks when the sun is directly overhead, and declines toward zero by sunset. OPWP plans to reassess the capacity contributions of specific projects as they are awarded, and the technology and project configuration are defined. The estimated capacity contribution of solar PV and other RE projects is shown in Table 4.

- **Wind Energy.** The Sultanate's first utility-scale wind farm will be operated by RAECo under a PPA with OPWP. The 50 MW project is currently under construction at Harweel in Dhofar Governorate, and is expected to begin operation in 2020. The most promising areas for onshore wind energy development are in coastal highland areas of Dhofar and Al Wusta Governorates, although certain mountainous areas of Sharqiyah Governorate also have potential.

  In 2019, OPWP plans to re-tender for a Wind Resource Assessment (WRA) campaign. Under the WRA, OPWP plans to install a number of wind monitoring stations at sites that provide the highest potential for development. These stations will provide data at 10-minute intervals, at various heights up to 80 meters, to support wind project development. This data will be published on OPWP's website and provided in RFP documents when the projects are tendered. OPWP recognizes that providing this data openly is key in securing competitive financing and leads to an overall lower risk profile of the intended project.

  OPWP plans to develop wind energy projects in tenders of 100-200 MW, subject to market assessment and site suitability. Generally, utility-scale wind energy development in Al Wusta Governorate needs transmission access to the MIS demand area. The new 400 kV transmission line from Izki to Duqm is expected to be completed in 2023. Hence, the wind energy development in sites of high value for the MIS is linked to the transmission line development. In parallel, OPWP is also assessing the development of wind projects in sites that are already in close proximity to the MIS, such as in the Al Sharqiyah region. The first project is scheduled to reach COD in 2024. The project procurement would initiate the qualifications process in 2021.

  Wind energy output is seasonal and intermittent during the day. The greatest output periods for the Dhofar project are expected to be in the evening and night. OPWP has utilized ground-measured wind data in Harweel, supplemented by satellite data, to estimate the contribution of wind projects to generation adequacy at around 35% of the projects' installed capacity. This may change as data is collected from the WRA and award of projects providing accurate configuration and yield assessments at specific sites.

- **Waste-to-Energy (WTE).** In 2018, OPWP completed a feasibility study of a WTE project, building upon previous studies by Be'ah[7] for a project at Barka supplied by waste collections from Muscat and South Batinah. The Feasibility study indicates a range of up to 140 MW depending upon the energy content of waste, to be specified in the Waste Supply Agreement. A minimum of 100 MW is reported here and will be adjusted in future publications based on the outcome of the Agreement. The RFP for the project is expected to be released by Q3 2019 to achieve the COD date of Q2 2023. This project is being competitively procured as an IPP, under a long-term PPA with OPWP, using municipal solid waste supplied by Be'ah. OPWP expects it to be a continuously operating plant, i.e., baseload supply, with guaranteed capacity similar to supply from the gas-fired power plants currently under contract with OPWP. In Table 4, we assess a 95% capacity contribution to the installed capacity of the WTE plant.

Planned Capacity Contributions from Other Sources. As described earlier in this section, OPWP plans to purchase power from a number of sources where the provision of capacity is not guaranteed to OPWP. That said, a portion of this capacity can be considered to provide contributions towards meeting peak demand requirements. Table 5 summarizes the future expectations from the two primary sources for this category of capacity contributions, Demand Response and the Spot Market.

Table 5 Planned Capacity Contribution from Other Sources - MIS

	2019	2020	2021	2022	2023	2024	2025
				MW			
Demand Response[a]	-	-	30	40	50	70	100
Spot Market[b]	-	-	-	TBD	TBD	TBD	TBD
Total Capacity	**-**	**-**	**30 +**	**40 +**	**50 +**	**70 +**	**100 +**

[a] Reported levels of Demand Response represents a target. These quantities will need to be proven (and approved by the AER) before they can be considered as firm capacity.
[b] Spot Market capacity contribution will be evaluated following the "Power 2022" procurement process and evaluation of 2024 capacity requirements.

These planned initiatives are mentioned below:

- **Demand Response.** Demand Response (DR) can provide a significant and cost-effective resource toward reducing capacity requirements. OPWP has set a target to achieve a 100 MW capacity contribution from DR by 2025. OPWP conducted a preliminary proof-of-concept trial at one site in 2016, reducing demand by 25 MW during the peak period. In 2019, OPWP plans to identify DR potential in more customer segments, assess compensation options, and begin to develop verification protocols and contracting approaches. Demonstration trials would recommence in 2020. OPWP expects to launch the DR program for commercial operation in 2021.

- **Electricity Spot Market**. Development of the Oman electricity spot market is proceeding on schedule. AER approved the detailed market rules in 2017, with the understanding that certain technical annexes and methodologies will be finalized during implementation of the IT system.

[7] Be'ah (Oman Holding Company for Environment Services SAOC) was established by Royal Decree (46/2009) to undertake solid waste management and framing sustainability goals in terms of resource preservation in the Sultanate of Oman.

OPWP has commenced staffing the Market Operator organization, which is intended to be a ring-fenced department within OPWP, and implementation of the Market Management System is under way. The market is scheduled to begin operational trials during 2020 and commercial operation is targeted for the end of 2020. The electricity spot market will operate alongside the existing system of long-term PPAs and PWPAs.

OPWP expects that the spot market will increase competition in Oman's power generation market, and make available additional capacity that might otherwise not be readily accessible through the existing P(W)PA procurement channel. We have indicated its capacity contribution in Table 5 as "TBD", that is, To Be Determined. There have been preliminary indications of interest from some existing and prospective industrial plants to participant in the market as generators, but these may not be confirmed until the market begins operation. OPWP expects that some existing plants participating in the Power 2022 procurement may join the spot market if they are not awarded new P(W)PAs, considering that the capacity requirement from Power 2022 is less than the current aggregate capacity of these plants. OPWP plans to assess the capacity contribution of spot market participants coming out of the Power 2022 initiative after new P(W)PA awards have been made.

Capacity Transactions with Other Power Systems. Energy trades or firm capacity purchases from neighboring power systems are important potential resources. Firm capacity exchanges have taken place between OPWP and ADWEC in 2016 and 2018. OPWP is finalizing arrangements with GCCIA to facilitate trade agreements with other GCCIA Member States.

The 400 kV North-South Interconnect project is currently on schedule for completion in 2023. OPWP and RAECo have coordinated supply plans accordingly for Duqm, Mahout and the MIS. These systems will be fully integrated and power flows between them will not be considered as capacity transactions.

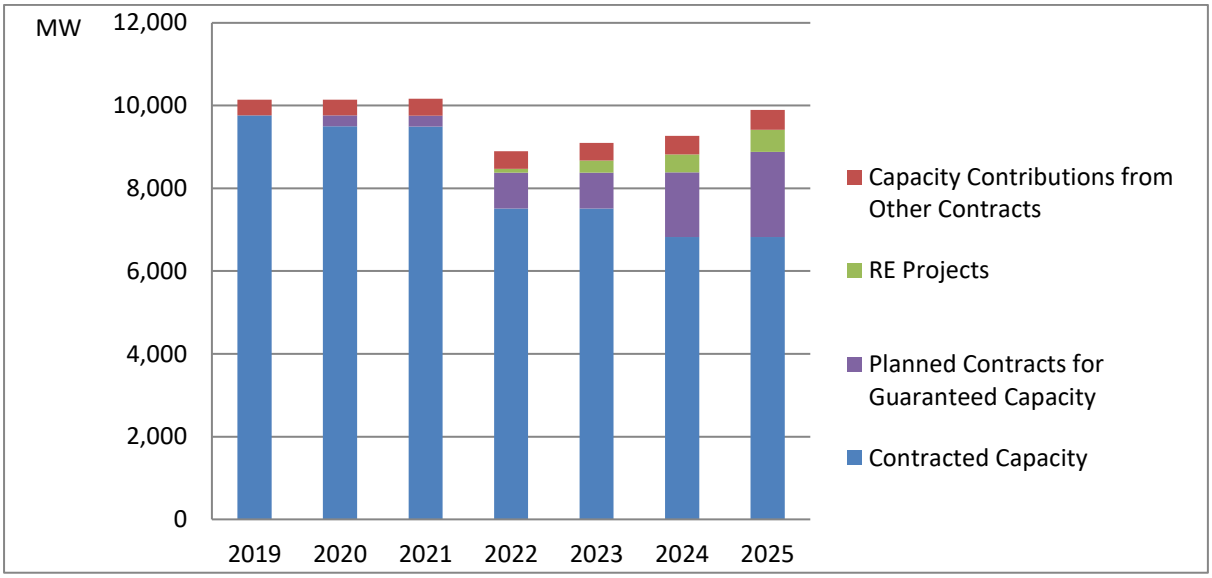
The 400 kV connection with the PDO system at Nahadah will enable large-scale capacity transactions and operational integration with PDO. No specific transactions have yet been planned, but OPWP and PDO are currently integrating resource plans relevant to the MIS and northern PDO system.

A direct 400 kV interconnect from Ibri to the Kingdom of Saudi Arabia and linking to GCCIA has also been evaluated and is in the planning process. This project would provide direct access to all GCCIA Member States and would enhance the benefits in stability, generation planning, and trade opportunities relative to the existing 200 kV link via UAE.

Summary

Figure 4 provides a summary of OPWP's current plans for generation capacity and resource development in the MIS for the period 2019 to 2025. The capacity indicated for each year corresponds to the quantity available as of the onset of the summer peak season in May.

Figure 4 Capacity Contributions from Generation Resources – MIS



	2019	2020	2021	2022	2023	2024	2025
				MW			
Contracted Capacity							
Total Contracted Capacity	**9,764**	**9,497**	**9,495**	**7,511**	**7,511**	**6,823**	**6,823**
Planned Contracts for Guaranteed Capacity							
Manah IPP Sale/ New PPA	-	264	264	264	264	264	264
Power 2022	-	-	-	600	600	600	600
Power 2024	-	-	-	-	-	700	700
Duqm IPP(s) (Export to MIS)	-	-	-	-	-	-	497
Total Planned Contracts for Guaranteed Capacity	**-**	**264**	**264**	**864**	**864**	**1,564**	**2,061**
Capacity Contributions from RE Projects							
Renewable Energy	-	-	-	100	295	430	530
Capacity Contributions from Other Contracts							
Demand Response	-	-	30	40	50	70	100
Non-firm Contracts [a]	380	380	380	380	380	380	380
Total Capacity Contributions to Peak Demand	**10,144**	**10,141**	**10,169**	**8,895**	**9,100**	**9,267**	**9,894**

[a] Includes SAC and GCC Interconnection

1.1.C Resource Adequacy and Mitigation Plans

Statutory and Regulatory Requirements

OPWP is required by the Sector Law and its license to ensure the adequacy of generation resources to meet future power demands. The Sector Law establishes OPWP's general responsibility to secure sufficient generation resources to meet the aggregated demands of licensed electricity suppliers. Further to this, the license issued to OPWP by the Authority for Electricity Regulation, Oman (AER) stipulates a specific generation security standard for the MIS that OPWP must comply with.

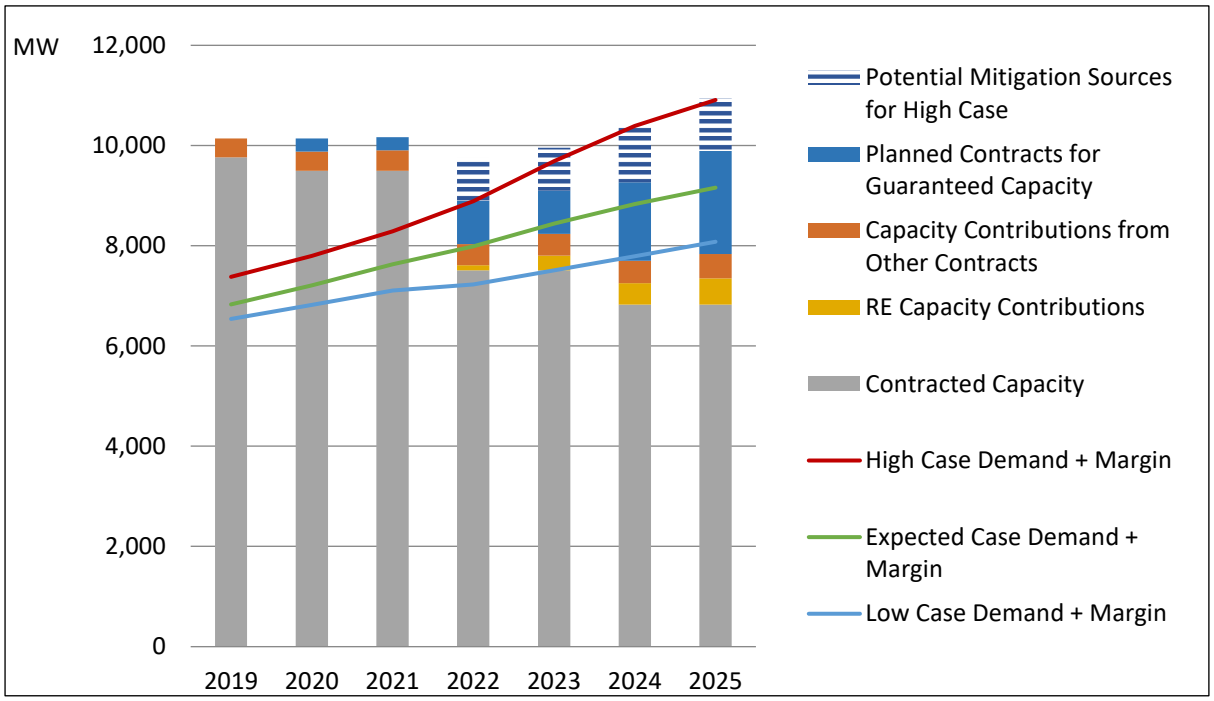
The generation security standard sets a maximum duration of power outage for the system, termed Loss-of-Load Hours ("LOLH"). OPWP must enter into agreements for enough production capacity to ensure that expected demand does not exceed available capacity for more than 24 hours in any year. This LOLH measure considers relevant uncertainties such as the reliability of generation units and the availability of non-firm generation resources. On a short-term basis, OPWP must demonstrate to the AER that sufficient supply agreements are in place to prevent an excess of 24 LOLH. On a long-term basis, OPWP must demonstrate that it has credible plans to put such agreements in place (via the procurement of new capacity or otherwise).

OPWP conducts computer simulations of power system performance to assess LOLH under a wide range of conditions that fluctuate randomly. The simulations are the basis for determining the expected level of LOLH and the adequacy of generation to meet the statutory standard. Generally, the number and type of generating units and the demand profile affect the expected LOLH level, which may also be sensitive to generation technology and other factors.

Resource Adequacy in the Expected Demand Scenario

During the 7-year planning horizon OPWP commits to meeting the minimum reliability standard of 24 LOLH, ensuring that after accounting for demand variability and potential forced outages from generators, the potential amount of insufficient supply does not exceed 24 hours in a given year. In order to translate this reliability standard into power capacity planning, OPWP assesses that, on average, a reserve margin of at least 6.5% over forecast peak demand is necessary to assure that expected LOLH in the MIS is 24 hours or less. The 6.5% reserve margin provides a capacity target, and OPWP evaluates resource adequacy on this basis for 2019 to 2025. The assessment can change as the power system develops. In future, as OPWP investigates the impact of new technologies, such as intermittent RE projects, the assessment of loss-of-load incidence may change. Figure 5 compares generation resources to capacity targets (peak demand plus 6.5%) associated with each of the three demand scenarios.

Figure 5 Resource Adequacy - MIS



	2019	2020	2021	2022	2023	2024	2025
Generation Resources				MW			
Contracted Capacity	9,764	9,497	9,495	7,511	7,511	6,823	6,823
Planned Contracts for Guaranteed Capacity	-	264	264	864	864	1,564	2,061
RE Capacity Contributions	-	-	-	100	295	430	530
Capacity Contributions from Other Contracts	380	380	410	420	430	450	480
Total Capacity Contributions to Peak Demand	**10,144**	**10,141**	**10,169**	**8,895**	**9,100**	**9,267**	**9,894**

The resource development plan is developed to provide sufficient capacity to meet the generation security standard for the Expected Demand scenario, with allowances for feasible mitigations that address requirements of the Low and High Demand scenarios. Table 6 compares planned capacity with the capacity target under the Expected Demand scenario. The resource development plan provides sufficient capacity to exceed the capacity target in every year.

Table 6 Resource Adequacy under Expected Case - MIS

	2019	2020	2021	2022	2023	2024	2025
				MW			
Peak Demand	6,410	6,770	7,160	7,500	7,810	8,190	8,600
Export to Duqm [a]	-	-	-	-	119	99	-
Total Peak Demand	**6,410**	**6,770**	**7,160**	**7,500**	**7,929**	**8,289**	**8,600**
Capacity Target (Demand + Margin)	**6,830**	**7,210**	**7,630**	**7,990**	**8,440**	**8,830**	**9,160**
Total Available and Planned Capacity Contracts	10,144	10,141	10,169	8,895	9,100	9,267	9,894
Additional Capacity Required	-	-	-	-	-	-	-

[a] The 400 KV Interconnect to PDO and Duqm is assumed to be completed by June 2023 allowing MIS supply.

In the initial years of the forecast period, from 2019 to 2021, contracted capacity exceeds demand by a significant margin. This is due to new capacity additions that were committed before the extent and effects of the economic downturn on demand became evident.

In 2022, four plants reach the end of their P(W)PA terms, reducing contracted capacity by nearly 2000 MW. The Power 2022 procurement process addresses needs for additional capacity in both 2022 and 2023 to meet the Expected Case demand scenario and to hedge against the High Case demand scenario, while the Power 2024 procurement will meet requirements beginning in 2024. The need for new contracted capacity under Power 2022 is shown in Figure 4 as 600 MW, while the awarded capacity may be in a range around this value.

Under the Expected Case demand scenario, currently contracted capacity is just sufficient to meet the capacity target in both 2022 and 2023, absent any new contract awards under Power 2022. It is the High Case demand scenario that requires additional capacity to be provided under Power 2022, as described under the following subsection.

In 2024, Barka II IWPP will reach the end of its P(W)PA term. New capacity contracts will be required to meet capacity requirements through 2025. Another option for OPWP is to purchase required capacity, or part of it, from the spot market. The Power 2024 procurement process is planned to meet these long-term capacity needs. OPWP currently estimates that we will need to procure about 700 MW via Power 2024, considering contributions from RE and DR resources, and the current demand forecast. This assessment is likely to change before Power 2024 launches, considering updates to demand growth expectations (particularly in Ad Duqm), the pace of project development, and other factors including assessment of capacity contributions from the spot market.

In Q3 2023, it is anticipated that the first phase of the North-South Interconnect project (up to the Duqm Power System) will be completed, as such, Table 6 accounts for additional demand requirements of the Duqm Power System (Extended Case) that can be met by utilizing capacity in the MIS.

Mitigation Options for the High Case Demand Scenario

In the High Case demand scenario, the capacity requirement in 2023 is about 1,250 MW higher than under the Expected Case scenario, and about 1,700 MW higher in 2025. Furthermore, the High Case is not considered an unlikely scenario. It is a scenario of somewhat higher economic growth than current international forecasts for Oman, which are quite uncertain and subject to oil price fluctuations and global economic influences. The High Case assumes average annual GDP growth of 3.4%, which is only marginally higher than growth over the last 5 years and is lower than the past 7-year growth average.

It is the High Case that defines OPWP's requirements from Power 2022. If OPWP procures zero capacity from Power 2022, there would be sufficient capacity under the Expected Case demand but a deficit of around 1,250 MW by 2023 under the High Case scenario. If OPWP were to contract for 1,250 MW under Power 2022 to meet the High Case requirement the risk of undersupply would be mitigated but at a high cost. On balance, OPWP plans to mitigate the risk at reasonable cost by contracting for a range around 600 MW, which may be met under several potential combinations of the competing plants, thereby promoting price competition in the procurement. In the case that more capacity is

needed, one option for OPWP would be to purchase the additional required capacity through the spot market.

Table 7 illustrates resource adequacy for this scenario. In 2022, planned contracts (including 600 MW under Power 2022) are just sufficient to meet the capacity target, but in 2023 there is a deficit of nearly 600 MW. The table shows a number of contingency options that may be available to meet that deficit. The largest of these is our assessment of spot market resources, comprising plant(s) that are not awarded contracts in Power 2022 but may participate in the spot market as uncontracted generation. Other contingency resources, including GCCIA purchases and/or temporary generation, may be required if spot market resources are not sufficient.

OPWP anticipates that up to 650 MW may be available from the spot market, depending upon the level of capacity awards through Power 2022, the need for capacity and assessment of market prices, and the feasibility to extend permits or other necessary conditions for plant operation. OPWP would also evaluate the security of supply with the AER if the likelihood of a supply deficit should increase. Under extreme conditions, short-term PPAs with uncontracted generators may be considered to some extent. The other mitigation options indicated are also quite feasible, though potentially more costly. Oman's GCCIA neighbors indicate surplus capacity on their systems during this period, which OPWP could access as capacity purchases.

These mitigation options confirm OPWP's ability to respond to a surge in demand beyond our Expected Demand forecast. This is important considering the Sultanate's aspirations to stimulate economic growth, and particularly to attract investment in the new industrial hub of Ad Duqm.

Power 2024 provides the opportunity to contract for more capacity than the 700 MW that is indicated, though this can only be available by 2024.

Similar to the Expected Case above, the High Case also accounts for supply requirements to the Duqm Power System beyond 2023 to accommodate for a potential outturn of demand that trends along the High Case in that power system.

Table 7 Resource Adequacy under High Case - MIS

	2019	2020	2021	2022	2023	2024	2025
High Case Scenario				MW			
Peak Demand	6,930	7,320	7,780	8,350	8,920	9,550	10,240
Export to Duqm	-	-	-	-	180	204	-
Total Peak Demand	**6,930**	**7,320**	**7,780**	**8,350**	**9,100**	**9,754**	**10,240**
Capacity Target (Demand + Margin)	**7,380**	**7,800**	**8,290**	**8,890**	**9,690**	**10,390**	**10,910**
Total Available and Planned Capacity Contracts	10,144	10,141	10,169	8,895	9,100	9,267	9,894
Additional Capacity Required	-	-	-	-	*590*	*1,123*	*1,016*
Mitigation Strategy for Deficit							
Spot Market Resources or New Capacity				650	650	640[a]	640[a]
Potential GCC Interconnection Purchase				200	200	200	200
PDO Import				-	-	TBD	TBD
Emergency Temporary Generation						300	200
Total Potential Mitigation Resources				**850**	**850**	**1,140**	**1,040**

[a] Capacity to be procured under Power 2024 may be increased under a High Demand scenario.

Mitigation Options for the Low Case Demand Scenario

In the Low Case demand scenario, the capacity target is nearly 1,000 MW less than in the Expected Demand scenario. The capacity surplus would be high, and OPWP would consider options to improve capacity utilization and reduce the surplus[8].

OPWP's principal approach to mitigation of surplus capacity would be to defer planned procurements, while honoring existing contracts in a situation of capacity surplus. In the current resource development plan, the main mitigation opportunities would include deferral or capacity reduction of Power 2024, and temporary deferral of the Demand Response program. Participants in both the DR program and Power 2024 would have access to the spot market during deferral/suspension periods.

[8] OPWP's action in 2017 provides a good example of mitigation of reduced demand. The previous 7-Year Statement indicated OPWP's plan to procure the Misfah IPP for COD in 2021. However, as the ongoing economic downturn confirmed OPWP's reduced demand forecast, the Misfah IPP procurement was suspended. OPWP's reduction to the capacity target for Power 2022 similarly demonstrates our approach to limit exposure to surplus capacity.

Table 8 Resource Adequacy under Low Case - MIS

	2019	2020	2021	2022	2023	2024	2025
Low Case Scenario				MW			
Peak Demand	6,140	6,400	6,680	6,790	6,970	7,230	7,590
Export to Duqm	-	-	-	-	82	88	-
Total Peak Demand	**6,140**	**6,400**	**6,680**	**6,790**	**7,052**	**7,318**	**7,590**
Capacity Target (Demand + Margin)	6,540	6,820	7,110	7,230	7,510	7,790	8,080
Total Available and Planned Capacity Contracts	10,144	10,141	10,169	8,895	9,100	9,267	9,894
Additional Capacity Required	-	-	-	-	-	-	-
Surplus over Capacity Target	*3,604*	*3,321*	*3,059*	*1,665*	*1,590*	*1,477*	*1,814*
Mitigation Strategy for Surplus							
Reduce or Defer Power 2024 Capacity Procurement	-	-	-	-	-	- 700	-700
Defer Demand Response	-	-	-30	-40	-50	-70	-100
Total Potential Mitigation Sources	**-**	**-**	**- 30**	**-40**	**-50**	**- 770**	**- 800**

1.1.D Combining Power Generation and Water Desalination

In developing its plans for procuring power generation resources, OPWP is required to consider the opportunity for combining power generation with water desalination so as to benefit from economies of co-location and co-procurement. The latest examples of combined development of power and desalination capacity are the Salalah IWPP in Dhofar (COD in 2011) and the Barka II IWPP (COD in 2009) in the MIS. In both cases, bidders proposed to use RO rather than MSF technology for water desalination, although the procurement specifications did not specify the technology to be used. OPWP expects that future plants will also be proposed to use RO technology due to its economic advantage.

OPWP does not anticipate a need both for power and water desalination capacity in a common location during the forthcoming 7-year period.

1.2 AD DUQM POWER SYSTEM

Ad Duqm is located on the eastern coastline of the Al Wusta region, approximately halfway between the Main Interconnected System (MIS) and the Dhofar Power System (DPS). The latest population data from the National Center for Statistics & Information reports that the total population in Wilayat Al Duqm, as of 2017, is 11,269[9]. This figure represents an almost 20% growth when compared against 2016 population, and is linked to the rapid developments of a new economic and industrial center.

The Ad Duqm region is currently served by a relatively small integrated generation and distribution system, owned and operated by the Rural Areas Electricity Company (RAECO). RAECO owns and operates a 67 MW diesel-fuel fired power plant for supply to this grid area. RAECO is the sole licensed electricity supplier within the service area covered by the system, supplying existing and new electricity customers.

OETC is working towards integrating the Ad Duqm Power System with the MIS, and aims to complete this in the year 2023. Following this, and the future developments of IPPs in the Ad Duqm Power System, it is expected that RAECO may either decommission the diesel power station, or maintain the power plant to provide system stability and support during periods of tight operating reserves and/or emergency support.

1.2.A Demand for Electricity

Historical Demand

Historically, all requirements to meet electricity demand in Ad Duqm has been within the jurisdiction of RAECO. Demand in this region has been largely dominated by residential and small commercial consumers. This, however, is expected to change rapidly due to the recent and continuing development of large commercial, tourism, and industrial projects. This is in addition to the continuously expanding grid, which will see the connection of newer demand centers, such as Mahout.

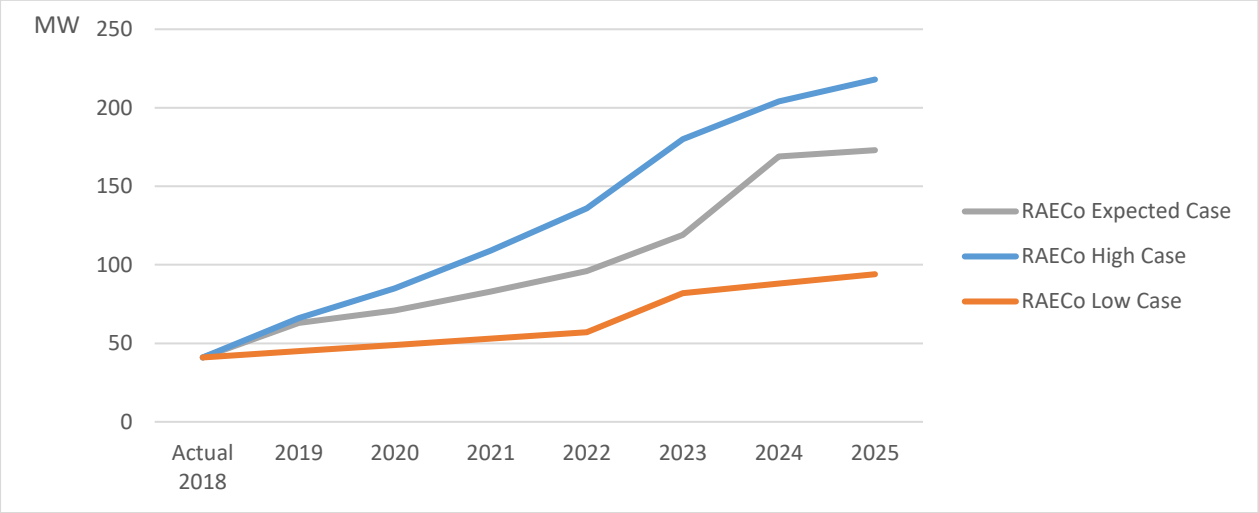
Demand Projections

Supported by Tanfeedh, the development of the Special Economic Zone Authority of Duqm (SEZAD) will contribute substantial economic growth and encourage an accelerated growth in population. The demand for electricity in Ad Duqm is expected to grow significantly as SEZAD realizes its ambitious development plans to transform Ad Duqm into a world class investment endpoint.

For the purposes of electricity demand projections, OPWP reports demand projections as provided by RAECO. These demand projections reflect domestic and industrial/commercial developments (as received by RAECO in the form of applications for new connection).

[9] National Center for Statistics & Information (2019) *Data Portal - Population.*

Figure 6 Electricity Demand Projections – Ad Duqm Power System



	Actual 2018	2019	2020	2021	2022	2023	2024	2025	Average Growth (%)
					MW[a]				
RAECo Expected Case	**41**	**63**	**71**	**83**	**96**	**119**	**169**	**173**	**23%**
Change from 2018-2024 Statement	*11*	*23*	*21*	*13*	*16*	*29*	*59*		
RAECo Low Case	**41**	**45**	**49**	**53**	**57**	**82**	**88**	**94**	**13%**
Change from 2018-2024 Statement	*11*	*15*	*19*	*13*	*17*	*22*	*18*		
RAECo High Case	**41**	**66**	**85**	**109**	**136**	**180**	**204**	**218**	**27%**
Change from 2018-2024 Statement	*1*	*16*	*15*	*29*	*26*	*50*	*64*		

Under the Expected Case scenario, peak demand is expected to grow at an average rate of 23% per year, from 41 MW in 2018 to 173 MW in 2025. The Expected Case scenario is developed by RAECO and accounts for historical demand and normal population growth within the area, the inclusion of interlinked and new demand areas, and demand related to committed and ongoing industrial and infrastructure projects within the Ad Duqm area. Notably, and following the completion of the North-South Interconnect project in 2023, demand in Mahout is expected to be absorbed by the system, and as such, is included in the demand projections.

The High Case scenario assumes that more of the prospective projects become committed. This scenario anticipates an average growth rate of 27% in peak demand, increasing from 41 MW in 2018 to 218 MW in 2025. This includes a higher growth scenario in the Mahout demand area.

Alternatively, the Low Case scenario assumes a slower rate of materialization in prospective projects in the Duqm region, in addition to a lower growth rate of demand in Mahout following its' interconnect in the year 2023. The Low Case scenario anticipates an average growth rate of 13% in peak demand, increasing from 41 MW in 2018 to 94 MW in 2025.

These projections do not include uncommitted projects in the industrial area, i.e., the potentially large influx of industrial demand associated with SEZAD development plans. It is currently anticipated that the refinery and petrochemical complex being developed by the Oman Oil Company and others will include captive power generation to serve their own requirements. SEZAD plans large-scale industrial

projects, diverse economic developments, and associated residential and commercial requirements over the next 30 years, accordingly, the demand growth rate within the zone is expected to accelerate rapidly as key projects are established. OPWP will attend closely to the development pace and implications for electricity demand.

1.2.B Power Generation Resources

Sources of Power

Ad Duqm and its surrounding areas are currently supplied by a single power station in the Ad Duqm system. This power station, which is owned and operated by RAECO, has a capacity of 67 MW and utilizes diesel-fired generators.

Resource Development Plan

The existing 67 MW diesel-fired power plant is sufficient to meet growing demands through the year 2019 in the Expected Case scenario. Figure 7 compares the demand trend with supply, including OPWP's resource development plan. As an isolated power system, RAECO can reliably supply nearly 60 MW of peak demand from its existing plant, allowing a margin equivalent to the loss of its largest generation unit (7.5 MW). While the current power station can meet demand in 2019 across the Expected and High Case scenarios, it is not able to do so reliably as peak demand is expected to exceed 60 MW. If demand begins to trend along the Expected and High Case scenarios, then additional resources will be needed to meet peak demand requirements as early as 2020.

The North-South Interconnect will allow electricity supply to Ad Duqm from the MIS in 2023, at much lower cost than RAECO's existing diesel generation plant. To meet the supply gap from 2020 until that time, RAECO is considering options such as temporary generation, purchase from the captive power plant being developed for the Oman Oil refinery (currently estimated to be completed in 2022), or expansion of the existing RAECO diesel power plant.

OPWP plans to develop wind energy plants and a baseload generation plant in the Duqm region, to be available soon after the North-South Interconnect reaches Duqm. Upon direction from the Government, OPWP initiated procurement of a Clean Coal IPP in 2018, following a feasibility study.[10] The project has not yet been approved, pending policy evaluation of alternatives. Considering the need to develop a baseload generator to serve the Duqm load center, OPWP plans to develop a Thermal Solar project with thermal storage if the procurement of the clean coal project is not approved to proceed in 2019. The Thermal Solar project is planned to provide around 600 MW by 2025, about the same capacity of the first block of the Clean Coal IPP.

Wilayat Ad Duqm has substantial potential for wind energy.[11] OPWP's initial plans are to develop around 200 MW of installed capacity in 2024. OPWP expects the capacity contribution to be about 70 MW (35% of installed capacity), based on analysis of the correlation between wind output and the demand profile, and the expected contribution toward meeting LOLH requirements. As data are

[10] RFQ was released in Q2 2018, and indicated a total capacity for the Clean Coal IPP of 1,200 MW. This represents the full capacity of the project which extends beyond the current 7 year planning period, as such, is not represented here but may be represented in future publications.

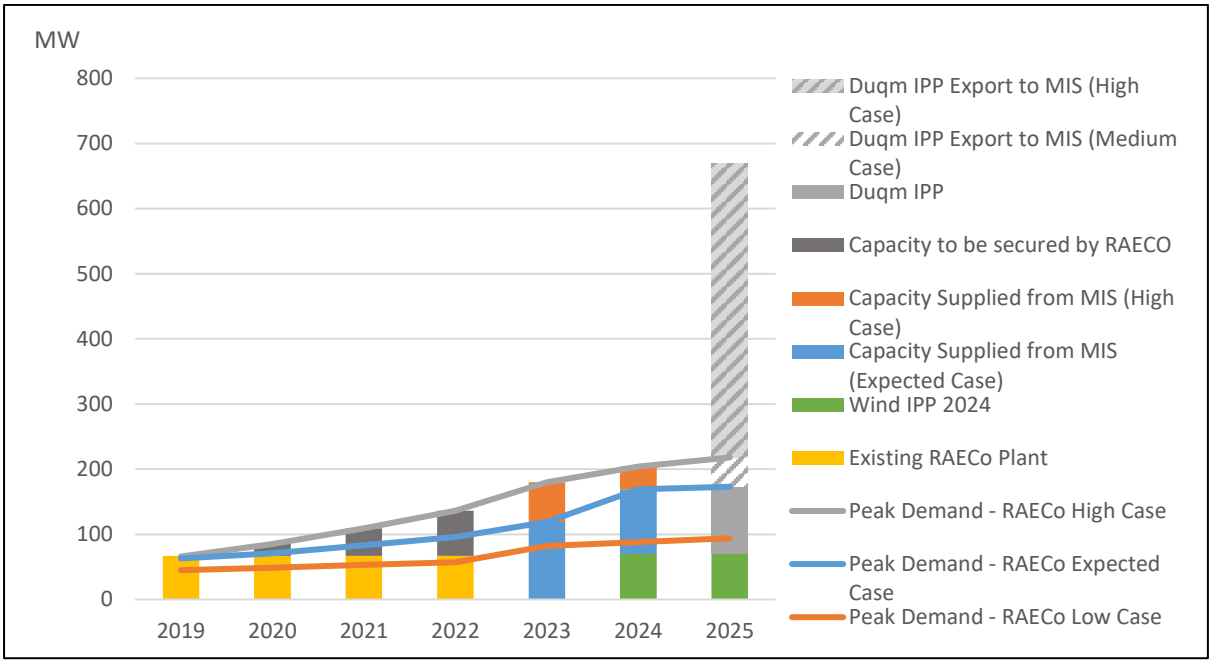
[11] Satellite data illustrates that annual mean wind speeds are in excess of 7 m/s.

collected through the Wind Resource Assessment and developed projects, OPWP will continue to monitor and update capacity contribution estimates.

The Duqm generation resources to be developed by OPWP are expected to export the majority of their output to the MIS, while securing and facilitating the growth of local demand at Ad Duqm.

Figure 7 demonstrates that RAECO's incremental supply requirement during the interim period from 2020 to 2022 is relatively low: up to 25 MW for the Expected Demand scenario and 51 MW for the High Case demand scenario. These needs are well within the range of supply from rental generators. However, cost considerations are important, particularly options that would reduce the high operating cost of diesel generation for baseload supply.

Figure 7 Resource Development Plan – Ad Duqm Power System



	2019	2020	2021	2022	2023	2024	2025
Peak Demand				**MW**			
RAECo Expected Case	63	71	83	96	119	169	173
RAECo Low Case	45	49	53	57	82	88	94
RAECo High Case	66	85	109	136	180	204	218
Contracted Capacity							
Existing RAECO Plant	67	67	67	67	67	67	67
Prospective Capacity							
Wind IPP 2024	-	-	-	-	-	200	200
Wind IPP Capacity Contribution	-	-	-	-	-	70	70
Duqm IPP [b]	-	-	-	-	-	-	600
Capacity Supplied from MIS							
RAECo Expected Case	-	-	-	-	119	99	-497
RAECo Low Case	-	-	-	-	82	18	-576
RAECo High Case	-	-	-	-	180	134	-452
RAECo Expected Case							
Additional Capacity Required							
RAECo Expected Case	-	4	16	29	-	-	-
RAECo Low Case	-	-	-	-	-	-	-
RAECo High Case	-	18	42	69	-	-	-

[a] OPWP currently assumes a 35% capacity contribution for the Wind IPP. This value will be updated once further analyses is carried out with ground-measured wind data.

[b] New capacity is expected to be required in the Duqm region. This may be supplied by either Clean Coal or Solar CSP (subject to Government approval)

1.3 DHOFAR POWER SYSTEM

The Dhofar Power System (DPS) covers the city of Salalah and surrounding areas in the Governorate of Dhofar, serving around 110,063[12] electricity customers.

The DPS comprises two generation facilities, the 132 kV transmission grid that is owned and operated by Oman Electricity Transmission Company (OETC), and the distribution network which is owned and operated by Dhofar Power Company (DPC). DPC also acts as the supplier of electricity for consumers in the Dhofar Power System.

The DPS is interconnected with the Petroleum Development Oman (PDO) power system via a 132 kV link between Thumrait and Harweel, with transfer capacity up to 150 MW. This interconnection provides important reliability benefits through the sharing of generation reserves. A proposed expansion of interconnection capacity is currently under consideration as part of the 400 kV North-South Interconnect project.

OPWP's role in the DPS is similar to its role in the MIS, which is to economically procure power required by DPC, respectively, in bulk from generation/production facilities connected to the DPS. OPWP is required to ensure that sufficient power generation resources are available to meet DPC electricity demand. If assessed to be beneficial, OPWP is also required to co-procure desalinated water with power generation in joint facilities.

1.3.A Demand for Electricity

Historical Demand

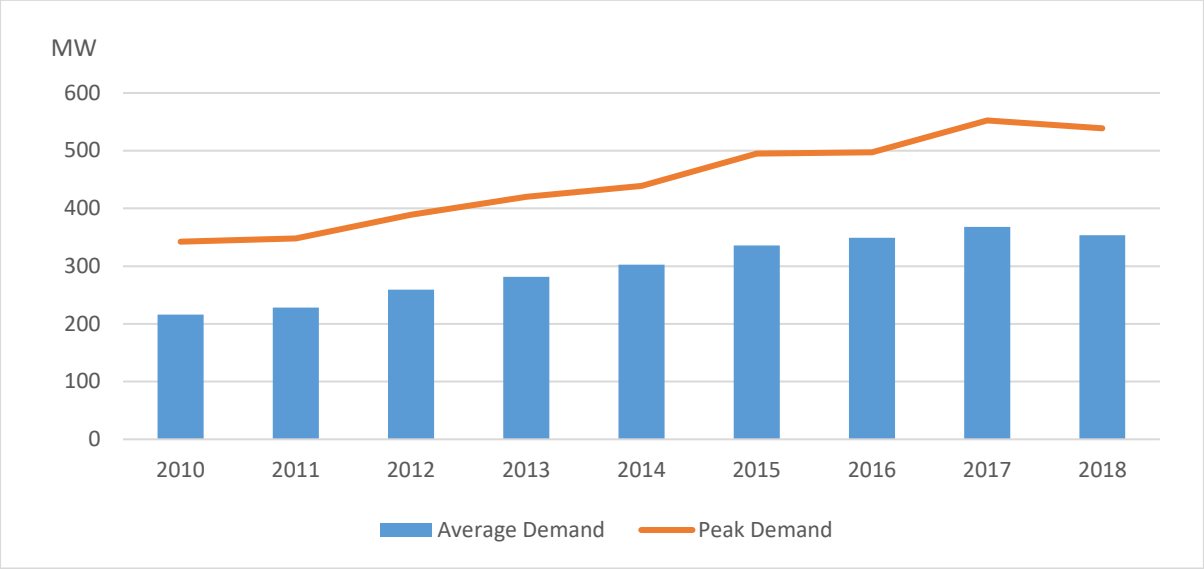
Electricity demand in 2018 saw, for the first time since reporting the system in the 7 Year Statement publications, a decrease against previous year outturn. Average demand reduced by 3.8% to 359 MW (corresponding to 3.1 TWh). Peak demand was 539 MW, a decrease of 2.4% when compared against the 2017 peak demand.

Among the characteristics of relatively small systems, and which has contributed towards the suppressed demand growth, is the sensitivity of peak/energy demand growth to the adoption/introduction of new energy policies aimed at improving the efficient consumption of electricity and whether or not large customers materialize. While part of what was observed in the DPS may be attributed to this, Mekunu Cyclone had a measurable impact on the region during the final week of May and early June, and is believed to have contributed towards the reduction in peak demand requirements (when compared against 2017). The occurrence of the cyclone coincided with the peak demand season and suppressed demand in its aftermath as businesses recovered and tourism activities/arrivals were reduced.

Figure 8 shows that the average growth rate in annual average demand over the past seven years has been 6.8%, while single-year growth has reached as high as 13.6%. In addition, peak demand in the DPS has grown at an annual average of 6.6% over the same period.

[12] AER Annual Report 2017

Figure 8 Historical Electricity Demand – DPS



	2010	2011	2012	2013	2014	2015	2016	2017	2018	Average Growth (%)
Historical Demand										
Average Demand (MW)	**216**	**228**	**259**	**282**	**303**	**336**	**349**	**368**	**359**	
Growth (%)		*5.5%*	*13.6%*	*8.9%*	*7.4%*	*10.9%*	*3.9%*	*5.4%*	*-2.4%*	6.7%
Peak Demand (MW)	**342**	**348**	**389**	**420**	**439**	**495**	**497**	**552**	**539**	
Growth (%)		*1.8%*	*11.8%*	*8.0%*	*4.5%*	*12.8%*	*0.4%*	*11.1%*	*-2.4%*	6.0%

Demand Projections

Demand projections for the represent the "net system demand", in that they are inclusive of assumed transmission and distribution system losses but exclude the internal auxiliary consumption of power and desalination plants. The methodology for demand forecasts assesses the influences of macroeconomic growth in addition to a separate analyses of underlying demand and certain bulk loads, comprising mainly industrial demands, which are assessed on a customer-specific basis.

The projections are presented as a range including Low, High Case and central Expected Case scenarios. All scenarios are based on an assumption of normal weather. The Low Case and High Case scenarios assume contrasting growth levels, with the same underlying assumptions for economic growth as used for the MIS projections. The projections are presented in Figure 9.

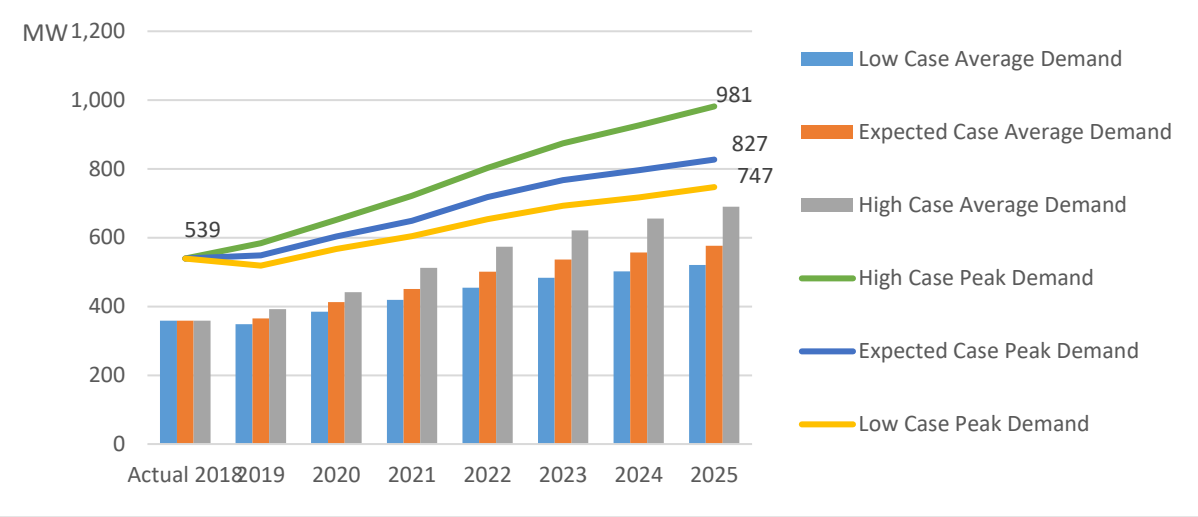
Under the Expected Case scenario, peak demand increases at about 6% per year, from 539 MW in 2018 to 827 MW in 2025. Energy consumption is projected to grow from 3.1 TWh (corresponding to 359 MW average demand) in 2018 to 5.1 TWh (577 MW average demand) in 2025, with an average increase of 7% per year. Peak demand projections are slightly higher than previous 7 Year Statement projections (7% vs 6%).

The High Case scenario has peak demand growth of 9% per year and energy growth of 10% per year. The Low Case scenario projects annual energy and peak demand growth of around 5% per year. They

are not symmetrical around the Expected Demand scenario, as there is currently more uncertainty with respect to the potential for higher growth.

CRT impacts are embedded in the DPS demand projections as they are for the MIS. OPWP has assessed CRT impacts in 2025 at 20 MW in the Expected Case scenario, and at 25 MW and 15 MW in the Low Case and High Case scenarios, respectively.

Figure 9 Electricity Demand Projections – DPS



	Actual 2018	2019	2020	2021	2022	2023	2024	2025	Average Growth (%)
Expected Demand									
Average Demand (MW)	359	365	412	451	501	536	557	577	7%
Underlying Demand	244	246	256	269	305	319	334	353	5%
Bulk Loads	115	119	156	183	196	217	222	224	10%
Annual Energy (TWh)	**3.1**	**3.2**	**3.6**	**4.0**	**4.4**	**4.7**	**4.9**	**5.1**	7%
Peak Demand (MW)	**539**	**549**	**603**	**649**	**718**	**767**	**796**	**827**	6%
Change from 2018-2024 Statement (MW)	*-31*	*-51*	*-77*	*-61*	*-22*	*-23*	*-14*		
Low Case Demand									
Average Demand (MW)	359	348	385	419	454	484	502	521	5%
Underlying Demand	244	232	238	246	272	280	291	308	3%
Bulk Loads	115	116	147	173	182	204	211	213	9%
Annual Energy (TWh)	**3.1**	**3.1**	**3.4**	**3.7**	**4.0**	**4.2**	**4.4**	**4.6**	6%
Peak Demand (MW)	**539**	**519**	**567**	**604**	**653**	**693**	**717**	**747**	5%
Change from 2018-2024 Statement (MW)	*-21*	*-61*	*-83*	*-66*	*-37*	*-37*	*-23*		
High Case Demand									
Average Demand (MW)	359	393	441	512	574	621	655	690	10%
Underlying Demand	244	258	268	282	330	354	380	412	8%
Bulk Loads	115	135	173	230	244	268	275	278	13%
Annual Energy (TWh)	**3.1**	**3.4**	**3.9**	**4.5**	**5.0**	**5.4**	**5.8**	**6.0**	10%
Peak Demand (MW)	**539**	**584**	**651**	**721**	**803**	**874**	**926**	**981**	9%
Change from 2018-2024 Statement (MW)	*-81*	*-76*	*-99*	*-79*	*-37*	*-26*	*-24*		

1.3.B Power Generation Resources

Contracted Capacity and Non-Firm Energy

OPWP's generation portfolio in the DPS includes the two plants that provide guaranteed capacity and a PPA with the wind farm to provide non-firm energy. They are described in Table 9 and are as follows:

- **Salalah IWPP:** capacity of 445 MW. The Salalah IWPP is a CCGT plant comprising five gas turbines and two steam turbines. It is located in the Mirbat/Taqah region and began operation in 2012.
- **Salalah II IPP:** capacity of 718 MW. Located in Raysut, the facility comprises eight OCGT units with a total capacity of 276 MW and six CCGT units (two blocks of 2 GTs and 1 ST each) with a total capacity of 445 MW.
- **Dhofar I Wind IPP:** installed capacity of 50 MW. The project is under construction near Harweel, for completion in 2020. OPWP has a PPA with the operator, RAECO. OPWP has assigned as provisional value of 35% following the results of analyses that looked at both correlation between wind speed and demand profile, and the expected impact and contributions towards meeting LOLh requirements. OPWP will continue to monitor and analyze relevant data to update capacity contribution estimates.

Table 9 Contracted Capacities (PPAs/PWPA) - DPS

Project Name	Contracted Capacity	Contract Type	Project company	Project status	Technology	Contract Expiry
Salalah IWPP	445 MW[a] 68,000 m³/d	PWPA	Sembcorp Salalah Power & Water Co. (SAOC)	Operational	CCGT Natural gas fired Fuel oil as back-up	2027
Salalah II IPP	718 MW[a]	PPA	Dhofar Generating Co. (SAOC)	Operational	OCGT CCGT Natural gas fired Fuel oil as secondary fuel and back-up	2033
Dhofar I Wind IPP	50 MW	PPA	RAECo (SAOC)	Under Construction	Wind Turbine	2033

[a] Capacities are rated on a net basis (i.e. after allowing for auxiliary consumption inside the plants) at 35°C ambient temperatures output.

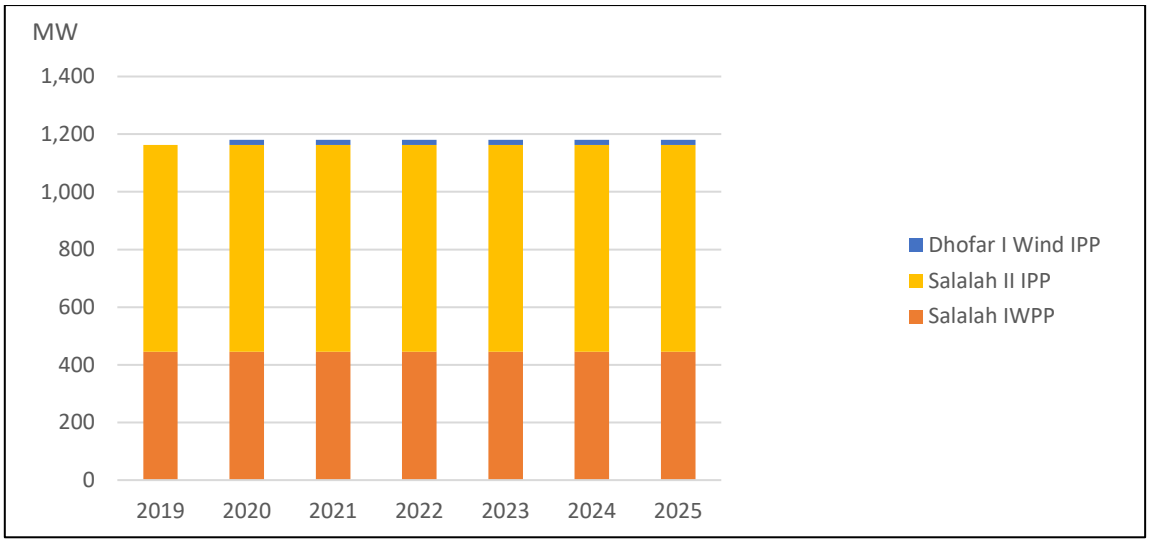
Resource Development Plan

OPWP has no plans to procure new gas-fired generation capacity for the DPS but plans additional RE development. The Dhofar region has excellent potential for wind energy development, consequently, OPWP has plans to develop a second wind energy farm. The timing and capacity of the project are subject to the outcome of a Master Plan currently under study by OETC that will assess the ability of the DPS to integrate higher levels of renewable penetration. When the North-South Interconnect project is completed to Dhofar, OPWP expects to develop more wind energy projects in the DPS.

Summary

Figure 10 presents the capacity contributions from power generation resources in the DPS.

Figure 10 Capacity Contributions from Generation Resources – DPS



	2019	2020	2021	2022	2023	2024	2025
Contracted Capacity				Net MW [a]			
Salalah IWPP	445	445	445	445	445	445	445
Salalah II IPP	718	718	718	718	718	718	718
Total Contracted Capacity	**1,163**	**1,163**	**1,163**	**1,163**	**1,163**	**1,163**	**1,163**
Capacity Contributions from Non-firm Contracts				MW			
Renewable Energy[b]							
Dhofar I Wind IPP [c]	-	50	50	50	50	50	50
Total Capacity	-	50	50	50	50	50	50
Capacity Contribution from Renewable Energy	-	**17.5**	**17.5**	**17.5**	**17.5**	**17.5**	**17.5**
Total Capacity Contribution to Peak Demand	**1,163**	**1,181**	**1,181**	**1,181**	**1,181**	**1,181**	**1,181**

[a] All capacities are rated on a net basis (i.e. after allowing for auxiliary consumption inside the plants) at 35°C ambient temperature.
[b] An additional Wind Project in the Dhofar Power System may be included in future plans and future 7 Year Statements – pending completion of OETC Master Plan and assessment of renewables integration.
[c] Capacity contribution of 35% is currently assumed for Harweel Wind IPP.

1.3.C Resource Adequacy and Mitigation Plans

Statutory and Regulatory Requirements

OPWP is required by the Sector Law and its license to ensure the adequacy of generation resources in the DPS to meet future power demands. The Sector Law establishes OPWP's general responsibility to secure sufficient generation resources to meet demand and the OPWP license establishes the generation security standard as 24 LOLH.

OPWP has concluded that, on the basis of simulation studies of the DPS, a reserve margin of about 12% over peak demand is necessary to achieve the 24 LOLH standard, considering the size of the system, characteristics of generation resources, and limited access to security reserves. This establishes the capacity target for each of the three demand scenarios over the 7-year planning horizon, shown in Figure 11.

When the North-South Interconnect is connected to the DPS, planning and operations of the DPS, PDO System, and MIS will be fully integrated. There is currently no firm date in which the interconnect to the DPS is expected to be complete. OPWP expects that the reserve margin requirement for the DPS would be reduced at that time, aligning with that of the MIS.

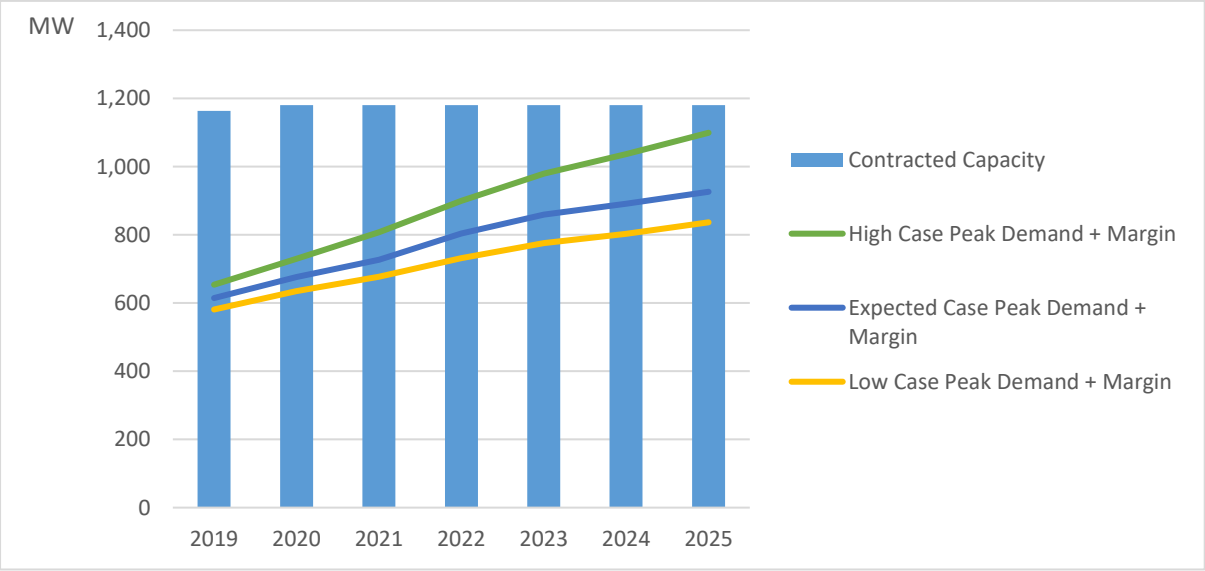
Resource Adequacy and Mitigation Plans

OPWP projects contracted capacity to be sufficient to meet the capacity targets associated with all three demand scenarios throughout the seven-year forecast period. Figure 11 and the accompanying table indicate capacity surpluses that reduce gradually with demand growth. By 2025, the capacity surplus reduces to around 100 MW in the High Case demand scenario.

The capacity surpluses arose as demand growth failed to meet expectations. From 2012 to 2015, peak and demand growth averaged more than 9% per year, prompting OPWP to procure new capacity (Salalah 2 IPP) that would meet future needs. The subsequent economic slowdown reduced average annual demand growth to around 1.8% in energy and 3% in peak demand.

Although there are costs associated with surplus capacity, the Salalah II IPP project will enable substantial gas savings due to its high efficiency. The new CCGT plant displaces generation from the older gas turbine plant, and is projected to achieve a net reduction in DPS gas consumption in 2019, despite the 2% growth in electricity requirements. This is illustrated further in Section 2.

Figure 11 Resource Adequacy – DPS



	2019	2020	2021	2022	2023	2024	2025
Generation Resources				Net MW [a]			
Total Contracted Capacity	**1,163**	**1,181**	**1,181**	**1,181**	**1,181**	**1,181**	**1,181**
Expected Case Demand							
Peak Demand	549	603	649	718	767	796	827
Peak Demand + Margin	614	676	727	804	859	891	926
Additional Capacity Required	-	-	-	-	-	-	-
High Case Demand							
Peak Demand	584	651	721	803	874	926	981
Peak Demand + Margin	654	730	808	899	979	1,037	1,099
Additional Capacity Required	-	-	-	-	-	-	-
Low Case Demand							
Peak Demand	519	567	604	653	693	717	747
Peak Demand + Margin	581	635	677	732	776	803	837
Additional Capacity Required	-	-	-	-	-	-	-

1.3.D Combining Power Generation and Water Desalination

As in the MIS, OPWP is required to consider the opportunity for combining power generation with water desalination in the DPS, so as to benefit from economies of co-location and co-procurement.

As needs for additional water desalination and power generation capacity are confirmed, OPWP will continue to assess the potential for economic benefits that may result from co-location and co-procurement.

1.4 MUSANDAM POWER SYSTEM

The Musandam Governorate is located in the northern-most region of the Sultanate of Oman, and extends into the Strait of Hormuz. The Musandam Governorate is an exclave of Oman, separated from the rest of the country by the United Arab Emirates. The latest population data from the National Center for Statistics & Information reports that the total population is estimated at around 45,155[13], which is expected to grow steadily over the coming years.

1.4.A Demand for Electricity

Demand Projections

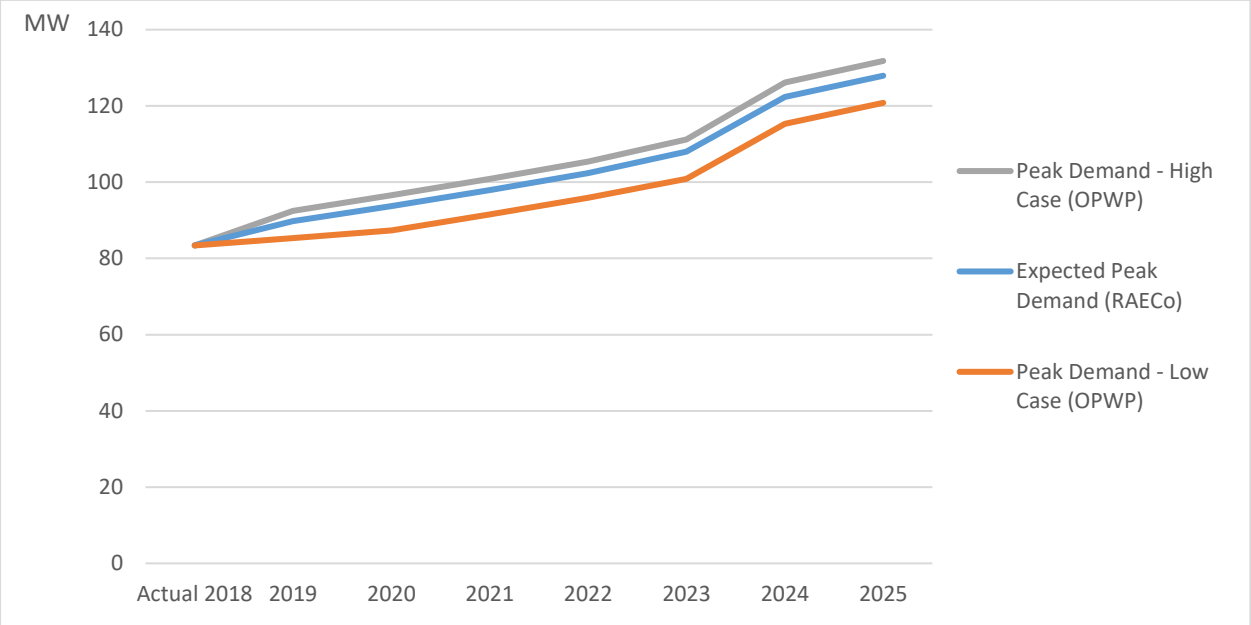
The pace of demand growth in Musandam is driven mainly by projects that aimed to boost tourism, economic, and commercial activities. The Expected, Low, and High Case peak demand scenarios for the Musandam Power System have been prepared by RAECO.

Similar to the demand forecasts presented for the other power systems, the different cases represent alternate assumptions of annual growth rates for underlying demand and materialization of identified bulk consumers. These three demand scenarios are shown in Figure 12. Across all three scenarios, the growth projections are around 3% lower than those in the previous 7-Year Statement.

Under the RAECO Expected Demand forecast, peak demand is expected to grow from 83 MW in 2018 to 128 MW in 2025, an average increase of 6.4% per year. The Low Case scenario assumes a growth rate of 5.5% for peak demand, increasing only to 121 MW in 2025. The High Case scenario assumes a quicker materialization of bulk consumers, as well as increased tourism and fishery activities. Peak demand is projected to grow by an average of 6.9% per year to reach 132 MW in 2025.

[13] National Centre of Statistics & Information (2019) *Data Portal - Population.*

Figure 12 Electricity Demand Projections – Musandam Power System



	Actual 2018	2019	2020	2021	2022	2023	2024	2025	Average Growth (%)
Peak Demand					MW				
RAECo Expected Case	**83**	**90**	**94**	**98**	**102**	**108**	**122**	**128**	**6.4%**
Change from 2018-2024 Statement	*-4*	*-5*	*-7*	*-21*	*-24*	*-25*	*-20*		
OPWP Low Case	**83**	**85**	**87**	**92**	**96**	**101**	**115**	**121**	**5.5%**
Change from 2018-2024 Statement	*1*	*-5*	*-9*	*-22*	*-23*	*-25*	*-19*	-	
OPWP High Case	**83**	**93**	**97**	**101**	**105**	**111**	**126**	**132**	**6.9%**
Change from 2018-2024 Statement	*-12*	*-11*	*-13*	*-29*	*-32*	*-34*	*-28*	-	

1.4.B Power Generation Resources

Sources of Power

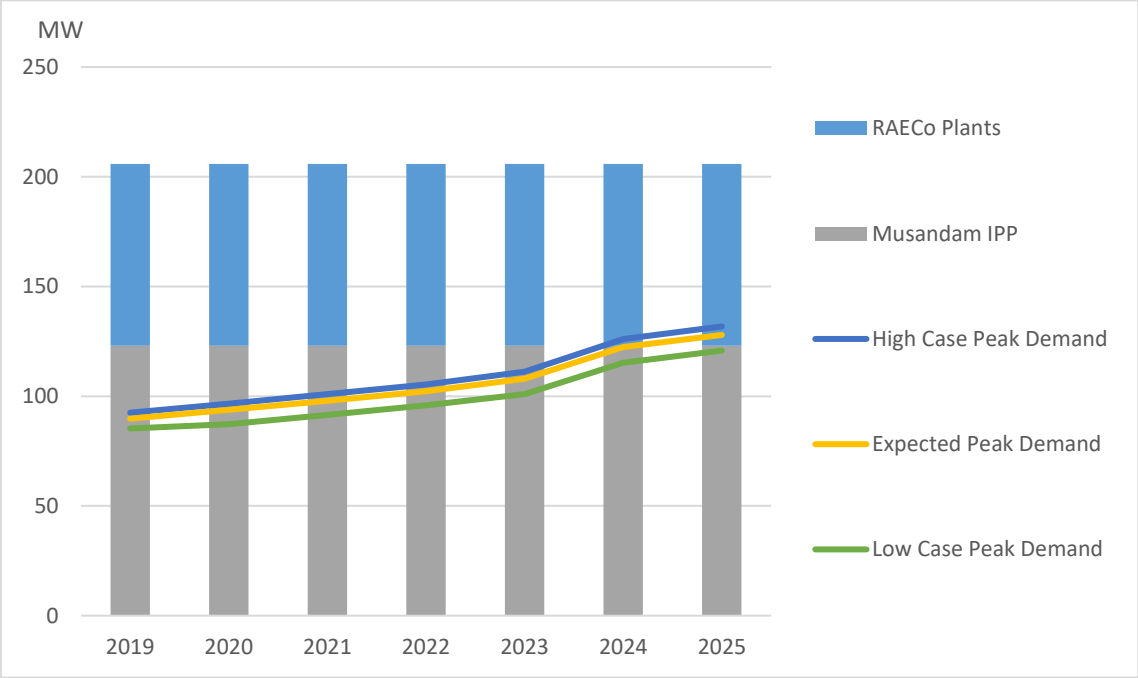
RAECO owns and operates power stations distributed near to load centers in the Musandam Governorate. They are all diesel-fired generators, with combined installed capacity of about 83 MW – this figure includes additional capacity that was added in 2018.

Musandam IPP commenced operation in 2017 operated by a consortium led by Oman Oil Company under a PPA with OPWP. The IPP is providing net firm capacity of 123 MW using reciprocating engines fueled primarily by natural gas.

Resource Development Plan

Figure 13 illustrates Musandam's supply/demand balance. The Musandam IPP provide sufficient capacity to secure all three demand scenarios through 2024 under the Expected Case (and by extension, the Low Case), and up to 2023 under the High Case scenario. For the year 2025, the RAECO diesel generator will continue to be available to provide additional capacity to cover any remaining capacity requirements during peak demand periods. No further resources are required during this time period.

Figure 13 Future Power Generation Expansion Plans - Musandam Power System



	2019	2020	2021	2022	2023	2024	2025
Peak Demand				MW			
RAECo Expected Case	90	94	98	102	108	122	128
RAECo Low Case	85	87	92	96	101	115	121
RAECo High Case	93	97	101	105	111	126	132
Contracted Capacity							
RAECo Plants (Current)	83	83	83	83	83	83	83
Musandam IPP [a]	123	123	123	123	123	123	123
Total Contract Capacity	**206**	**206**	**206**	**206**	**206**	**206**	**206**

[a]The MW figures are at 45°C

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SECTION 2
FUEL REQUIREMENTS

2.1 OVERVIEW

Fuel Diversification Policy

In 2018, OPWP began implementation of a Fuel Diversification Policy initiated by the Government, which set the following targets for the electricity sector:

- 10% (or more) of electricity generation is to be sourced from renewable resources by 2025.
- Coal can be utilized to fuel up to 3,000 MW of generation capacity by 2030.
- Gas efficiency will continue to be a priority of the electricity sector.
- Study of alternate sources for electricity generation.

OPWP plans to develop 2,400 to 3,000 MW of installed capacity of renewable energy (RE) projects by 2025,[14] aiming to exceed the 10% generation share target. Furthermore, OPWP's continuing progress with gas efficiency improvements is described below.

The impact of these initiatives will become evident as the new RE projects are developed and implemented. Figure 14 shows our projection of energy generation shares by fuel type among OPWP-contracted generators. By 2025, 16% of generation will be provided from fuels other than gas, primarily solar energy.

Figure 14 Fuel Shares in Electricity Generation

	2018	2019	2020	2021	2022	2023	2024	2025
Solar CSP or Clean Coal Plant	-	-	-	-	-	-	-	2
Waste	-	-	-	-	-	1	1	1
Solar PV	-	-	-	1	1	3	4	4
Wind	-	0	0	0	0	0	1	1
Gas-fired Plants	36	37	40	41	43	44	45	44

Efficiency – Fuel Utilization

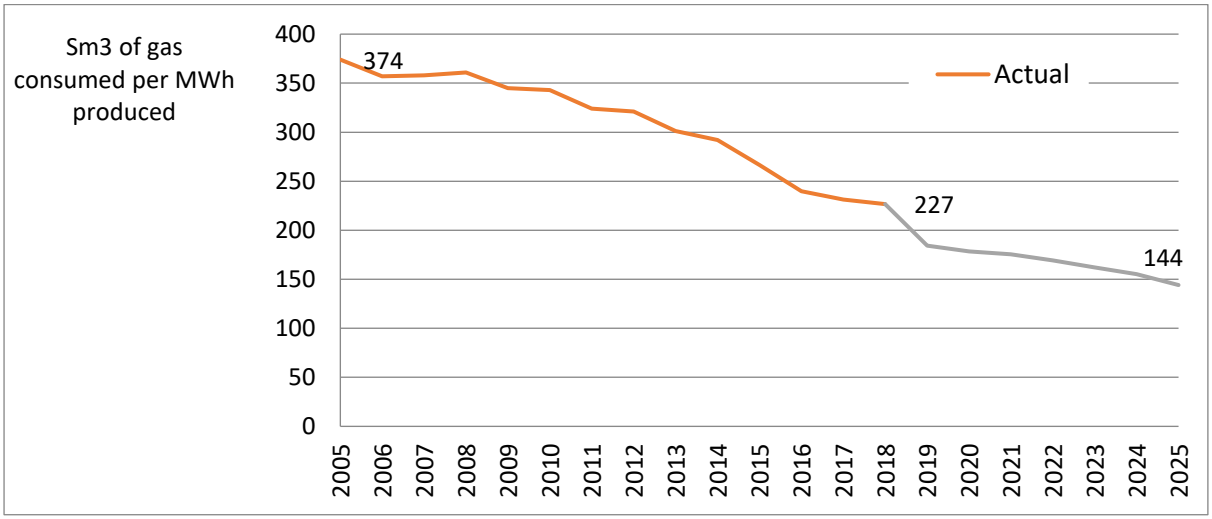
Since 2005, through the introduction of progressively more efficient generation plants, OPWP has achieved a 39% reduction in the gas required per unit of electricity production, from 374 Sm^3/MWh in 2005 to 227 Sm^3/MWh in 2018. In 2018 alone, improvements in gas utilization (when compared against gas utilization rates in 2005), suggests savings in excess of OMR 220 million. OPWP's procurement of new state-of-the-art CCGT plants in 2019, and new water desalination plants that shift

[14] The range depends on whether the Duqm Clean Coal is approved to proceed, or instead OPWP develops a 600 MW Solar CSP project.

water production from energy intensive MSF technology to efficient RO technology, will enable further improvements in gas utilization, as shown in Figure 15. By 2020, we expect a further 21% improvement in gas utilization against 2018.

After 2021, with the introduction of solar, wind, waste-to-energy, and possibly clean coal or solar CSP plants, as well as improved dispatch control technology, OPWP expects that the gas requirements for electricity generation will fall to around 144 Sm^3/MWh, or 61% less than that required in 2005.

Figure 15 Gas Required per Unit of Electricity Generation – MIS



2.1 MAIN INTERCONNECTED SYSTEM

2.1.A 2018 Fuel Consumption

Total gas consumption at the main power and desalination plants in 2018 was about 7.44 billion Sm^3, equivalent to 20.25 million Sm^3/d, about 3% more than in 2017. Transmission grid upgrades has enabled better access to the most efficient generation plants.

2.1.B Projected Fuel Requirements

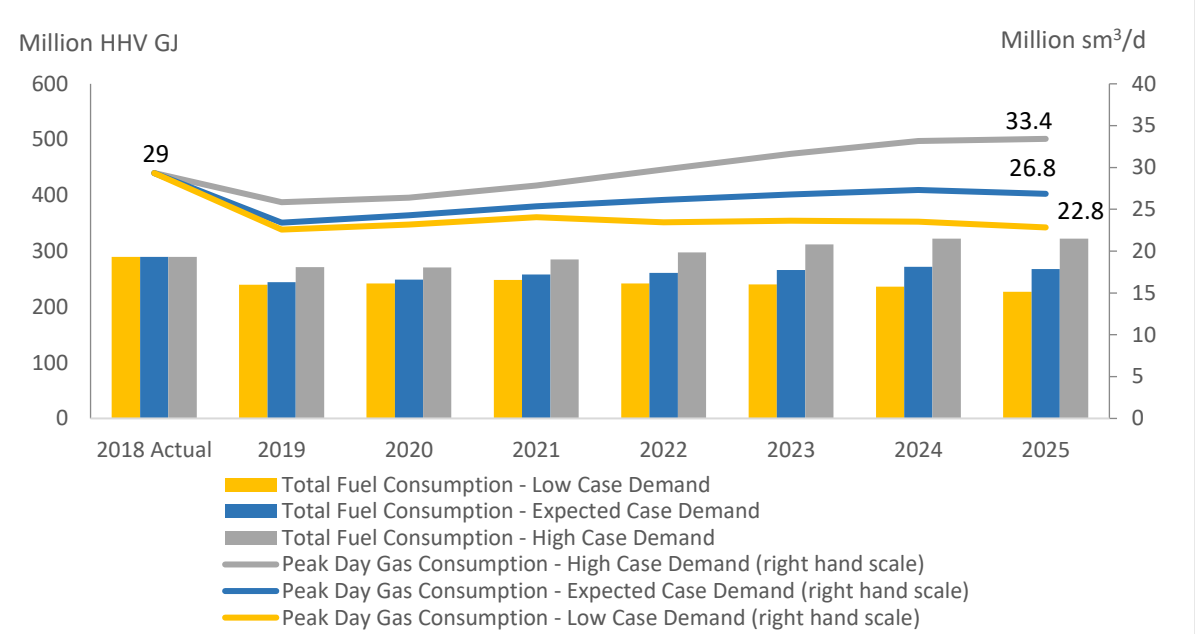
OPWP projects annual gas requirements to decline by around 1% per year from 2018 to 2025 under the Expected Case. This scenario, in addition to the Low Case and High Case scenarios, are illustrated in Figure 16. The previous 7-Year Statement projected that MIS gas consumption would grow at an average annual rate of 0.5%, and the change is due mainly to demand reductions, as described in Section 1.1.

Under the Low Case demand scenario, total fuel consumption would decrease at an average of 3% per year. In the High Case demand scenario, total fuel consumption would increase at an average rate of 2% per year. In each of the three scenarios, the rate of growth in fuel consumption is below that of electricity demand.

Figure 16 shows a drop in gas consumption in 2019 compared to 2018. This is due to several important developments: completion of the new Ibri and Sohar IPPs in 2019, retirement of Al Ghubrah IWPP and Wadi Al Jizzi IPP during 2018, and completion of the new Barka IV IWP and Sohar IV IWP which

allow fuel-intensive MSF water production to be curtailed. From 2021 to 2025, the introduction of renewable energy projects will restrain the growth in gas requirements even as electricity demand continues to increase.

Figure 16 Projected Fuel Requirements – MIS



	2018 Actual	2019	2020	2021	2022	2023	2024	2025	Average Growth (%)
Expected Demand									
Gas Consumption (million Sm³/d)									
Annual Average	20.3	17.1	17.4	18.1	18.3	18.7	19.0	18.8	-1%
Peak Day	29.3	23.4	24.3	25.4	26.1	26.8	27.3	26.8	-1%
Total Fuel Consumption (million HHV GJ)[a]	**290**	**244**	**249**	**258**	**261**	**266**	**272**	**268**	**-1%**
Gas	*290*	*244*	*249*	*258*	*261*	*266*	*272*	*268*	*-1%*
Low Case Demand									
Gas Consumption (million Sm³/d)									
Annual Average	20.3	16.8	16.9	17.4	17.0	16.8	16.6	15.9	-3%
Peak Day	29.3	22.6	23.2	24.0	23.4	23.6	23.5	22.8	-4%
Total Fuel Consumption (million HHV GJ)[a]	**290**	**240**	**242**	**249**	**242**	**240**	**237**	**227**	**-3%**
Gas	*290*	*240*	*242*	*249*	*242*	*240*	*237*	*227*	*-3%*
High Case Demand									
Gas Consumption (million Sm³/d)									
Annual Average	20.3	19.1	18.9	20.0	20.9	21.9	22.5	22.6	2%
Peak Day	29.3	25.9	26.4	27.8	29.7	31.7	33.2	33.4	2%
Total Fuel Consumption (million HHV GJ)[a]	**290**	**272**	**271**	**285**	**298**	**312**	**322**	**322**	**2%**
Gas	290	272	271	285	298	312	322	322	*2%*

[a] Based on natural gas HHV of 1,050 BTU/scf

2.2 DHOFAR POWER SYSTEM

2.2.A 2018 Fuel Consumption

Gas consumption in 2018 was 743 million Sm^3 (equivalent to 2 million Sm^3/d), about 13% lower than in 2017, whereas electricity production decreased by 3%. [AA1] Gas utilization improved due to transmission grid improvements and resolution of gas supply issues that enabled higher dispatch of Salalah II IPP. It is also worth noting that Cyclone Mekunu altered normal consumption patterns from the end of May into June 2018. Gas consumption during May-June 2018 was on average 8% lower than similar months in 2017. With respect to the peak, peak daily natural gas consumption was 3.1 million Sm^3 in 2018 compared to 3.0 million Sm^3 in 2017.

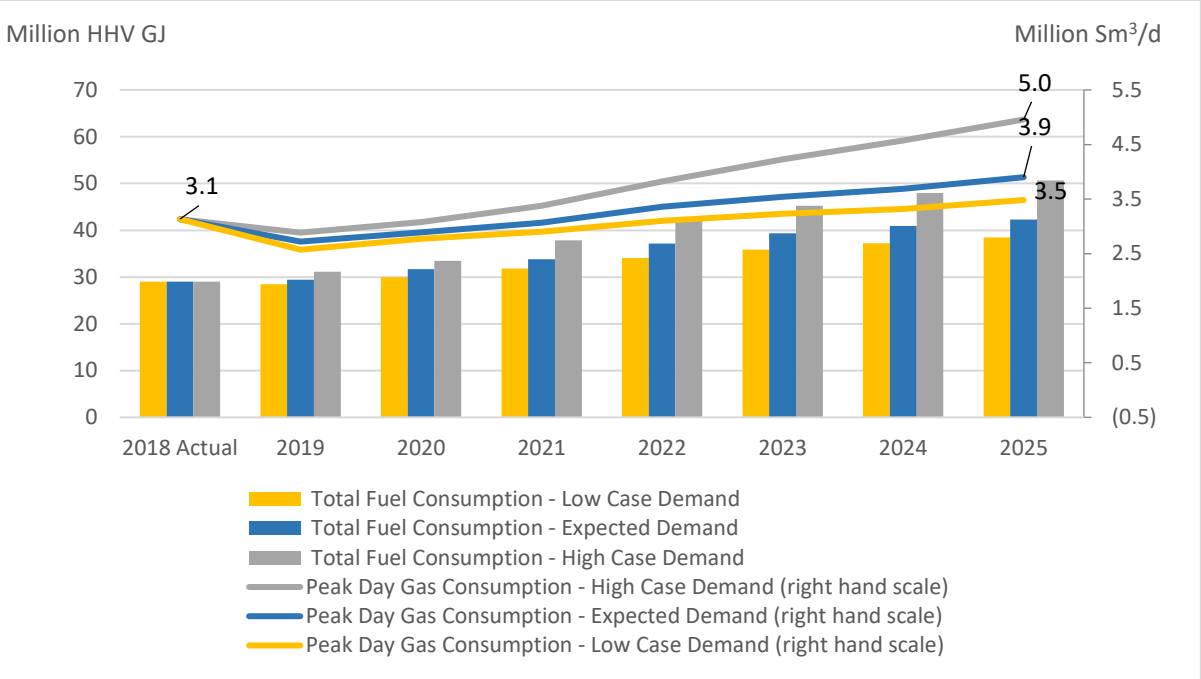
2.2.B Projected Fuel Requirements

Fuel requirements projections for each of the three demand scenarios are illustrated in Figure 17. The projections include the impact of the Dhofar I Wind IPP (50 MW) at Harweel in Q4 2019.

Total fuel consumption is expected to increase at an annual average of around 6% under the Expected Demand scenario, 4% under the Low Case scenario, and 8% in the High Case. These growth rates in fuel consumption compare to energy demand growth of 7%, 5%, and 10%, respectively.

Figure 17 illustrates a reduction in peak day gas consumption in 2019. OPWP carried out an assessment of this, and found that LDC had utilized Salalah IWPP more than Salalah II during the peak period in 2018, but expects to utilize Salalah II more in 2019 and subsequent years.

Figure 17 Projected Fuel Requirements – DPS



	2018 Actual	2019	2020	2021	2022	2023	2024	2025	Average Growth (%)
Expected Demand									
Gas Consumption (million Sm³/d)									
Annual Average	2.0	2.1	2.2	2.4	2.6	2.8	2.9	3.0	6%
Peak Day	3.1	2.7	2.9	3.1	3.4	3.5	3.7	3.9	3%
Total Fuel Consumption (million HHV GJ)[a]	**29**	**29**	**32**	**34**	**37**	**39**	**41**	**42**	**6%**
Gas	*29*	*29*	*32*	*34*	*37*	*39*	*41*	*42*	*6%*
Low Case Demand									
Gas Consumption (million Sm³/d)									
Annual Average	2.0	2.0	2.1	2.2	2.4	2.5	2.6	2.7	4%
Peak Day	3.1	2.6	2.8	2.9	3.1	3.2	3.3	3.5	2%
Total Fuel Consumption (million HHV GJ)[a]	**29**	**28**	**30**	**32**	**34**	**36**	**37**	**38**	**4%**
Gas	*29*	*28*	*30*	*32*	*34*	*36*	*37*	*38*	*4%*
High Case Demand									
Gas Consumption (million Sm³/d)									
Annual Average	2.0	2.2	2.3	2.7	2.9	3.2	3.4	3.6	8%
Peak Day	3.1	2.9	3.1	3.4	3.8	4.2	4.6	5.0	7%
Total Fuel Consumption (million HHV GJ)[a]	**29**	**31**	**33**	**38**	**42**	**45**	**48**	**51**	**8%**
Gas	29	31	33	38	42	45	48	51	8%

[a] Based on natural gas HHV of 1050 BTU/scf

SECTION 3
WATER

3.1 MAIN INTERCONNECTED SYSTEM

The Main Interconnected System (MIS) serves the largest population area and the greatest demand for potable water in the Sultanate. OPWP provides desalinated water to the Public Authority for Water (PAW), the principal "water department". PAW is responsible for potable water supply to consumers. The MIS is an integrated network that currently serves the potable water requirements of the Governorates of Muscat, Batinah South, Ad Dakhiliyah, Batinah North, and Al Buraymi. The MIS will expand to include supply to the Governorate of Ad Dhahirah upon completion of a new transmission pipeline in 2021.

OPWP also provides desalinated water to Majis Industrial Services Company (MISC), as backup supply to the MISC desalination plant, which supplies process water used by industry in the Sohar Industrial Port area. [15]

The MIS consists of three supply zones, each of which has sources of desalinated water under contract to OPWP, well water supply that is operated by PAW, and transmission facilities that allow water transfer between zones under the management of PAW. The water supply zones are as follows:

- **Muscat Zone** includes the potable water demands of the Governorate of Muscat. The current sources of desalinated water for this zone are Ghubrah II IWP, Qurayyat IWP, and transfers from the Barka Zone.
- **Barka Zone** includes the potable water demands of the Governorates of Batinah South and Ad Dakhiliyah. The current sources of desalinated water for this zone are Barka IWPP (including the expansions RO I and RO II), Barka II IWPP, and Barka IV IWP.
- **Sohar Zone** includes the potable water demands of the Governorates of Batinah North and Al Buraymi, with the addition water demand from the Governorate of Ad Dhahirah from 2021 onwards.[16] The current source of desalinated water for this zone is Sohar IWPP.

3.1.A Demand for Water

PAW has provided OPWP with projections of average and peak water demand for the MIS, shown in Figure 18. Peak demand represents the daily demand (including network losses) during the week of highest demand of the year.

PAW has provided a single, "medium case scenario" only, which is driven fundamentally by population growth, distribution network expansion, and modest growth in per-capita water consumption. The population portion of this scenario derives from one of six population forecast scenarios published by the National Center for Statistics and Information (NCSI).[17] It assumes moderate growth of the Omani population and that the Expatriate share of the total population declines from 45% in 2017 to 33% in

[15] MISC supplies its customers from its own RO plant which was commissioned in December 2011. During the 7-year period from 2019 to 2025, OPWP is requested to provide desalinated water to MISC during maintenance and unplanned plant outages at the MISC RO plant. In practice, backup supply has been required for short duration. The expected water demand from MISC for this purpose is not of material volume in comparison to PAW demand in the Sohar Zone and is not included in the demand projections.

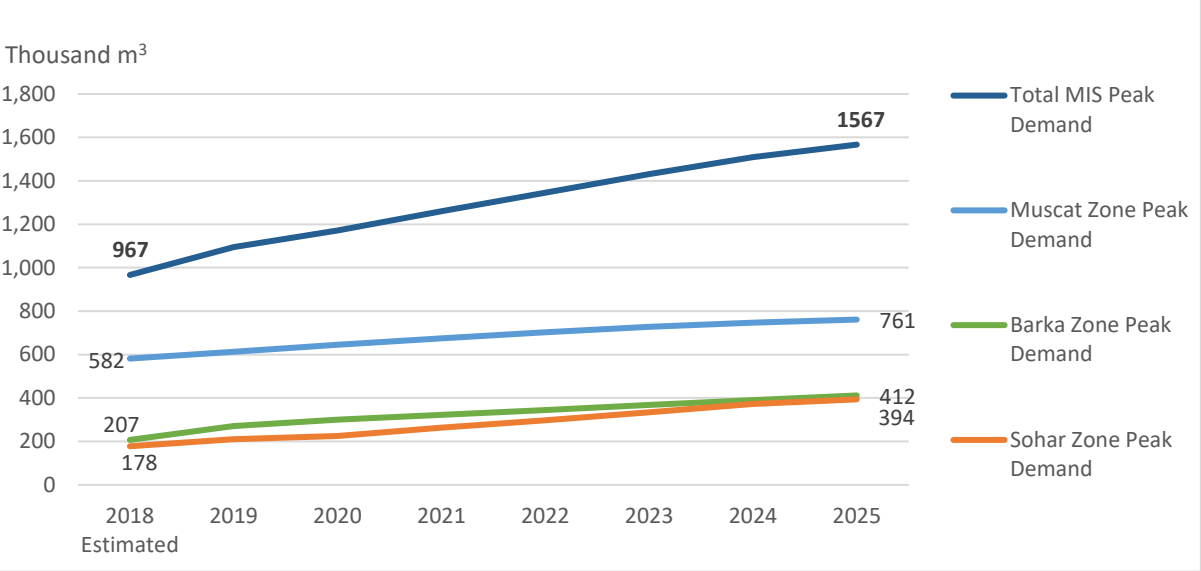
[16] The water demand of Ad Dhahirah Governorate is not included in Sohar Zone or MIS demand projections until the date of planned connection in 2021.

[17] National Centre for Statistics and Information, "Population Projections in the Sultanate of Oman, 2017-2040", (in Arabic); Population Statistics Bulletin, Issue 7, 2017. PAW has selected the M2 scenario, which is around the middle of the NCSI range.

2040. The assumed pace of network expansion is much less than in past years. In summary, PAW projects average annual growth of about 6% over the forecast horizon to 2025.

The PAW forecast for 2019 to 2025 is less than the forecast presented for capacity planning in the previous 7 Year Statement, Issue 12. The reduction in peak demand is about 5% (73,000 m^3/d) in 2024.

Figure 18 Water Demand Projections – MIS



	2018[a]	2019	2020	2021	2022	2023	2024	2025	Average Growth (%)
Medium Case Scenario	Thousand m^3/d								
Muscat zone									
Peak Demand	582	614	645	675	703	728	747	761	4%
Average Demand	511	538	565	591	616	637	653	665	4%
Barka zone									
Peak Demand	207	271	301	322	344	368	391	412	10%
Average Demand	172	225	249	266	283	302	320	336	10%
Sohar zone									
Peak Demand	178	211	226	263	298	335	373	394	12%
Average Demand	148	177	189	221	251	281	311	328	12%
Total MIS									
Peak Demand	**967**	**1,096**	**1,172**	**1,260**	**1,345**	**1,431**	**1,510**	**1,567**	**7%**
Change from 2017-2024 Statement	-100	-50	-75	-83	-81	-77	-73	-	
Average Demand	**831**	**940**	**1,003**	**1,078**	**1,150**	**1,220**	**1,284**	**1,329**	**6%**
Change from 2017-2024 Statement	-57	-12	-34	-39	-37	-33	-31	-	

[a] The Average Demand is based on actual 2018 outturns while the Peak Demand is estimated using peak factor.

3.1.B Water Supply Resources

The sources of potable water supply include operating water desalination plants, new desalination plants under construction or procurement, and PAW sources. The water desalination resources that are under contract with OPWP in the MIS are summarized in Table 10.

OPWP's contracted sources of desalinated water in the MIS are described as follows:

- **Ghubrah II IWP.** Owned by Muscat City Desalination Company and operated under a WPA with OPWP, the plant has contracted desalination capacity of 191,000 m^3/d (42 MIGD) using RO technology.
- **Qurayyat IWP.** Awarded in December 2014 to the Qurayyat Desalination Company, and to be operated under a WPA with OPWP, Qurayyat IWP has contracted desalination capacity of 200,000 m^3/d (44 MIGD), using RO technology. It is currently delivering commercial water and expected to achieve full contractual commercial operation in Q2, 2019.
- **Barka IWPP**. Owned by ACWA Power Barka and operated under a PWPA with OPWP. The Barka IWPP was originally contracted with a desalination capacity of 91,200 m^3/d (20 MIGD) using MSF technology, and added RO capacities of 45,000 m^3/d (10 MIGD) in 2014 and 57,000 m^3/d (12.5 MIGD) in 2016. The supply contracts for Barka IWPP are scheduled to expire in December 2021. The current agreement provides contracted desalinated capacity of the RO plants, while the MSF units are intended to remain on standby, to be utilized as a contingency reserve.
- **Barka II IWPP.** Owned by SMN Power Barka and operated under a PWPA with OPWP, the Barka II IWPP has a capacity of 120,000 m^3/d (26 MIGD) using RO technology. The PWPA will expire in March 2024.
- **Barka IV IWP.** Owned by Barka Desalination Company, and operated under a WPA with OPWP with contracted capacity of 281,000 m^3/d (62 MIGD), using RO technology, The WPA will expire in 2038.
- **Sohar IWPP.** Owned by Sohar Power Company and operated under a PWPA with OPWP, Sohar IWPP has a desalination capacity of 150,000 m^3/d (33 MIGD), using MSF units. The PWPA will expire in March 2022.
- **Sohar IV IWP.** Awarded in November 2015 to Myah Gulf Desalination Company, and to be operated under a WPA with OPWP with contracted capacity of 250,000 m^3/d (55 MIGD), using RO technology, Sohar IV IWP is currently expected to begin commercial operation in Q3, 2019.

Table 10 Contracted Capacities (WPAs/PWPAs) - MIS

Project	Contracted Capacity	Contract Type	Plant Owner	Plant Status	Technology	Contract Expiry
Barka IWPP	91,200 m^3/d	PWPA	ACWA Power Barka (SAOG)	Operational	MSF	2021
	45,000 m^3/d	WPA		Operational	RO	2021

	57,000 m^3/d	WPA		Operational	RO	2021
Barka II IWPP	120,000 m^3/d	PWPA	SMN Barka Power Co. (SAOC)	Operational	RO	2024
Barka IV IWP	281,000 m^3/d	WPA	Barka Desalination Co. (SAOC)	Operational	RO	2038
Ghubrah II IWP	191,000 m^3/d	WPA	Muscat City Desalination Co. (SAOC)	Operational	RO	2038
Qurayyat IWP	200,000 m^3/d	WPA	Qurayyat Desalination Co. (SAOC)	Under construction	RO	2037
Sohar IWPP	150,000 m^3/d	PWPA	Sohar Power Co. (SAOG)	Operational	MSF	2022
Sohar IV IWP	250,000 m^3/d	WPA	Myah Gulf Desalination Co. (SAOC)	Under construction	RO	2038

In addition to the foregoing sources that are under contract to OPWP, PAW operates wellfields at several locations in the MIS that offset the need for water desalination capacity. The production capacity from these sources is shown in aggregate by supply zone and by year in Figures 19A, 19B, 19C and 19D. The Government has a policy to limit water extraction from wellfields to allow natural replenishment of underground aquifers. Some wellfields are experiencing a decline in water quality due to encroaching salinity from over-use. Hence, wellfields are considered as emergency water resources, and the extent of their availability during the forecast period is somewhat uncertain.

3.1.C Resource Adequacy and Development Plan

The expansion plan for water desalination capacity aims to meet peak demand, plus a reserve margin for security of supply. PAW has redefined the reserve margin requirement as a level-of-service standard equivalent to the spare capacity needed to compensate for the expected level of unplanned plant outages and the uncertainty in the demand forecast. A value of 7% is allocated to cover operational outages. In addition, a value of 1% is added to the margin for demand uncertainty in the first 5 years period followed by 2% in the second 5 years period. The margin used from 2019-2022 is 8% followed by 9% margin for the years 2023-2025.

OPWP's assessment of resource adequacy and development plans is presented by supply zone. It shows the extent of transfers between zones, inter-zonal reserve sharing, and constraints that are otherwise not evident in a summary presentation of the MIS.

Muscat Zone

The Muscat zone is currently supplied by the Ghubrah II IWP, Qurayyat IWP and PAW wellfield resources. Qurayyat IWP has been delivering pre-COD commercial water since 2018, and is expected to achieve final technical acceptance and begin contractual commercial operation in Q2, 2019. Currently, resources within the Muscat zone are not sufficient to meet demand, and water transfers from Barka Zone are required to provide for the balance.

Figure 19A provides a summary of annual water supply requirements and supply sources in the Muscat zone. The transfer to Muscat from Barka is constrained. The transmission facility provides for transfers from Barka to both Ad Dakhiliyah and Muscat, and is the only source of desalinated water supply for Ad Dakhiliyah. Supply to Ad Dakhiliyah is currently transmission-constrained, although upgrades to both pumping and pipeline capacity are in progress. The water demand in Ad Dakhiliyah will not be fully met until 2023 upon completion of the network reinforcement project. The available transfers to Muscat will then decline from 2023 onwards, reflecting the increase in supply to Ad Dakhiliyah.

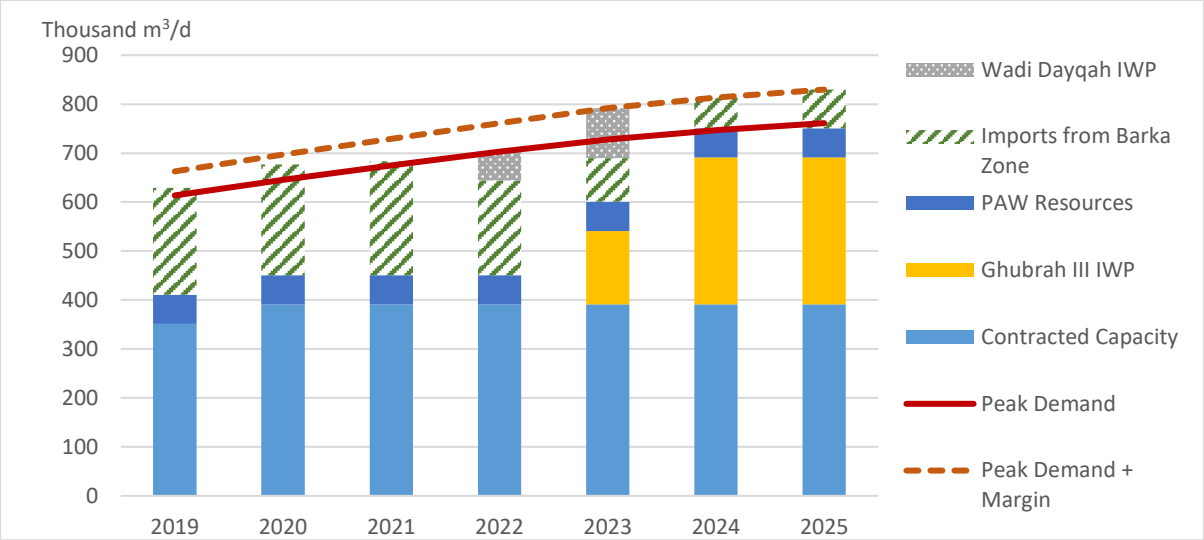
PAW has requested OPWP to procure two projects to provide additional water desalination capacity within the Muscat zone: Ghubrah III IWP and Wadi Dayqah IWP. They are described as follows:

- **Ghubrah III IWP.** The project will have capacity of 300,000 m^3/d, using RO technology. OPWP began the procurement process in 2016 but PAW put the procurement process on temporary hold in 2017 pending reassessment of water demand. The procurement process resumed in Q4, 2017 on PAW's direction, and Ghubrah III IWP is now scheduled for commercial operation in Q3, 2023. The project will be located on a portion of the site occupied by Ghubrah IWPP, which has been retired and began decommissioning and site clearance in 2018.

- **Wadi Dayqah IWP.** This project is designed as a dual-purpose facility to take water from the Wadi Dayqah reservoir for both agricultural and potable water supply. It will include an RO plant to provide potable water. The capacity for potable water supply will be 102,000 m^3/d. PAW prepared the design concept and requested OPWP to procure the project in Q4, 2017. The COD is currently scheduled for Q4, 2022. Wadi Dayqah IWP has a non-firm capacity which depends on the level of rainfall. The project is intended to diversify desalinated water sources and provide supply during emergencies.

In a January 2019 revision to its supply plan, PAW requested OPWP to provide early water from Wadi Dayqah at 72,000 m^3/d in 2022, and to defer the Ghubrah III schedule by one year, from Q3 2022 to Q3 2023, with an early water requirement of 120,000 m^3/d during the 2023 peak season. This plan is incorporated into Figure 19A. OPWP notes that the PAW supply plan to the Muscat zone is vulnerable to unplanned disruptions in construction schedules and the availability of rainwater supply in 2022 and 2023, when reserves may not be available during periods of peak demand. PAW may consider demand-based mitigation measures if contingencies require.

Figure 19A Resource Adequacy and Development Plan – Muscat Zone



	2019	2020	2021	2022	2023	2024	2025
Muscat Zone				Thousand m³/d			
Average Demand	538	565	591	616	637	653	665
Peak Demand	614	645	675	703	728	747	761
Peak Demand + Margin	663	697	729	761	792	814	830
Contracted Capacity							
Ghubrah II IWP	191	191	191	191	191	191	191
Qurayyat IWP	160	200	200	200	200	200	200
Prospective Capacity							
Wadi Dayqah IWP	-	-	-	72	102	-	-
Ghubrah III IWP	-	-	-	-	120	300	300
PAW Resources							
Wells Capacity[a]	60	60	60	60	60	60	60
Total Muscat Zone Capacity	**411**	**451**	**451**	**523**	**673**	**751**	**751**
Reserve over Peak Demand	-203	-194	-224	-180	-55	4	-10
Reserve over Peak Demand + Margin	-252	-246	-278	-238	-119	-63	-79
Transfers							
Available Transfer Capacity from Barka to Muscat[b]	218	226	232	193	147	133	121
Required Transfers from Barka to Muscat[c]	218	226	232	193	119	63	79
Muscat Zone Capacity +/- Required Transfers	**629**	**677**	**683**	**716**	**792**	**814**	**830**
Reserve over Peak Demand (shortfall)	15	32	8	13	64	67	68
Reserve over Peak Demand + Margin (shortfall)	-34	-20	-46	-45	0	0	0

[a]The wells will be used up to the maximum capacity during peak demand periods when the desalination capacity is not sufficient to meet the demand. PAW is responsible of maintaining and operating these wells to overcome supply deficit.
[b]Available transfer capacity is the transmission capacity less the peak demand requirement of Ad Dakhiliyah, subject to the availability of Barka resources. Due to the network constraints, the Dakhiliyah demand will not be fully met by desalination resources until the reinforcement project is completed in 2023.
[c]Transfers required to meet Muscat Peak Demand + Margin, subject to maximum available transfer capacity.

Barka Zone

The Barka zone is currently supplied by Barka IWPP, Barka II IWPP, Barka IV IWP, and PAW-operated wellfield resources. These resources currently exceed the demand requirements within the Barka zone and enable transfers to the Muscat zone.

Figure 19B provides a summary of annual water supply requirements and supply sources in the Barka zone. The following developments are noted:

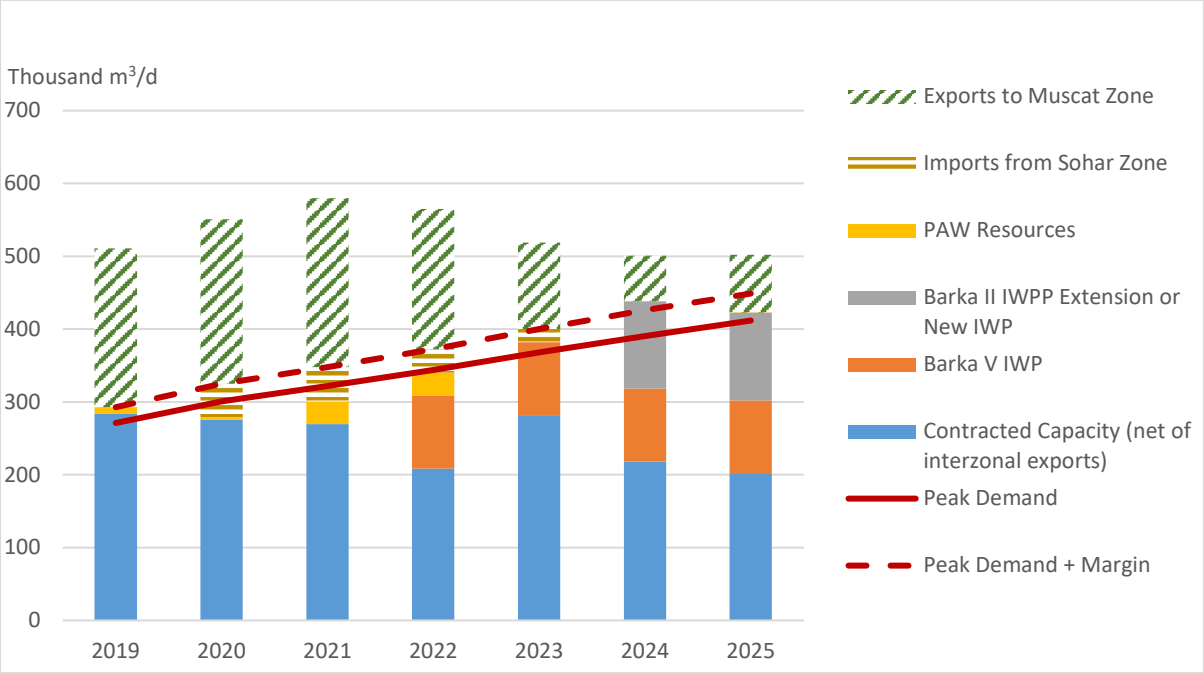
- From 2020 to 2022, transfers from Sohar Zone are needed to boost the available Barka capacity and enable maximum transfer to Muscat Zone,
- The Barka IWPP PWPA expires in 2022, such that 101,000 m^3/day of capacity must be replaced,
- Barka V is scheduled to begin commercial operation in Q2 2022, with capacity of 100,000 m^3/d,[18]
- In 2023, the addition of Ghubrah III IWP in the Muscat Zone is expected to reduce the need for transfers to Muscat from the Barka Zone, and
- In 2024, the Barka II IWPP PWPA expires, such that 120,000 m^3/d of capacity must be replaced. OPWP will initiate a negotiation for contact extension with the owners in 2020, and if necessary will procure new capacity for COD in 2024.

These procurement actions are expected to secure sufficient capacity to meet targets at a reasonable cost and provide for demand growth in this supply zone. PAW-operated wellfields in South Batinah and Ad Dakhiliyah are planned to provide contingency supply during peak months at capacity of up to 32,000 m^3/d.

In general, during the forecast period, the Barka zone is expected to have adequate capacity to meet peak demand requirements, although the target reserve margin is not achieved until 2023, subject to planned capacity additions in the Muscat and Sohar zones.

[18] In 2018, OPWP negotiated with the Barka IWPP owners for a contract extension. The negotiations were not able to meet the benchmark tariff. As a replacement for Barka IWPP capacity, OPWP initiated procurement of the Barka V IWP with capacity of 100,000 m^3/d at an adjacent site, scheduled to start operation in Q2, 2022.

Figure 19B Resource Adequacy and Development Plan – Barka Zone



	2019	2020	2021	2022	2023	2024	2025
Barka Zone				Thousand m³/d			
Average Demand	225	249	266	283	302	320	336
Peak Demand	271	301	322	344	368	391	412
Peak Demand + Margin	293	325	348	372	400	426	449
Contracted Capacity							
Barka I IWPP (RO)	101	101	101	-	-	-	-
Barka I IWPP (MSF- standby only)	91	91	91		-	-	-
Barka II IWPP	120	120	120	120	120	-	-
Barka IV IWP	281	281	281	281	281	281	281
Prospective Capacity							
Barka V IWP	-	-	-	100	100	100	100
Barka II Extension or New IWP						120	120
PAW Resources							
Wells Capacity[a]	9	2	31	32	0	0	0
Total Barka Zone Capacity[b]	**511**	**504**	**533**	**533**	**501**	**501**	**501**
Reserve over Peak Demand	240	203	211	189	133	110	89
Reserve over Peak Demand + Margin	218	179	185	161	113	103	84
Transfers							
Available Transfer Capacity from Sohar to Barka [c]	0	47	47	47	47	34	36
Required Transfer Capacity from Sohar to Barka	0	47	47	32	18	0	1
Required Transfers from Barka to Muscat	-218	-226	-232	-193	-119	-63	-79

Barka Zone Capacity +/- Required Transfers	**293**	**325**	**348**	**372**	**400**	**438**	**423**
Reserve over Peak Demand (shortfall)	22	24	26	28	32	48	11
Reserve over Peak Demand + Margin (shortfall)	0	0	0	0	0	12	-26

[a]The maximum wells capacity in Barka zone is around 32 thousand m^3/d.
[b] Excluding Barka I IWPP standby capacity.
[c]Subject to reserves available in Sohar zone.

Sohar Zone

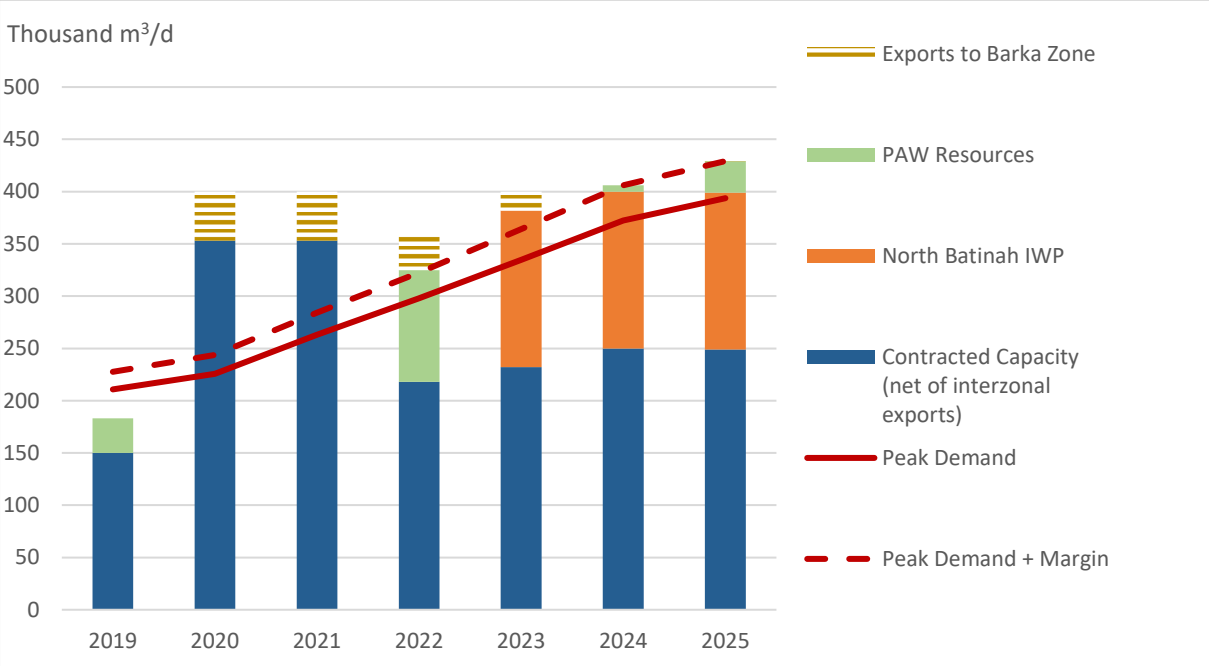
The Sohar Zone is currently supplied by the Sohar IWPP and PAW-operated wellfield resources. The Sohar IV IWP is under construction and expected to begin commercial operation in Q3, 2019. Figure 19C provides a summary of annual water supply requirements and supply sources in the Sohar Zone.

PAW plans to utilize wellfield resources to meet the peak demand in 2019 until the completion of Sohar IV IWP. Wellfield capacity of 33,000 m^3/d is expected to be available, reducing the expected modest supply deficit in 2019. Completion of the transmission connection to Ad Dhahirah is expected by end of 2021, increasing peak demand to the Sohar Zone. However, wellfields in Ad Dhahirah provide capacity of up to 10,000 m^3/d. Reliable capacity of wellfield resources is somewhat uncertain. PAW plans to reserve production to emergencies, while developing resources further to enable peak output of up to 107,000 m^3/d to meet the capacity target in 2022 after the retirement of Sohar IWPP.

The Sohar IWPP PWPA expires in March 2022. PAW has requested OPWP to procure a new facility, shown as North Batinah IWP, with capacity of 150,000 m^3/d, through a tendering process that began in 2018. Per PAW request, the new IWP is scheduled to begin commercial operation in Q1 2023.

Figure 19C indicates that this timing for the North Batinah IWP implies a modest supply deficit in 2022, when transfers from Sohar to Barka are also required. At that time, the Sohar zone wells capacity is expected to meet the capacity target. OPWP notes that supply security in the Sohar Zone appears to be vulnerable in 2022 and 2023 depending upon a historically high level of wellfield output for an extended period in 2022, and timely completion of the North Batinah IWP in 2023. Reserves meet the planning target for the remainder of the forecast period.

Figure 19C Resource Adequacy and Development Plan – Sohar Zone



	2019	2020	2021	2022	2023	2024	2025
Sohar Zone			Thousand m³/d				
Average Demand	177	189	221	251	281	311	328
Peak Demand	211	226	263	298	335	373	394
Peak Demand + Margin	228	244	284	322	364	406	429
Contracted Capacity							
Sohar IWPP	150	150	150		-	-	-
Sohar IV IWP	-	250	250	250	250	250	250
Prospective Capacity							
North Batinah IWP	-	-	-	-	150	150	150
PAW Resources							
Wells Capacity[a]	33			107		6	30
Total Sohar Zone Capacity	**183**	**400**	**400**	**357**	**400**	**406**	**430**
Reserve over Peak Demand	-28	174	137	59	65	34	36
Reserve over Peak Demand + Margin	-45	156	116	35	36	0	1
Transfers							
Available Transfer Capacity from Barka to Sohar[b]	0	0	0	0	0	12	0
Required Transfer from Sohar to Barka	0	-47	-47	-32	-18	0	-1
Sohar Zone Capacity +/- Required Transfers	**183**	**353**	**353**	**325**	**382**	**406**	**429**
Reserve over Peak Demand (shortfall)	-28	127	90	27	47	34	35
Reserve over Peak Demand + Margin (shortfall)	-45	109	69	3	18	0	0

[a] In 2019, the wells capacity is based on the actual maximum output of North Batinah and Buraymi wells during peak periods. In 2022, the capacity represents PAW maximum expected wells capacity of around 107 thousand m^3/d including Baitnah North wells, Buraymi wells, and Dhahirah wells after interconnection in 2022.
[b] The transfer capacity is 49,000 m3/d to Sohar, subject to reserves available in Barka. From 2019 to 2022, no reserves are expected to be available from Barka during the peak season, as capacity is required to serve the demand requirements of Barka and Muscat Zones.

MIS Summary

In summary, the PAW resource development plan provides for sufficient supply to meet peak demand in all years. It meets the target margin in the final years of the forecast period. However, in the Muscat Zone, the present analysis suggests that resource adequacy is vulnerable until Ghubrah III IWP becomes available in 2023. From 2021 to 2023, resource adequacy throughout the MIS depends upon interzonal transfers, with a relatively tight reserve margin, and is vulnerable in the event of unexpected contingencies.

OPWP and PAW work together to anticipate potential difficulties and to develop mitigation plans should they prove to be necessary. OPWP has also taken a number of actions to prevent or mitigate potential construction delays: contractual access to Early Water or pre-COD water, contractual access to standby RO trains, an active program of progress monitoring and consultation during the construction period, allowance for a longer construction period in the planning process, and scheduling contractual COD targets to be earlier in the year prior to the onset of the peak season.

3.2 SHARQIYAH WATER NETWORK

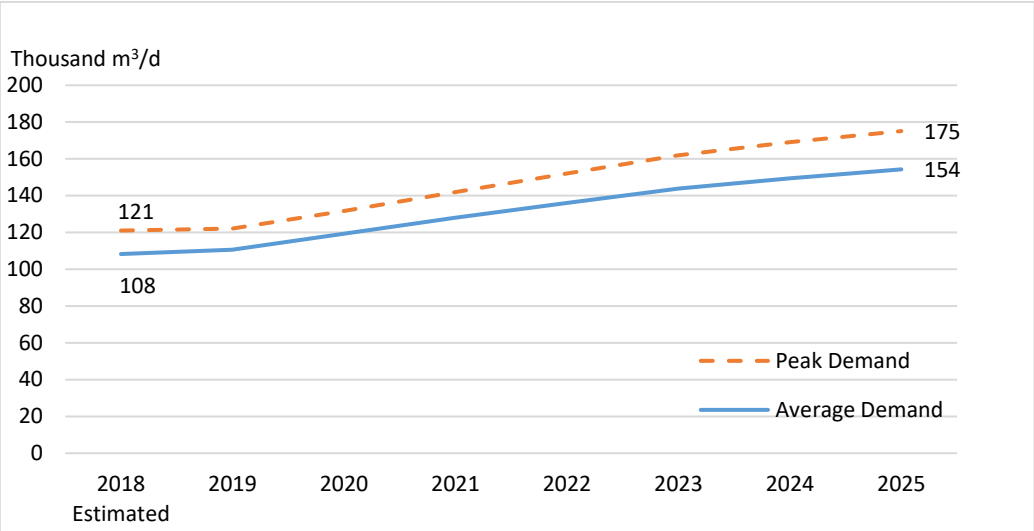
The Sharqiyah Water Network is developed and operated by PAW, serving Ash Sharqiyah North and Ash Sharqiyah South Governorates (excluding Massirah Island). It is not connected with the MIS. OPWP provides desalinated water to PAW from the Sur II IWP. PAW provides water to other communities of the Governorate of Ash Sharqiyah South from its own resources, including wells and small RO plants.

3.2.A Demand for Water

Sharqiyah Zone refers to the area served by the Sharqiyah Water Network that is or will be connected to OPWP water desalination plants. It excludes areas of PAW supply that are isolated from the Network.

PAW demand forecast for the Sharqiyah Zone is shown in Figure 20. The demand is driven by population growth, growth in per capita consumption, and the expected network expansion. PAW adopted the accelerated NCSI m^2 population growth scenario to project the domestic water demand growth. In addition, PAW incorporated new bulk demand in the forecast such as Sharqiyah university and Sur industrial area demand. Accordingly, PAW projects average growth for peak and annual average demand is at 5% over the 7-year horizon, which is less than forecast provided for the previous 7-Year Statement, Issue 12. The growth rate is not constant. PAW is extending the Sharqiyah Water Network and increasing transmission capacity to the new Asilah IWP by 2021. In pace with the network developments, the demand growth is projected at 8% in 2020-2021, 7% in 2022-2023, and in 2024 - 2025 the growth rate will slow down to 4% when the network expansion is expected to be completed.

Figure 20 Water Demand Projections – Sharqiyah Water Network



	2018 Estimated	2019	2020	2021	2022	2023	2024	2025	Average Growth (%)
	Thousand m³/d								
Peak Demand	**121**	**122**	**132**	**142**	**152**	**162**	**169**	**175**	**5%**
Change from 2018-2024 Statement	*6*	*1*	*-2*	*-6*	*-8*	*-7*	*-6*	-	
Average Demand	**108**	**111**	**119**	**128**	**136**	**144**	**149**	**154**	**5%**
Change from 2018-2024 Statement	*-6*	*-11*	*-14*	*-15*	*-13*	*-10*	*-9*	-	

3.2.B Water Supply Sources

The supply sources available to meet water demand include existing water desalination plants, new desalination plants under construction or procurement, and PAW sources. The resources that are under contract with OPWP are summarized in Table 11, and described as follows:

- **Sur II IWP**. Owned and operated by Sharqiyah Desalination Company under a WPA with OPWP, Sur II IWP has contracted capacity of 131,000 m³/d (29 MIGD), using RO technology. This includes the recent 48,000 m³/d expansion, which was completed in 2017.

- **Asilah IWP.** Awarded in December 2017 to Al Asilah Desalination Company, to be operated under a WPA with OPWP with contracted capacity of 80,000 m³/d (17 MIGD), using RO technology. Asilah IWP is expected to begin commercial operation in Q2, 2021.

In addition to the capacity under contract to OPWP, PAW has wells at several locations. They may be utilized, to a limited degree, for water supply when desalinated water capacity is not sufficient to meet demand.

Table 11 Contracted Capacities (WPAs) – Sharqiyah Zone

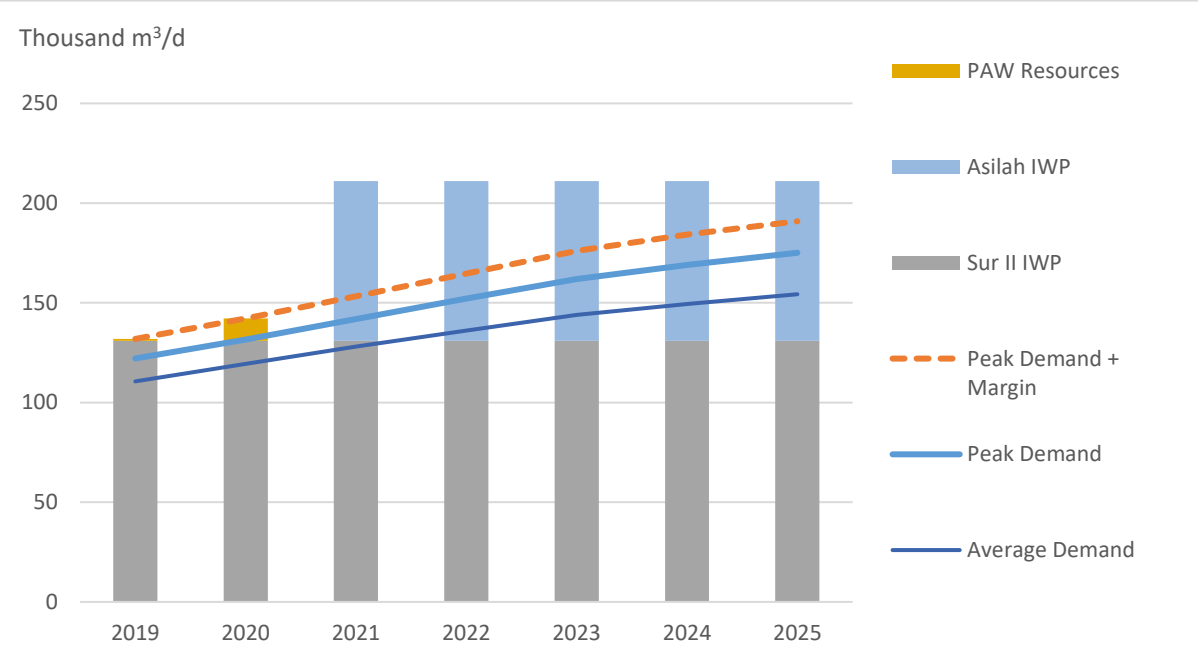
Project Name	Contracted Capacity	Contract Type	Project Company	Project Status	Technology	Contract Expiry
Asilah IWP	80,000 m³/d	WPA	Al Asilah Desalination Company (SAOC)	Under construction	RO	2041
Sur II IWP	131,000 m³/d	WPA	Sharqiyah Desalination Company (SAOG)	Operational	RO	2029

3.2.C Resource Adequacy and Development Plan

The capacity target for the Sharqiyah Zone is a margin of 8% for 2019-2022 and 9% for 2023-2025 over peak demand, as for the MIS. Figure 21 compares the capacity target to the supply plan.

The figure shows that contracted capacity is not sufficient to meet peak water demand with margin in the next two years 2019-2020. PAW well resources are required to produce during this period until the completion of Asilah IWP in Q2, 2021 with capacity of 80,000 m³/d. The supply plan meets capacity requirements for the remainder of the forecast period.

Figure 21 Resource Adequacy and Development Plan – Sharqiyah Water Network



	2019	2020	2021	2022	2023	2024	2025
Supply Requirements	Thousand m³/d						
Peak Demand	**122**	**132**	**142**	**152**	**162**	**169**	**175**
Peak Demand + Margin	**132**	**142**	**153**	**165**	**176**	**184**	**191**

Contracted Capacity							
Sur II IWP[a]	131	131	131	131	131	131	131
Asilah IWP[b]	0	0	80	80	80	80	80
Total Contracted Capacity	**131**	**131**	**211**	**211**	**211**	**211**	**211**
Reserve over Peak Demand (Shortfall)	**9**	**-1**	**69**	**59**	**49**	**42**	**36**
Reserve over Peak Demand + Margin (Shortfall)	**-1**	**-11**	**58**	**46**	**35**	**27**	**20**
PAW Resources Supply Requirement[c]	1	11	0	0	0	0	0

[a] Including Sur capacity addition of 48,000 m³/d.

[b] Expected COD for Asilah IWP is in Q2, 2021.

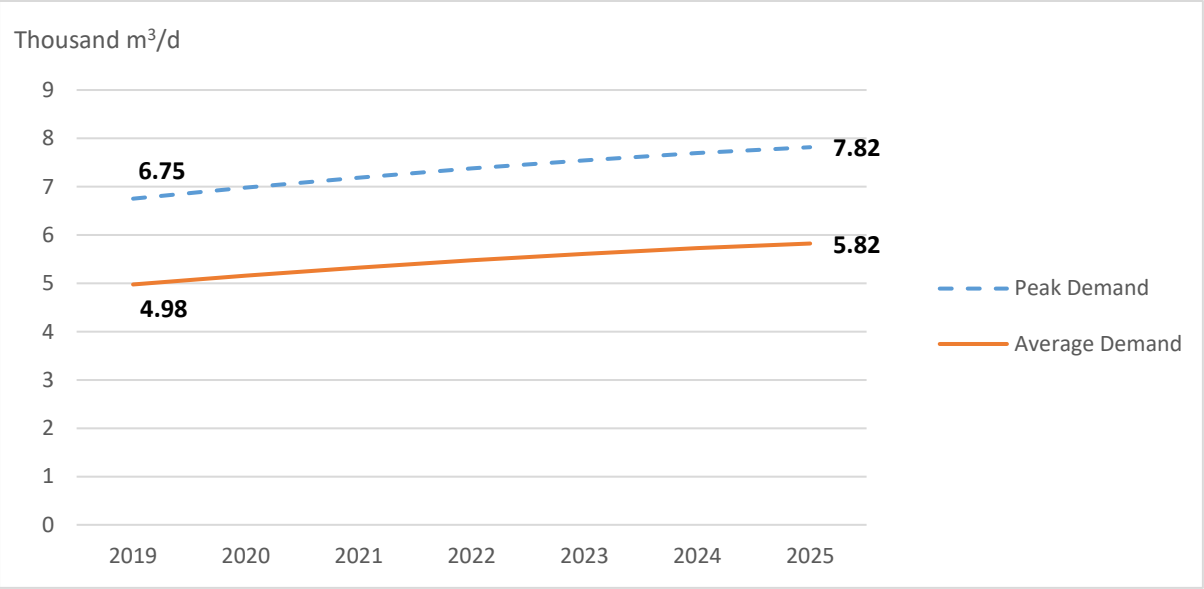
[c] PAW wells or tankers supply are considered only as an emergency supply in the near term.

3.3 MASSIRAH WATER NETWORK

3.3.A Demand for Water

The Massirah Zone comprises the Massirah Wilayat in Ash Sharqiyah South Governorate. PAW requested OPWP in 2018 to procure water desalination capacity for its water network on Massirah Island. PAW provided water demand projections, shown in Figure 22. PAW expects the peak demand to grow by 2% per annum in the next 7 years driven by the existing and new developments in the area.

Figure 22 Water Demand Projections – Massirah Zone



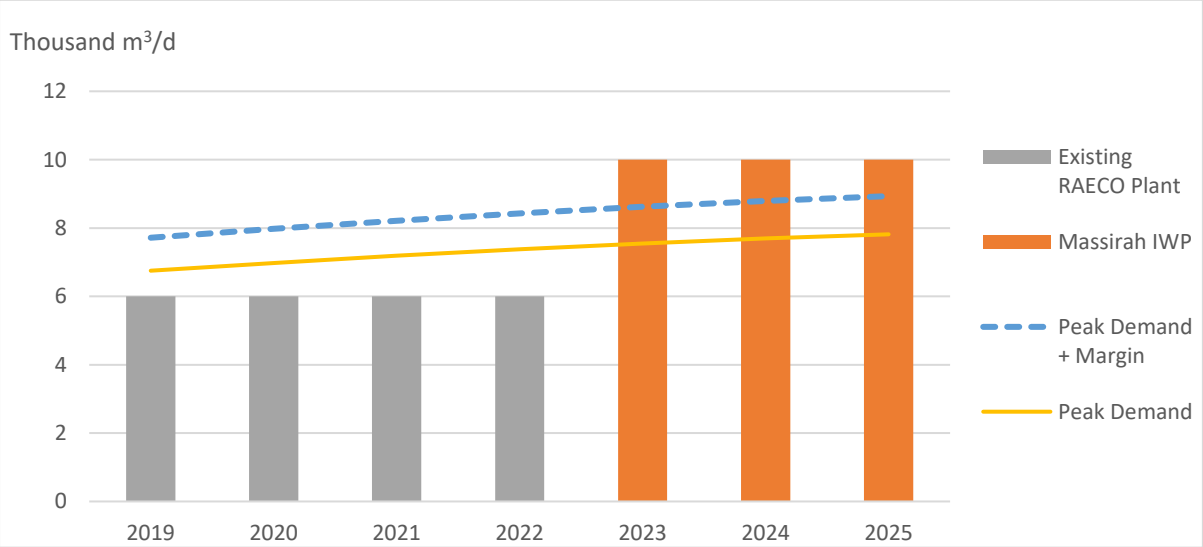
	2019	2020	2021	2022	2023	2024	2025	Average Growth (%)
				Thousand m³/d				
Peak Demand	**6.75**	**6.98**	**7.19**	**7.38**	**7.55**	**7.69**	**7.82**	**2%**
Average Demand	**4.98**	**5.16**	**5.32**	**5.47**	**5.61**	**5.73**	**5.82**	**3%**

3.3.B Resource Adequacy and Development Plan

The Massirah Zone is currently served by a RAECO plant, with a capacity of 6,000 m^3/d, and PAW underground water resources. PAW requested OPWP to initiate the procurement of a new IWP with a capacity of 10,000 m^3/d (2.2 MIGD). The RFQ is expected to be released in Q3, 2019 to begin commercial operation in Q1, 2023.

Figure 23 compares the desalination capacity target with the prospective water sources. PAW underground resources are expected to cover the deficit up to 2022. The prospective Massirah IWP would have sufficient capacity to meet water capacity requirements from 2023 onwards, replacing the existing RAECO plant and allowing PAW to discontinue wells production for aquifer recharge.

Figure 23 Water Supply and Demand Balance – Massirah Zone



	2019	2020	2021	2022	2023	2024	2025	Average Growth (%)
Supply Requirements				Thousand m^3/d				
Peak Demand	**6.8**	**7.0**	**7.2**	**7.4**	**7.5**	**7.7**	**7.8**	**2%**
Peak Demand + Margin	**7.7**	**8.0**	**8.2**	**8.4**	**8.6**	**8.8**	**8.9**	
Prospective Capacity								
Existing RAECO Plant	6	6	6	6				
Massirah IWP					10	10	10	
Total Desalination Resources Capacity	**6**	**6**	**6**	**6**	**10**	**10**	**10**	
Reserve over Peak Demand (Shortfall)	-0.8	-1.0	-1.2	-1.4	2.5	2.3	2.2	
Reserve over Peak Demand + Margin (Shortfall)	-1.7	-2.0	-2.2	-2.4	1.4	1.2	1.1	
PAW Resources Requirements	0.8	1.0	1.2	1.4	-	-	-	

3.4 DHOFAR WATER NETWORK

The Directorate General of Water (DGW) in the Office of the Minister of State and Governor of Dhofar is the principal "water department" responsible for potable water supply to consumers, and for the development, operation and maintenance of the Dhofar Water Network. OPWP provides desalinated water to DGW.

3.4.A Demand for Water

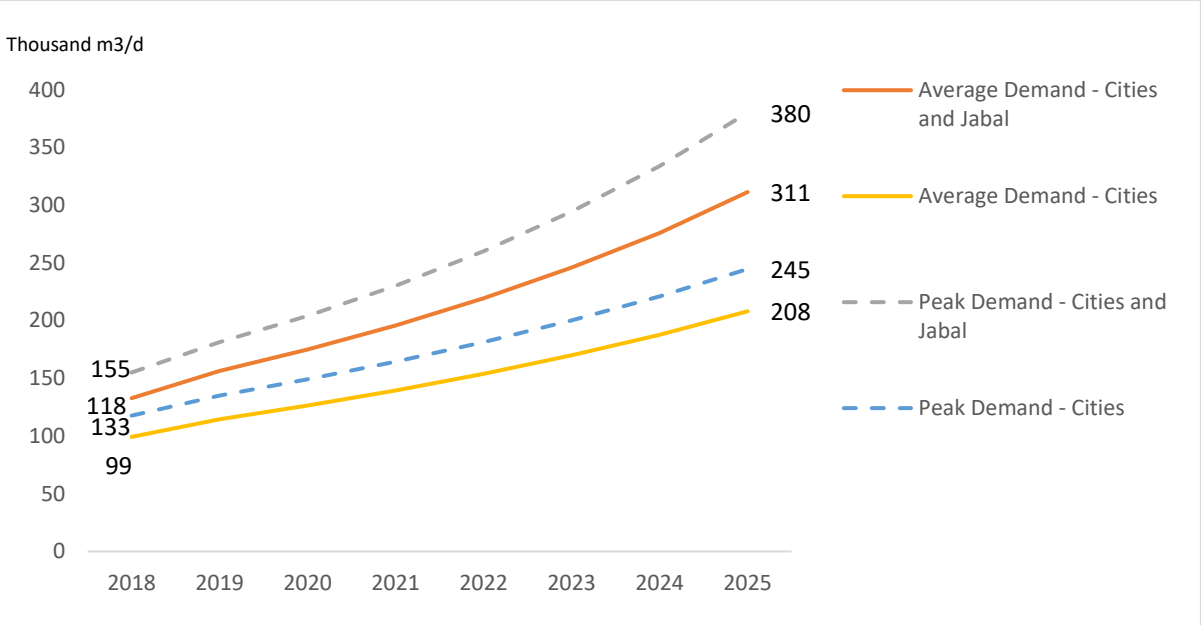
DGW has provided OPWP with the water demand projection for the Governorate of Dhofar, shown in Figure 24. It includes the aggregated potable water demands of the wilayats of Salalah, Taqah and Mirbat.

DGW has differentiated the forecast into two demand groups: (1) Cities of Salalah, Taqah, and Mirbat, which comprise demand served by the existing water distribution network; and (2) Jabal areas, which Jabal are not currently connected to the network. The Jabal demand is currently served by local wells and by tankers that are supplied from the Cities areas. DGW plans to expand its network to supply the Jabal communities during the forecast period. The expansion plans are under study and have not yet been approved by the Government. However, the water supply plan considers a scenario in which the expansion occurs.

The projected growth rate is higher than that provided for the previous 7-yaer Statement, Issue 12, representing 13% and 11% growth per year for peak and annual demand over the forecast period respectively. The wilayat of Salalah comprised around 92% of total water consumption in 2018. This share is projected to decline slightly over the next 7 years due to higher growth rates in the wilayats of Mirbat and Taqah. The respective growth rates for the wilayats of Salalah, Taqah and Mirbat are 11%, 13%, and 24% annually during the forecast period.

OPWP notes the sharp increase in demand growth relative to previous projections. DGW has advised that demand is mainly constrained by the availability of supply. Currently, water consumption per capita is substantially higher than in the MIS. The relatively high demand levels are attributed mainly to non-domestic water use, though other factors may also contribute.

Figure 24 Water Demand Projections – Dhofar Water Network



	2018 Estimated	2019	2020	2021	2022	2023	2024	2025	Average Growth (%)
Peak Demand				Thousand m³/d					
Cities	118	135	149	164	181	200	221	245	11%
Jabal	37	46	55	66	79	94	113	135	21%
Total	**154**	**181**	**204**	**230**	**260**	**294**	**334**	**380**	**14%**
Change from 2018-2024 Statement	*5*	*18*	*26*	*36*	*48*	*63*	*81*	-	
Average Demand									
Cities	99	114	126	139	154	170	188	208	11%
Jabal	34	42	49	56	65	76	88	103	17%
Total	**133**	**156**	**175**	**196**	**219**	**246**	**276**	**311**	**13%**
Change from 2018-2024 Statement	*-5.9*	*4.8*	*9.3*	*15.6*	*22.7*	*31.2*	*40.6*	-	

3.4.B Water Supply Sources

The sources of water supply include water desalination plants under contract to OPWP and groundwater resources operated by DGW. OPWP has two water desalination plants under contract for water supply to DGW. They are described in Table 12 and as follows:

- **Salalah IWPP.** Owned and operated by Sembcorp Salalah Power and Water Company under a PWPA with OPWP, Salalah IWPP has a capacity of 68,000 m³/d (15 MIGD), using RO technology, and was commissioned in 2012.
- **Salalah III IWP.** Awarded in December 2017 to Dhofar Desalination Company, to be operated under a WPA with OPWP with contracted capacity of 113,650 m³/d. Salalah III IWP is scheduled to begin commercial operations in Q4, 2020.

In addition to this desalination capacity, DGW uses a network of groundwater sources to meet the balance of water demand. DGW estimates that the groundwater supplies have a total capacity of around 100,000 m³/d to 110,000 m³/d (including 70,000 m³/d in the cities). DGW plans to utilize

desalinated water to meet average and peak demand requirements, and to reserve groundwater resources for emergency supply. This is also consistent with national policy to limit ground well production, to allow replenishment of aquifers.

Table 12 Contracted Capacities (WPAs) – Dhofar Water Network

Project Name	Contracted Capacity	Contract Type	Project Company	Project Status	Technology	Contract Expiry
Salalah IWPP	68,000 m^3/d	PWPA	Sembcorp Salalah Power & Water Company (SAOC)	Operational	RO	2027
Salalah III IWP	113,650 m^3/d	WPA	Dhofar Desalination Company (SAOC)	Under Construction	RO	2040

3.4.C Resource Adequacy and Development Plan

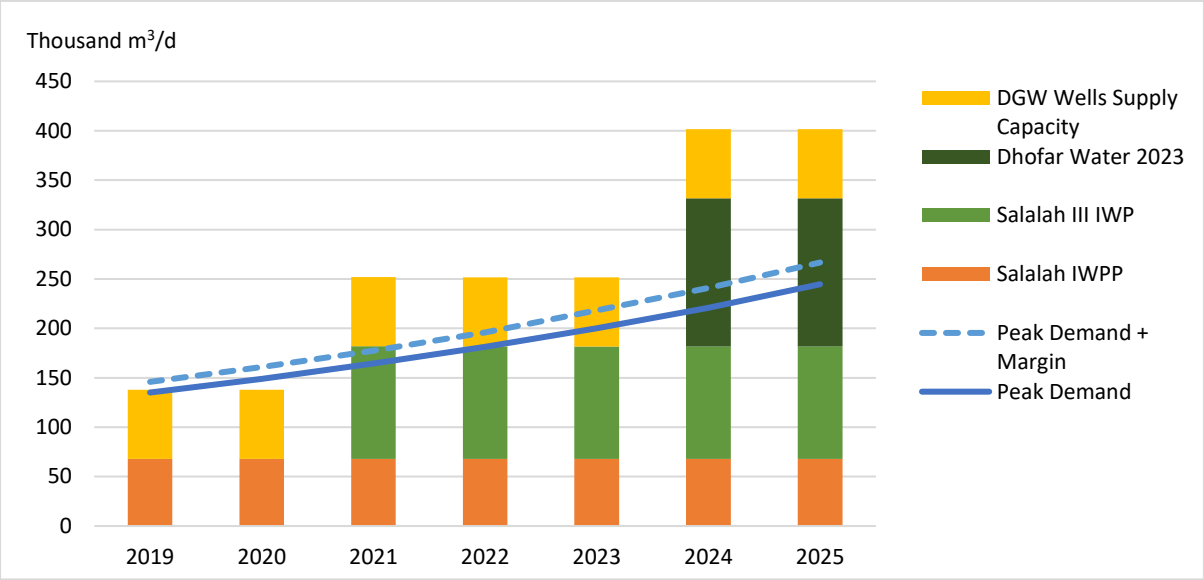
The resource adequacy presentation addresses two scenarios: (1) Dhofar Cities' demand only, and (2) Combined Dhofar Cities' and Jabal demand, which corresponds to DGW's proposed network expansion plan. The capacity target assumes the same reserve margin standard as the MIS and Sharqiyah Zone in the northern regions of the Sultanate.

Figure 25 provides a summary of the demand/supply balance for the next 7 years under the first scenario, restricting demand to the current extent of the Dhofar Water Network. Until the completion of Salalah III IWP, the total capacity including wells in Salalah cities is not sufficient to meet the capacity target. DGW would need to arrange temporary resources to overcome the deficit in 2019 and 2020.

Salalah III IWP will eliminate the need for underground water supply in 2021 and reduce the reliance on DGW wells capacity in 2022 and 2023. Additional desalination capacity is required to fulfill DGW's objective to reserve groundwater for emergency supply only.

DGW has requested OPWP to procure a desalination capacity of 150,000 m^3/d to begin operation in Q4, 2023 subject to regulatory approval. The new Dhofar Water IWP will be located at Raysut. In this scenario, focusing on Cities' demand under the current water network, the project capacity level would meet demand growth for at least 2-3 years beyond 2025, though depending upon the extent of demand from tankers supply to Jabal areas.

Figure 25 Resource Adequacy and Development Plan – Dhofar Cities Only



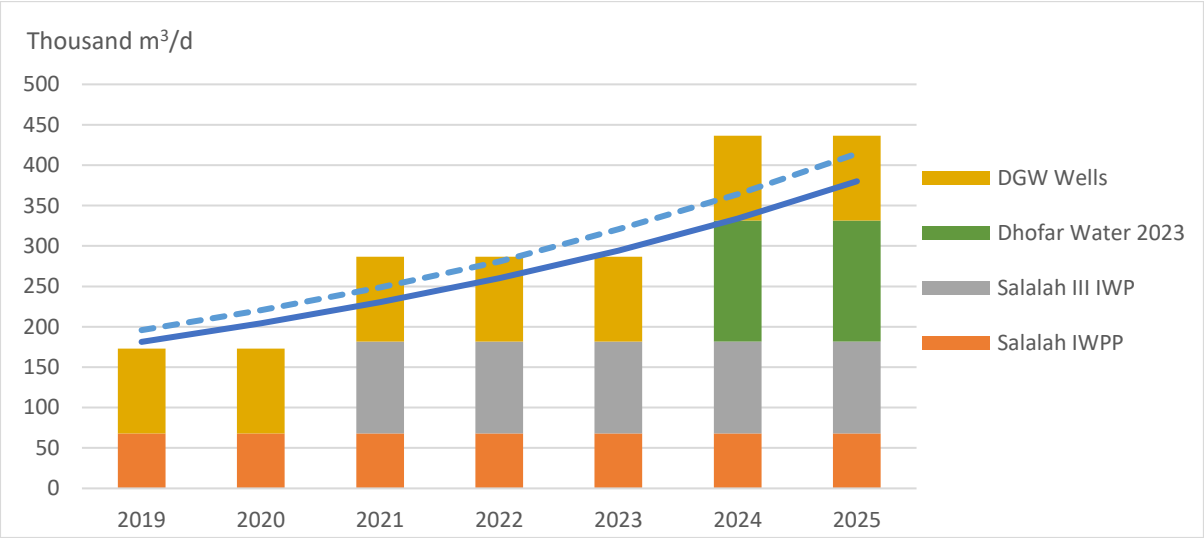
	2019	2020	2021	2022	2023	2024	2025
Supply Requirements				Thousand m³/d			
Cities Peak Demand	**135**	**149**	**164**	**181**	**200**	**221**	**245**
Cities Peak Demand + Margin	**146**	**161**	**178**	**196**	**218**	**241**	**267**
Contracted Capacity							
Salalah IWPP	68	68	68	68	68	68	68
Salalah III IWP			114	114	114	114	114
Total Contracted Supply	68	68	182	182	182	182	182
Prospective Capacity							
Dhofar Water 2023						150	150
Total Desalination Resources Capacity	**68**	**68**	**182**	**182**	**182**	**332**	**332**
Reserve over Peak Demand (Shortfall)	**-67**	**-81**	**18**	**0**	**-19**	**111**	**87**
Reserve over Peak Demand + Margin (Shortfall)	**-78**	**-93**	**4**	**-14**	**-37**	**91**	**65**
DGW Resources							
Wells Capacity[a]	70	70	70	70	70	70	70
Wells Supply Requirements	70	70	0	14	37	0	0
Reserve over Peak Demand (Shortfall)	3	-11	88	70	51	181	157
Reserve over Peak Demand + Margin (Shortfall)	-8	-23	74	56	33	161	135

[a] Representing the wells capacity inside the cities only. Total DGW wells capacity has an approximate supply range of 100,000 m³/d to 110,000 m³/d.

Figure 26 shows the demand-supply balance for the second scenario, considering DGW's requested network expansion to include all the water demand in the Jabal areas, for which Government approval is pending. It illustrates that groundwater supply would be required in every year to supplement desalinated water supply. Considering that DGW has specified the well capacity of the Jabal areas as being in the range of 30,000 to 40,000 m^3/d, it appears that this capacity may be exceeded, and that incremental demand may be required from tankers supplied from the Dhofar Water Network.

In this case, if supply to meet this demand level is approved, desalinated water from Salalah IWPP, Salalah III IWP, and the prospective Dhofar 2023 IWP would not be sufficient to meet the network's total water supply needs through 2025 as shown in Figure 26, resulting in continued use of groundwater resources.

Figure 26 Resource Adequacy and Development Plan – Dhofar Cities and Jabal



	2019	2020	2021	2022	2023	2024	2025
Supply Requirements				Thousand m^3/d			
Peak Demand - Cities	135	149	164	181	200	221	245
Peak Demand - Jabal	46	55	66	79	94	113	135
Total Peak Demand	**181**	**204**	**230**	**260**	**294**	**334**	**380**
Total Peak Demand + Margin	**196**	**221**	**249**	**281**	**321**	**364**	**414**
Contracted Capacity							
Salalah IWPP	68	68	68	68	68	68	68
Salalah III IWP	-	-	114	114	114	114	114
Total Contracted Capacity	**68**	**68**	**182**	**182**	**182**	**182**	**182**
Prospective Capacity							

Dhofar Water 2023	-	-	-	-	-	150	150
Total Desalination Resources Capacity	**68**	**68**	**182**	**182**	**182**	**332**	**332**
Reserve over Peak Demand	-113	-136	-49	-78	-113	-2	-48
Reserve over Peak Demand + Margin	-128	-153	-67	-99	-139	-32	-83
DGW Resources							
Wells Capacity[a]	105	105	105	105	105	105	105
DGW Groundwater Supply Requirements	**105**	**105**	**49**	**78**	**105**	**2**	**48**
Reserve over Peak Demand (Shortfall)	-8	-31	56	27	-8	103	57
Reserve over Peak Demand + Margin (Shortfall)	-23	-48	38	6	-34	73	22

[a] Total wells supply is shown as 105,000 m^3/d, considering an approximate capacity range of 100,000 m^3/d to 110,000 m3/d. This range includes wells capacity within the cities (70,000 m^3/d) and supply outside the cities.

SECTION 4
PROCUREMENT ACTIVITIES

4.1 POWER PROJECTS

Current/Near-Term Procurement Activities

OPWP's current and near-term procurement activities for power projects include the following, and are summarized in Table 13:

- **Ibri II Solar IPP.** In 2017, OPWP initiated the procurement process for a 500 MW Solar PV project at Ibri. Bids were received in 2018, and the project is expected to be awarded by Q1 2019, for 2021 COD.
- **Power 2022.** The Power 2022 capacity procurement encompasses the sale of assets of the existing Manah IPP, and procurement of around 600 MW of capacity for operation in 2022. The first stage of the RFQ process is complete, in which the four existing generators with expiring P(W)PAs were given the opportunity to commit capacity at or below benchmark tariffs for prospective contract extensions. On the basis of their submissions, OPWP has determined that the competition process for capacity meets requirements and that no new-build capacity is required in the subsequent RFP process. OPWP plans to issue RFPs for both Power 2022 and Manah IPP in Q2 2019, bids to be due in Q4 2019, and awards would be announced in Q1 2020. Bidders have the opportunity to propose P(W)PA terms in the range of 4 to 15 years.
- **Duqm IPP.** In 2018**,** OPWP issued an RFQ as the first step toward procurement of a 1,200 MW clean coal IPP located at Duqm. The RFP is currently on hold pending final approval of the project and site. If provided final approval enabling RFP release by Q2 2019, OPWP would expect to award the project in Q2 2020, and that the first 600 MW block would begin commercial operation in Q2 2025, followed by full power in 2026. If the clean coal IPP is not approved, OPWP plans to begin procurement of a Solar CSP IPP with thermal storage for COD in a similar time period, subject to approvals.
- **Solar IPP 2022.** OPWP plans to start procurement of its second Solar IPP in 2019, to achieve commercial operation in 2022. This project may also have installed capacity of 500 MW or more, subject to our site and market evaluations. We expect to issue the RFQ in Q3 2019, followed by RFP in Q4, and award in Q3 2020, for COD in Q4 2022.
- **Barka WTE IPP.** In 2018, OPWP completed a feasibility study for a Waste-to-Energy plant, in preparation for procurement. The facility will utilize municipal waste collected by Be'ah from Muscat and South Batinah areas, and will be located near Barka. The facility is expected to produce at least 100 MW under a PPA with OPWP. OPWP expects to issue the RFQ in Q3 2019, RFP in Q4 2019, and to award the project in Q2 2020 for COD in Q2 2023.
- **Solar IPP 2023.** OPWP plans to launch the third of the series of solar IPP procurements toward the end of 2019, to achieve commercial operation in 2023. This project may also have installed capacity of 500 MW or more, subject to our site and market evaluations.
- **Wind IPPs 2023.** OPWP plans to procure two wind IPPs toward the end of 2020, in different locations, to achieve commercial operation in 2023. The expected locations are in Duqm and the MIS, and they are expected to have a combined installed capacity of 300 MW.
- **Power 2024.** OPWP plans to initiate a second procurement round in 2020 for new PPAs that would begin in 2024. Existing generators with expiring or expired P(W)PAs, bidders for new capacity, and participants in the spot market may be eligible to participate in this competition,

subject to qualification. OPWP expects to issue the RFQ in Q1 2020, followed by the RFP in Q3. Contract awards are anticipated in Q2 2021 for COD or contract start in Q2 2024.

Table 13 Procurement Activities in 2019-2020 – Power Projects

	System	Capacity	RFQ	RFP	Bids Due	Award Anticipated	COD
Ibri II Solar IPP	MIS	500	Completed	Completed	Completed	Q1, 2019	Q2, 2021
Power 2022	MIS	600	Completed	Q2, 2019	Q4, 2019	Q1, 2020	Q1, 2022
Barka WTE IPP	MIS	100	Q3, 2019	Q4, 2019	Q1, 2020	Q2, 2020	Q2, 2023
Duqm IPP [a]	Duqm/ MIS	600	Completed	Q2, 2019	Q4, 2019	Q2, 2020	Q2, 2025
Solar IPP 2022	MIS	500	Q3, 2019	Q4, 2019	Q2, 2020	Q3, 2020	Q4, 2022
Solar IPP 2023	MIS	500	Q4, 2019	Q1, 2020	Q3, 2020	Q4, 2020	Q3, 2023
Wind IPP 2023	Duqm/ MIS	300	Q4, 2020	Q1, 2021	Q3, 2021	Q3, 2021	Q4, 2023
Solar IPP 2024	MIS	500	Q2, 2020	Q3, 2020	Q1, 2021	Q2, 2021	Q3, 2024
Power 2024[b]	MIS	700	Q1, 2020	Q3, 2020	Q1, 2021	Q2, 2021	Q2, 2024

[a] Pending approval. The procurement plan assumes approvals are received by Q1, 2019. If approved as a clean coal IPP, 600 MW represents the first block, with full power reaching 1,200 MW in 2026. Alternatively, this project may be replaced by a CSP project of a similar capacity, pending further studies and approvals.

[b] Capacity requirement is likely to change depending upon the outcome of Power 2022, demand growth, and assessments of capacity contributions from other resources, such as spot market

Future Procurement Activities

From 2021 to 2025, OPWP plans to continue to procure new solar and/or wind IPPs on an annual basis during this period. This includes procurement for a number of solar projects, primarily using PV technology, and potentially CSP pending further studies and approvals.

In addition, procurement of projects via long-term P(W)PAs, OPWP may procure short-term capacity or energy via transactions with neighboring power systems, and plans to develop a Demand Response program in which demand reductions will be contracted with participating electricity customers.

4.2 WATER PROJECTS

Current/Near-Term Procurement Activities

OPWP's current and near-term procurement activities for water projects include the following, and are summarized in Table 14:

- **Barka V IWP.** OPWP plans to procure 101,000 m^3/d (22 MIGD) of desalination capacity at Barka for operation beginning in Q2 2022. The release of the RFP for this project is currently planned for Q2 2019, and is pending approvals from the relevant authorities.

- **Ghubrah III IWP.** OPWP initiated the procurement process in Q1 2018 for capacity of 300,000 m^3/d (66 MIGD) at Ghubrah, to commence operation in Q3, 2023. The release of the RFP for this project is planned for Q2 2019 and is pending approvals from the relevant authorities.

- **North Batinah IWP.** OPWP initiated the procurement process in 2018 for new IWP capacity of 150,000 m^3/d (33 MIGD) in the North Batinah region, for COD in 2023. The RFP is expected to be issued in Q3 2019, for award in Q1 2020.

- **Wadi Dayqah IWP.** In Q2 2019, OPWP expects to begin procurement of capacity of around 125,000 m^3/d (27.5 MIGD) at the Wadi Dayqah reservoir near Qurayyat. It is a dual-purpose project, providing both potable water and irrigation water for agriculture. The potable water requirement is about 67,000 m^3/d. The project is scheduled to achieve COD by Q4, 2022.

- **Massirah IWP.** PAW has requested OPWP to procure an IWP to provide capacity of around 10,000 m^3/d (2.2 MIGD) at Massirah Island in the Governorate of Ash Sharqiyah South. Following technical assessments and land allocation, OPWP expects to issue the RFQ in Q3, 2019 with a scheduled COD for Q1, 2023.

- **Dhofar Water 2023.** OPWP plans to initiate the procurement process for this project in Q3 2019 for 2023 COD at a capacity of 150,000 m^3/d (33 MIGD). Release of the RFP is subject to confirmation of land allocation and availability of transmission infrastructure.

Table 14 Procurement Activities in 2019-2020 – Water Projects

	System	Capacity	RFQ	RFP	Bids Due	Award Anticipated	COD
Barka V IWP	MIS	22 MIGD	Completed	Q2, 2019	Q3, 2019	Q3, 2019	Q2, 2022
Ghubrah III IWP	MIS	66 MIGD	Completed	Q2, 2019	Q3, 2019	Q4, 2019	Q3, 2023
North Batinah IWP	MIS	33 MIGD	Completed	Q3, 2019	Q4, 2019	Q1, 2020	Q1, 2023
Wadi Dayqah IWP[a]	MIS	27.5 MIGD	Q2, 2019	Q2, 2019	Q4, 2019	Q1, 2020	Q4, 2022
Massirah IWP[a]	Massirah	2.2 MIGD	Q3, 2019	Q1, 2020	Q1, 2020	Q2, 2020	Q1, 2023
Dhofar Water 2023[a]	Dhofar Water Network	33 MIGD	Q3, 2019	Q4, 2019	Q2, 2020	Q3, 2020	Q3, 2023

[a] Subject to securing the sites and other critical approvals (if relevant).

Future Procurement Activities

From 2021 to 2025, OPWP may procure additional water desalination capacity projects. However, the Government is currently working on a plan for restructuring of the water sector into a number of regional companies, which may come to fruition in this time period. OPWP's future role as procurer of water desalination capacity will be determined through this process.