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

(2020 – 2026)

(Issue 14)

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GLOSSARY

APSR	Authority for Public Services Regulation, Oman
BST	Bulk Supply Tariff
BTU/scf	British thermal units per standard cubic foot
CCGT	Combined-cycle gas turbine
COD	Commercial operation date
CRT	Cost reflective tariff
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
EE	Energy Efficiency
ESCO	Energy Services Company
EWEC	Emirates Water and Electricity Company
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)
MEM	Ministry of Energy and Minerals
MIGD	Million imperial gallons per day
MIS	Main Interconnected System
MISC	Majis Industrial Services Company (SAOC)
MJEC	Majan Electricity Company (SAOC)
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
RE	Renewable Energy
RFP	Request for Proposal
RFQ	Request for Qualification
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)
WRA	Wind Resource Assessment

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, and the Dhofar Water Network.

Over the next seven years, OPWP is committed to achieve ambitious goals to diversify the sources of electricity generation. New solar and wind projects are forecast to contribute almost 13% of electricity production by 2025, and efficient utilisation of gas consumption will continue to improve over the planning horizon. In 2021, 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 14, for the period 2020 to 2026; 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 grow at a suppressed rate, about 4% per year on average, from 6,353 MW in 2019 to 8,490 MW in 2026. However, demand growth is expected to be less from 2019 to 2022 due to the impact of low oil prices and the COVID-19 pandemic on the economy. 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. While the CRT is expected to suppress demand during the afternoon peak over the near term, OPWP anticipates that the introduction of more solar projects over the planning horizon will reduce BST prices during the afternoon period, leading to a gradual increase in peak demand during the mid-to-later years of the 7 year planning period as CRT customers respond to these price signals. Energy consumption is expected to follow the growth in peak demand requirements, at an annual average of 3.6% per year, including negative growth in 2020 due to an expected economic recession.

High and Low Case scenarios are also considered. The Low Case projects 2% annual growth in peak demand, reaching 7,080 MW in 2026, almost 1,410 MW below the Expected Case. The High Case projects 7% annual growth in peak demand at 10,220 MW by 2026, exceeding the Expected Case by over 1,500 MW.

In the Dhofar Power System, peak demand is expected to grow at 5% per year, from 549 MW in 2019 to 793 MW in 2026. The Low Case projects 4% growth, reaching 706 MW by 2026, about 90 MW below the Expected Case. The High Case, on the other hand, projects 8% growth in peak demand, reaching 938 MW by 2026, 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 2021, completion of the 400 kV North-South Interconnect to the Duqm Power System in 2024 (with potential exchanges via the PDO system commencing in 2023), the continuing push for RE projects driven by economics, and assigning capacity contribution values to alternative resources, such as Sahim and private PV initiatives and uncontracted capacity participating in the Spot Market. 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) procurement of capacity via a combination of uncontracted contributions from the Spot Market and dedicated, contract-based procurement rounds[1] (Power 2022 and/or Power 2024, to the extent required); (2) completion of phase 1 of the Wind Resource Assessment by early 2021; (3) commencement of operations at Ibri II Solar IPP in 2021; (4) reassessment of the suspended Waste-to-Energy project in 2021; (5) Manah I & II Solar IPPs to commence operation in 2023; (6) an additional Solar IPP of capacity 500 MW_p planned for COD in 2025; and (7) a wind IPP of around 100 MW planned for COD in 2025 and to be located in the Sharqiyah region.

In the Dhofar Power System, the first Dhofar Wind IPP is began operating in 2019, and OPWP seeks to develop an additional Wind IPP with a capacity of around 100 MW and to be located adjacent to the existing project in Harweel.

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,; and (2) the Duqm Solar IPP, to provide about 300 MW of baseload supply utilizing Concentrated Solar Power (CSP) technology. These plans are subject to approval.

Fuel Requirements

The new non-gas fired projects under the fuel diversification initiative is forecasted to contribute almost 13.5% of total electricity production by 2025 – exceeding the policy target by around 3.5%. This percentage is anticipated to increase further to 14.5% by 2026.

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 2026, despite the 3.5% annual growth in electrical energy requirements. Average gas utilisation by the generation fleet (sm^3 per MWh produced) is projected to improve by 17% from 2020 to 2026. Much of the improvements will occur in 2020 (when compared against 2019) as the new high-efficiency power plants (Ibri IPP and Sohar III IPP) and large RO water desalination plants which commenced operations in 2019 have their first full year of operation in 2020. 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 2% per year, which follows the 4% growth of electrical energy requirements. The projections include the Dhofar I Wind IPP starting in 2019 and Dhofar II Wind IPP in 2025, both of which are expected to have a positive impact on gas savings.

Desalinated Water Requirements

Peak water demand in the Main Interconnected System (MIS) is projected to increase at 6% per year, from 1,016 thousand m^3/d in 2019 to around 1,503 thousand m^3/d in 2026. In the Sharqiyah Zone, water demand is expected to increase at 6%, from 124 thousand m^3/d in 2019 to 183 thousand m^3/d in 2026.

In the MIS, developments include: (1) Sohar IWPP and Barka IWPP contract expiration in 2022; (2) addition of Barka V IWP (100,000 m^3/d, 22 MIGD) in 2023; (3) new desalination capacity (150,000 m^3/d, 33 MIGD) in the North Batinah region, in 2025; (4) addition of early water capacity from Ghubrah III IWP (150,000 m^3/d, 33 MIGD) in 2023, and full capacity (300,000 m^3/d, 66 MIGD) in 2024; (5) Barka II IWPP contract expiration in 2024; (6) new desalination capacity (120,000 m^3/d, 26.4 MIGD) in the Barka Zone by 2024; and, (7) new desalination capacity (200,000 m^3/d, 44 MIGD) in the Muscat Zone by 2026.

[1] In Q4 2020, OPWP and the Authority began a process of reviewing the overall capacity procurement framework. This is further discussed in Section 1.1 b: Procurement Plans and Spot Market

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

In Dhofar, DGW forecasts water demand to grow at 13%, and peak water demand to increase from 164,000 m^3/d in 2019 to 379,000 m^3/d in 2026, 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 2025 (150,000 m^3/d, 33 MIGD) in 2025.

Previous versions of the 7 Year Statement included a section for the Masirah Water Network along with procurement plans for an IWP there, however, OPWP has removed this section from this issue upon receiving notice from the PAW that the project is suspended, and requires further review and assessments. OPWP may look to re-introduce this section in the future, subject to the outcome of these assessments.

Procurement Activities

The main procurement activities for power projects in 2020 include: (1) Manah I & II Solar IPPs; and, (2) completion of Power 2022 procurement cycle. Beyond 2020, future procurement initiatives include additional RE IPPs, and possibly Power 2024 procurement round.

The main procurement activities for water projects in 2020 and 2021 include: (1) Barka V and Ghubrah III IWPs. Beyond 2020, future procurement initiatives include the addition of Barka Water 2024 and release of North Batinah IWP RFP and Dhofar Water.

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 1,064,561[2] electricity customers.

The MIS comprises twelve power generation facilities (eleven of which are operational and one is under construction), 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.

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.[3]

Historical Demand

In 2019, electricity demand was lower than what was expected under OPWP's previous forecast. The average demand shows zero growth over 2018 demand, which is consistent with low economic growth[4] and the below-normal temperature profile in 2019. Peak demand increased by about 3% to 6,353 MW, while average demand remained similar to 2018 levels, at 3,748 MW (corresponding to 32.8 TWh of energy).

Cost Reflective Tariffs (CRT) were introduced to large industrial, commercial and government consumers in 2017. The CRT is time-differentiated and is designed to more accurately reflect 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. While the bulk of peak reduction impacts due to the CRT were observed in 2017 and 2018, some incremental impacts were observed in 2019.

[2] APSR Annual Report 2018

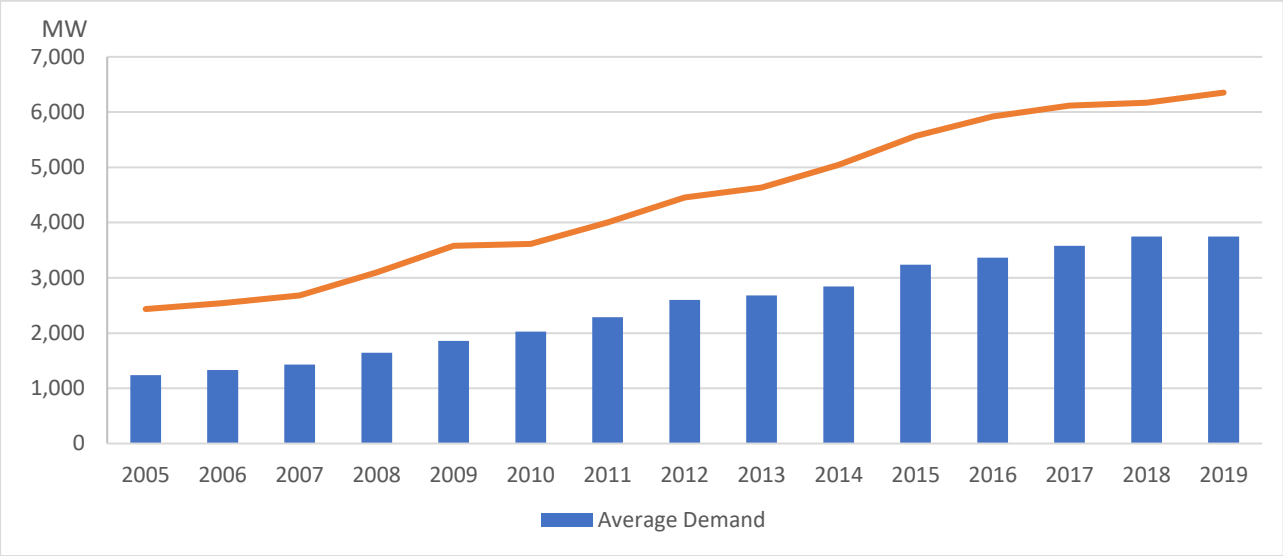
[3] This approach assures equivalence toward planning the generation supply required to meet consumer demand. However, from the perspective of power system operations, electricity demand and output are monitored at available metering points located at substations and power plants. The system "gross demand" 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.

[4] International Monetary Fund estimates 2019 economic growth in Oman at 0.5% (International Monetary Fund, World Economic Outlook, April 2020).

Over the last 7-year period (2012-2019), peak electricity demand in the MIS grew at an average annual rate of about 6%, from 4,455 MW in 2012 to 6,353 MW in 2019. Energy consumption and average demand grew by about 6.5% 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 2019.

Figure 1 Historical Electricity Demand – MIS



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	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	3,748	
Growth (%)		*7.2%*	*7.6%*	*15.1%*	*12.9%*	*9.1%*	*12.7%*	*13.7%*	*3.3%*	*6.0%*	*13.8%*	*3.9%*	*6.4%*	*4.8%*	*0.0%*	*8.3%*
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	6,353	
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%*	*3.0%*	*7.2%*

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, using an econometric model of the relationship of electricity demand to real Gross Domestic Product (GDP) over a recent period, with adjustments for weather, price, and other effects. Economic growth has been relatively slow since oil prices fell in 2014 and 2015, and is expected to be affected strongly by the impacts of the COVID-19 pandemic

in 2020. The most recent growth estimates for 2019 and 2020 are 0.5% and -2.8% respectively.[5] OPWP demand scenarios reflect forecasts of Oman economic growth published by the World Bank, International Monetary Fund (IMF), and Economist Intelligence Unit. Based on these sources, OPWP developed a range for the GDP growth trajectory to 2026, in three scenarios that described a range for annual average GDP growth from 1.5% to 3.7% over the 7-year period. They determine 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.

Electricity price impacts on demand are also considered. Many large customers shifted their demand following the introduction of the Cost Reflective Tariff (CRT) in 2017.

We expect further demand shifts in response to tariff changes as the CRT develops and consumers shift consumption to periods of lower cost. In 2022 and 2023, the additions of solar capacity in the system will lead to lower cost during the afternoon period and subsequently the afternoon Bulk Supply Tariff (BST, the main component of CRT) will be lower, at levels similar to the current off-peak tariff. In parallel, the night-time tariff will increase. OPWP expects that many CRT consumers will revert to pre-CRT consumption profiles benefiting from low afternoon tariffs and the initial CRT impact on peak demand may reverse. They will increase demand during the afternoon. A further impact of the influx of solar PV is that the BST will increase at night, when solar plants are not generating. As CRT customers increase consumption in the afternoon, OPWP expects them to reduce demand at night. This will reduce the need for new generating capacity that would otherwise be required to accommodate the night peak.

Policy developments may also affect the pace and extent of consumer response to CRT. However, the forecast scenarios do not consider any tariff reforms or impacts, as none are currently confirmed.

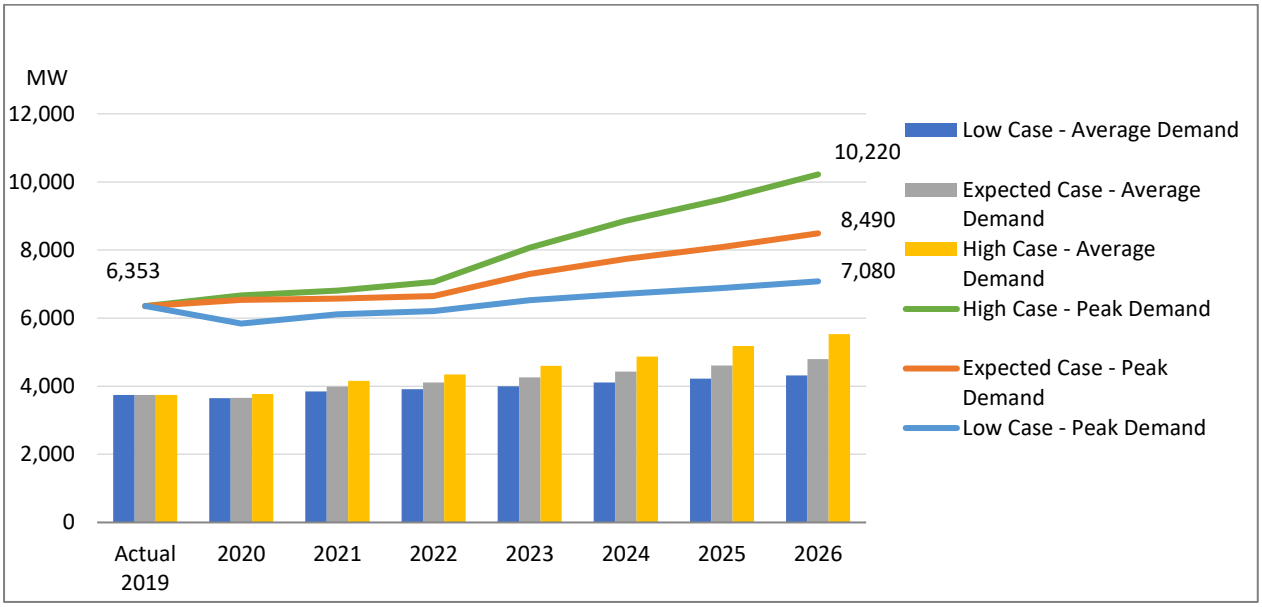
In addition, we expect that energy efficiency (EE) promotion and appliance standards programs will reduce the demand in the coming period. APSR has begun an Energy Services Company (ESCO) program to carry out energy audits in 14 large government buildings in 2020. This program is expected to lead to energy saving investments, and to expand to other government buildings later. The forecast considers energy efficiency impacts to occur gradually, mainly as the equipment asset base is replaced by more efficient devices, such as LED lamps and efficient AC units. EE programs are assumed to reduce energy demand in the range of 2-3% over the forecast period. The impact of the development of rooftop solar is also considered in Section 1.2 of this report.

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.

[5] International Monetary Fund, World Economic Outlook, April 2020.

Figure 2 Electricity Demand Projections – MIS



	Actual 2019	2020	2021	2022	2023	2024	2025	2026	Average Growth (%)
Expected Case Demand									
Average Demand (MW)	**3,748**	**3,660**	**3,990**	**4,110**	**4,260**	**4,430**	**4,610**	**4,800**	**3.6%**
Distribution Loads	3,091	2,910	2,980	3,070	3,170	3,320	3,490	3,670	2%
Directly-Connected Loads	657	750	1,010	1,040	1,090	1,110	1,120	1,130	8%
Annual Energy (TWh)	**33**	**32**	**35**	**36**	**37**	**39**	**40**	**42**	**4%**
Peak Demand (MW)	**6,353**	**6,540**	**6,570**	**6,650**	**7,300**	**7,740**	**8,090**	**8,490**	**4%**
Change from 2019-2025 Statement (MW)	*-57*	*-230*	*-590*	*-850*	*-510*	*-450*	*-510*	-	-
Low Case Demand									
Average Demand (MW)	**3,748**	**3,650**	**3,850**	**3,910**	**4,000**	**4,110**	**4,220**	**4,320**	**2%**
Distribution Loads	3,091	2,910	2,950	2,980	3,030	3,100	3,200	3,290	1%
Directly-Connected Loads	657	740	900	930	970	1,010	1,020	1,030	7%
Annual Energy (TWh)	**33**	**32**	**34**	**34**	**35**	**36**	**37**	**38**	2%
Peak Demand (MW)	**6,353**	**5,840**	**6,110**	**6,210**	**6,530**	**6,710**	**6,880**	**7,080**	**2%**
Change from 2019-2025 Statement (MW)	*213*	*-560*	*-570*	*-580*	*-440*	*-520*	*-710*	-	-
High Case Demand									
Average Demand (MW)	**3,748**	**3,770**	**4,160**	**4,350**	**4,600**	**4,870**	**5,180**	**5,530**	**6%**
Distribution Loads	3,091	2,920	3,060	3,220	3,410	3,660	3,960	4,290	5%
Directly-Connected Loads	657	850	1,100	1,130	1,190	1,210	1,220	1,240	9%
Annual Energy (TWh)	**33**	**33**	**36**	**38**	**40**	**43**	**45**	**48**	6%
Peak Demand (MW)	**6,353**	**6,670**	**6,810**	**7,060**	**8,070**	**8,860**	**9,490**	**10,220**	**7%**
Change from 2019-2025 Statement (MW)	*-577*	*-650*	*-970*	*-1,290*	*-850*	*-690*	*-750*	-	-

The Expected Case scenario projects 3.6% annual growth in energy demand (i.e., average demand). Peak demand is projected to increase at an annual average of 4% per year, from 6,353 MW in 2019 to 8,490 MW in 2026.

The Expected Case projections for both peak demand and total energy requirements from 2020 to 2022 are lower than that in the previous 7-Year Statement (Issue 13), due to current expectations of economic growth. Annual energy demand is expected to contract in 2020 along with the economy, and then to rebound in 2021, followed by relatively modest annual growth ranging from 3% to 4.1%. In this scenario, peak demand is projected to register some growth in 2020, considering several large industrial projects completed early in the year and assuming pandemic suppression measures end in June allowing businesses to re-open during the normal peak demand period. However, peak demand growth is assumed to be muted in 2022 and 2023 due to the disruptions related to the 2020 economic impacts, such that the cumulative impacts on energy and peak demand are about the same by 2023.

In 2023, the CRT consumers are expected to react to changes in the CRT by shifting demand back to the afternoon period, leading to an increase in peak demand for the remainder of the period. The aggregate impact is about 300 MW in the Expected Case. The average GDP growth per year from 2023-2026 is 3.6%.

The Low Case scenario projects peak demand growth at an average of 1.6% per year, from 6,353 MW in 2019 to 7,080 MW in 2026. This scenario assumes a deeper impact of COVID-19 in 2020, including more limited relaxation of pandemic suppression measures through June, and continuing weak economic growth for several years. Annual average demand under this scenario is also expected to grow at around 2% per year. This follows an assumption of more modest economic growth than the Expected Case scenario and a reduced consumer response to CRT changes.

The High Case scenario projects peak demand to grow at 7% annually, to 10,220 MW by 2026. The total energy growth rate is projected to grow at a slightly lower rate, at 6% per year. These higher growth rates correspond to more robust GDP growth at about 3.7% on average for the forecast period. From 2023 onwards it is assumed that CRT consumers responses to change in BST will be larger than the Expected Case Scenario.[6]

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, though with low probability of occurrence.

[6] There is a further possibility that the shift in BST prices will attract demand from industries that currently self-supply using their own generators, because afternoon CRT rates may be below their cost of generation. OPWP plans to evaluate this prospect in discussions with the auto-generators in 2020.

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 neighbouring 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 adopted a fuel diversification policy in 2017, which requires that 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. OPWP has estimated the energy production and expected contribution to peak demand of RE projects on the basis of power system simulations using ground measurement data collected over a number of years and correlations with satellite data where no such ground measured data is available. Once specific projects are under development, and later in operation, OPWP will look to re-assess 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 twelve 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 2020-2026 period is set out in Figure 3[7]. This shows total contracted capacity of 9,497 MW in 2020, 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.

[7] While RE projects are to be contracted under a PPA, they are classified as a non-firm resources, and so are represented in (Table 2 Non-Firm Contracts).

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 II IWPP: Contracted capacity of 688 MW at 45°C. The P(W)PA is scheduled to expire in 2024.

Manah IPP: Contracted capacity of 264 MW at 45°C. The PPA expired on 30 April 2020. Manah IPP is unique in that it was developed under a Build-Own-Operate-Transfer (BOOT) model. Ownership of the assets has been transferred over to Ghubrah Power & Desalination Company (GPDCO). OPWP is negotiating terms with GPDCO for the procurement of Ancillary Services required by OETC for a limited time period, with no contribution to MIS capacity requirements.

Rusail IPP: Contracted capacity of 694 MW at 45°C. The PPA is scheduled to expire on 31st March 2022.

Sohar IWPP: Contracted capacity of 597 MW at 45°C. The PWPA is scheduled to expire on 31st March 2022.

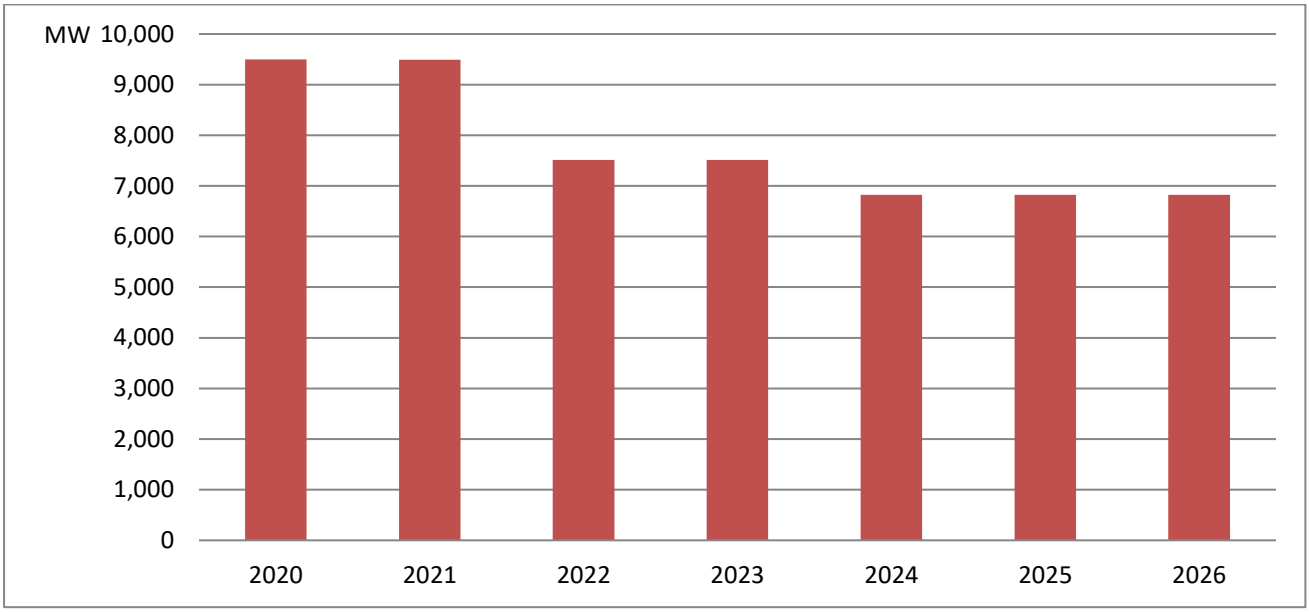
Table 1 Details of PPAs/PWPAs – MIS

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. (SAOG)	Operational	CCGT Natural gas fired Fuel oil as back-up	2028
Ibri IPP	1,539 MW	PPA	Ad-Dhahirah Generating Co. (SAOC)	Operational	CCGT Natural gas fired Fuel oil as back-up	2034
Ibri II Solar IPP	500 MW	PPA	Shams Ad-Dhahirah Generating Co. (SAOC)	Under Construction	Solar PV - Tracking	2035
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. (SAOG)	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)	Operational	CCGT Natural gas fired Fuel oil as back-up	2034
Sur IPP	2,018 MW	PPA	Phoenix Power Co. (SAOG)	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. The Manah PPA expired in April 2020.

Figure 3 Contracted Generation Capacity – MIS



	2020	2021	2022	2023	2024	2025	2026
Contracted Capacity	Net MW [a]						
Al Kamil IPP	291	291	-	-	-	-	-
Barka IWPP [b]	397	397	-	-	-	-	-
Rusail IPP	694	694	-	-	-	-	-
Sohar IWPP	597	597	-	-	-	-	-
Barka II IWPP	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	1,538	1,537	1,535	1,535	1,535	1,535	1,535
Sohar III IPP	1,742	1,741	1,738	1,738	1,738	1,738	1,738
Total	**9,497**	**9,495**	**7,511**	**7,511**	**6,823**	**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] Barka IWPP's accessible contracted capacity is 439 MW. The plant is expected to be operated in a configuration where the MSF unit is not running but is available in standby mode. This configuration allows a dispatch of 397 MW only.

Non-Firm Contracts

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 summarised in Table 2:

- Renewable Energy projects under PPAs to OPWP;
- the 220 kV interconnect with the GCCIA via 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 Contracts - MIS

	2020	2021	2022	2023	2024	2025	2026
Non-Firm Contracts - Renewables			MW				
Ibri II Solar IPP [a]	-	-	500	500	500	500	500
Total - RE Capacity Contribution	**-**	**-**	**220**	**220**	**220**	**220**	**220**
Non-Firm Contracts - Others							
SAC [b]	180	180	180	180	180	180	180
GCCIA Interconnect	200	200	200	200	200	200	200
Total - Others	**380**	**380**	**380**	**380**	**380**	**380**	**380**
Total	**380**	**380**	**600**	**600**	**600**	**600**	**600**

[a] Ibri II Solar IPP Capacity Contribution value has been re-assessed and has increased to 44%. This value has been updated from 20%, as shown in the previous 7 Year Statement. This value maybe be updated further as the project becomes operational and additional data is made available.

[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.

Ibri II Solar IPP. The current procurement of a 500 MW Solar PV project (Ibri II Solar IPP) is under construction. The project was awarded in February 2019 to Shams Ad Dhahira Generating Company. The scheduled COD is Q2 2021. The project is configured with single-axis tracking and bi-facial PV panels. Due to the configuration and design of the project, which allows for more stable generation during the daytime, the capacity contribution of the project was re-assessed and has since been updated to around 44% (from the previous 20%).

GCCIA Interconnect. A 220 kV interconnection between the Oman (MIS) and the GCCIA power systems, via the UAE (Abu Dhabi) 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, APSR approved OPWP's recognition of the interconnect's assessed capacity benefit of reserve-sharing arrangements and contribution to planning reserve requirements of 200 MW. This is based on its record of performance and the contractual obligations with the GCCIA to provide reserves support.

GCCIA is conducting a detailed study of a second interconnect to connect Oman directly from Ibri to Salwa (KSA). The proposed link is a 400 kV DC link of about 700 km. The study's initial outcomes indicate that the net transfer capacity to Oman would increase from 400 MW to about 1,600 MW. Accordingly, it is expected that the two interconnects would contribute more to the planning reserve requirements. The time horizon for the project as per the study outcome is around 2025. However, the project is pending final approvals. Following approval and

a confirmed development timetable, the expanded interconnect capacity will be included in OPWP's 7-year resource planning.

OPWP has completed energy exchanges with EWEC in Abu Dhabi in 2016 and 2018 for net fuel savings at no cost, and exported 400 MW to EWEC in 2020 under an agreed tariff. Further trading opportunities with GCCIA neighbours are expected in coming years.

Surplus Generation. Several industries with captive power plants are connected to 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 similar amounts 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 for a third time in 2018, for an additional three years. The agreement is expected to be renewed again in 2021, or SAC may instead continue to supply via the spot market after the PPA expires.

Resource Development Plan

OPWP continues to commit to the Fuel Diversification Policy issued by the Government, as the resource development plan features rapid development of renewable energy (RE) resources that meet or exceed the policy target. The resource development plan comprises new capacity contracts, renewable energy contracts, demand response, and capacity contributions from other non-firm resources. New capacity contracts and Spot Market resources are considered as flexible resources, where the amount of capacity made available from these resources can closely match capacity needs as the demand forecast changes throughout the years.

Renewable Energy (RE) Development Plan

OPWP's renewable energy development plan currently comprises solar and wind projects. OPWP plans to procure around 1,600 MW of RE IPPs in the MIS by 2026 (additional RE IPPs are being planned for other systems and are reported later in this publication). Table 3 summarizes the plan through 2026. The locations and type of future RE projects depend on demand growth, approval of transmission projects and site allocations. Procurement timelines may be amended following demand forecast updates.

OPWP's plans for solar and wind development are described as follows:

- **Manah I Solar and Manah II Solar IPPs.** OPWP began procurement of its second and third solar IPPs in 2019. The RFQ process is complete and the RFP is expected to be released in Q3 2020 for award in Q1 2021. The projects are located on adjacent sites in Ad-Dakhiliyah. It is a single procurement process, in which there will be separate single awards for each site, to different developers. Each project will have contracted maximum offtake capacity of around 500 MW using PV technology. The two projects have different COD schedules, in Q2 and Q3 2023 respectively.

- **MIS Solar IPP 2025.** The site for the fourth solar IPP is currently under review, following completion of a site assessment study in December 2019. Candidate sites include a previously defined site at Adam and a number of sites along the new transmission corridor from Nahadah to Suweihat and Duqm. This project is expected to use PV technology, with capacity around 500 MW. The RFQ is planned for release in Q4 2021 and the project will have the COD scheduled in Q2 2025.

- **Jalan Bani bu Ali Wind IPP 2025.** OPWP plans to develop a wind power project in the MIS for COD in Q1 2025. OPWP has reserved a site at Jalan Bani bu Ali in North Sharqiyah Governorate and is currently undertaking a pre-feasibility of developing a Wind IPP at the site. As part of OPWP's Wind Resource

Assessment Campaign (WRA), two 100-metre tall wind masts were installed in February 2020 to collect at least one year's wind data prior to release of the RFP (the data collected will be made available to the public via OPWP's website). OPWP plans to issue the RFQ in Q3 2021 and the RFP in Q1 2022. The installed capacity is nominally estimated at around 100 MW but will be confirmed following assessment of the measured wind data.

Table 3 Renewable Energy Development Plan – MIS

	2020	2021	2022	2023	2024	2025	2026
				MW [a]			
Manah I Solar IPP	-	-	-	-	500	500	500
Manah II Solar IPP	-	-	-	-	500	500	500
MIS Solar IPP 2025	-	-	-	-	-	500	500
Jalan Bani Bu Ali Wind IPP 2025	-	-	-	-	-	100	100
Total - Installed Capacity	**-**	**-**	**-**	**-**	**1,000**	**1,600**	**1,600**
Total - Capacity Contributions	**-**	**-**	**-**	**-**	**200**	**335**	**335**

[a] The year in which capacities are reported represent the year in which the project is anticipated to contribute to peak demand requirements.

OPWP expects the upcoming solar PV projects will contribute at least 20% of their peak installed capacity to the MIS peak demand. 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 3.

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 utilised 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.

In February 2019, OPWP awarded the Ibri II Solar IPP to Shams Ad-Dhahirah Company with a scheduled COD in Q2 2021. Following the award, OPWP was able to undertake more realistic capacity contribution assessments and has accordingly increased the value to 44%. This is primarily due to the configuration of the project where both single-axis tracking and bi-facial PV panels are to be used. This updated value is represented in Table 2 above.

In 2018, OPWP completed a feasibility study of a waste-to-energy (WTE) project, for a project at Barka to be supplied by municipal waste collected from Muscat and South Batinah Governorates. The project was included in OPWP's last 7-Year Statement, Issue 13, with a minimum capacity of 100 MW. The project was suspended for a period of 12 months but OPWP has since received instructions from the APSR to engage in discussions with Be'ah[8] and to take the project forward.

[8] 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.

Private Solar Projects and Demand Response

The capacity contributions of private solar projects and the prospective Demand Response programme are more uncertain than OPWP-procured RE projects. These planned initiatives are described below:

- **Demand Response.** Demand Response (DR) can provide a significant and cost-effective resource toward reducing capacity requirements. In 2021 OPWP plans to conduct a study of DR potential and develop a roadmap, rather than commit to a target for capacity contribution at this time. The study and roadmap will provide a basis for a regulatory decision regarding the proposed program.

- **Sahim and Other Private Solar PV Developments.** With the establishment of the framework that allows for the installation and connection of distributed solar generation in 2017**,** Government and private entities have started developing Solar PV projects across Oman. These are mainly expected to offset electricity demand, and to some extent may provide net supply contributions. The principal government initiatives include Sahim I, Sahim II and the ESCO program being launched by the APSR for governmental buildings. There are also independent private projects being developed for commercial, industrial, government, and residential buildings. OPWP anticipates that the installed capacity of these rooftop PV and similar projects will develop to about 230 MW by 2026. We consider that about 20% of installed capacity may contribute reliably to peak demand, as we do for the Solar PV IPPs being procured by OPWP. This provides for the gradual ramp-up to 45 MW by 2026, as shown in Table 4. The largest contribution is attributed to the Sahim II program for residential rooftop Solar PV installations.

  OPWP is coordinating with the electricity distribution companies to monitor the progress of solar PV installations, and with the APSR on the progress of government initiatives. The projections will be updated accordingly in coming years.

A portion of the capacity expected from these sources can be considered to provide contributions towards meeting peak demand requirements. Table 4 summarizes the expected capacity contributions from these sources.

Table 4 Capacity Contributions from Private Solar and Demand Response - MIS

	2020	2021	2022	2023	2024	2025	2026
MW							
Demand Response [a]	-	-	-	-	TBD	TBD	TBD
Sahim and other private solar PV initiatives [b]	-	5	15	20	30	35	45
Total	**-**	**5**	**15**	**20**	**30**	**35**	**45**

[a] Currently not confirmed, pending a study of DR potential and development roadmap.

[b] Assumes 20% of installed capacity as peak contribution. This category is considered as offsets to demand and to some extent may provide net supply contributions. In this 7-Year Statement, the demand forecast has not been adjusted to reflect private PV impacts, and instead they are shown in this table as resources.

Procurement Plans and Spot Market

OPWP currently plans to procure future capacity and energy needs via dedicated procurement rounds (i.e., long-term contracts) and the Spot Market. In Q4 2020, OPWP and the Authority began a process of reviewing the overall capacity procurement framework with a view of establishing a plan that will provide clarity to all stakeholders for the next 10 years. In addition, will also aim to consider opportunities that will enhance the overall efficiency and ease the transition to adopt more renewable energy. The revised procurement plan will complement the current available option, the Spot Market, with the option of entering into bilateral agreements and will investigate other options aimed at enhancing the efficiency and reduce overall cost of procurement of electricity.

The establishment of bilateral agreements is one of the measures following the liberalisation of the electricity market. The Authority undertook a study in 2020 to assess the readiness of the market for implementing this particular measure. The Authority intends to submit its views and seek necessary approvals to undertake this liberalisation measure in phases.

Current plans for procurement rounds and Spot Market initiatives are described below. Details of the plans may be subject to change due following the capacity procurement framework review:

- **Power 2022.** The project is facing considerable delays following the impact of the COVID-19 pandemic on the economy and reducing the forecasted electricity demand. OPWP and the Authority are coordinating with relevant stakeholders and the final conclusions in relation to Power 2022 are expected by the end of Q1 2021.

- **Power 2024.** The target for procurement in Power 2024 is dependent upon the review of capacity procurement framework, capacity awarded under Power 2022 and the capacity target for procurement through the Spot Market. OPWP plans to initiate the Power 2024 procurement only after finalising the outcome of Power 2022 and in accordance with the development of demand.

- **Electricity Spot Market.** OPWP continues to develop the Oman electricity spot market in conjunction with industry stakeholders. APSR approved the detailed market rules in 2017. OPWP awarded the contract for the development of the Market Management System (MMS) to GE in September 2018. Accordingly, the high-level and low-level design requirements of the MMS were completed on April 2019 as per the plan. The Market Operator organisation establishment, which is intended to be a ring-fenced department within OPWP is progressing and coordination work is ongoing with other key stakeholders including, APSR, OETC, Generators and Auto-generators. The market is scheduled to begin the operational trials in the first half of 2021, with commercial operation following thereafter. The electricity spot market will operate alongside the existing system of long-term PPAs and PWPAs.

  Considering the uncertainty about the level of market participation by uncontracted generators prior to market launch, OPWP has not assigned a value to their expected capacity contributions during the initial years of market operations under the Expected Case demand scenario (as in Table 5).

Table 5 summarizes the capacity expectations from these resources.

Table 5 Procurement Plans and Spot Market - MIS

	2020	2021	2022	2023	2024	2025	2026
				MW			
Power 2022	-	-	TBD	TBD	TBD	TBD	TBD
Power 2024	-	-	-	-	TBD	TBD	TBD
Spot Market	-	-	TBD	TBD	TBD	TBD	TBD
Total Capacity Need[a]	**-**	**-**	TBD	TBD	**760**	**980**	**1,100**

[a] Total Capacity Need represents amount of capacity required to achieve targeted reserve margins. Values from 2024-2026 may change subject to outcome of Power 2022 procurement cycle and updates to demand forecasts.

Capacity Transactions with Other Power Systems.

Energy trades or firm capacity purchases from neighbouring power systems are important potential resources. Firm capacity exchanges have taken place between OPWP and EWEC in 2016 and 2018, and a capacity export to EWEC took place in 2020. 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 2024. OPWP and Tanweer 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.

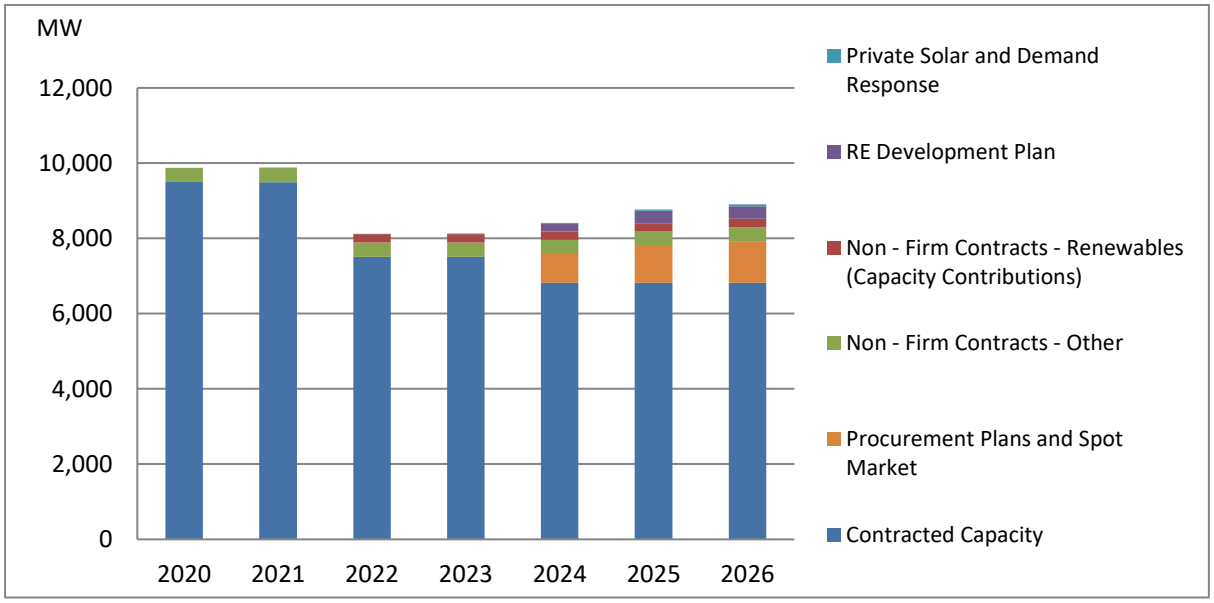
The 400 kV connection with the PDO system at Nahadah will enable large-scale capacity transactions and operational integration with PDO. No specific transactions have yet been planned, but OPWP and PDO are currently integrating resource plans relevant to the MIS and northern PDO system.

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 220 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 2020 to 2026. The capacity indicated for each year corresponds to the quantity available as of the onset of the summer peak.

Figure 4 Capacity Contributions from Generation Resources – MIS



	2020	2021	2022	2023	2024	2025	2026
				MW			
Contracted Capacity	**9,497**	**9,495**	**7,511**	**7,511**	**6,823**	**6,823**	**6,823**
Capacity Contributions from:							
Non - Firm Contracts	**380**	**380**	**600**	**600**	**600**	**600**	**600**
RE Development Plan	**-**	**-**	**-**	**-**	**200**	**335**	**335**
Private Solar and Demand Response	**-**	**5**	**15**	**20**	**30**	**35**	**45**
Procurement Plans and Spot Market	**-**	**-**	**TBD**	**TBD**	**760**	**980**	**1,100**
Total	**9,877**	**9,880**	**8,126**	**8,131**	**8,413**	**8,773**	**8,903**

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 Public Services Regulation, Oman (APSR) 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 APSR 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).

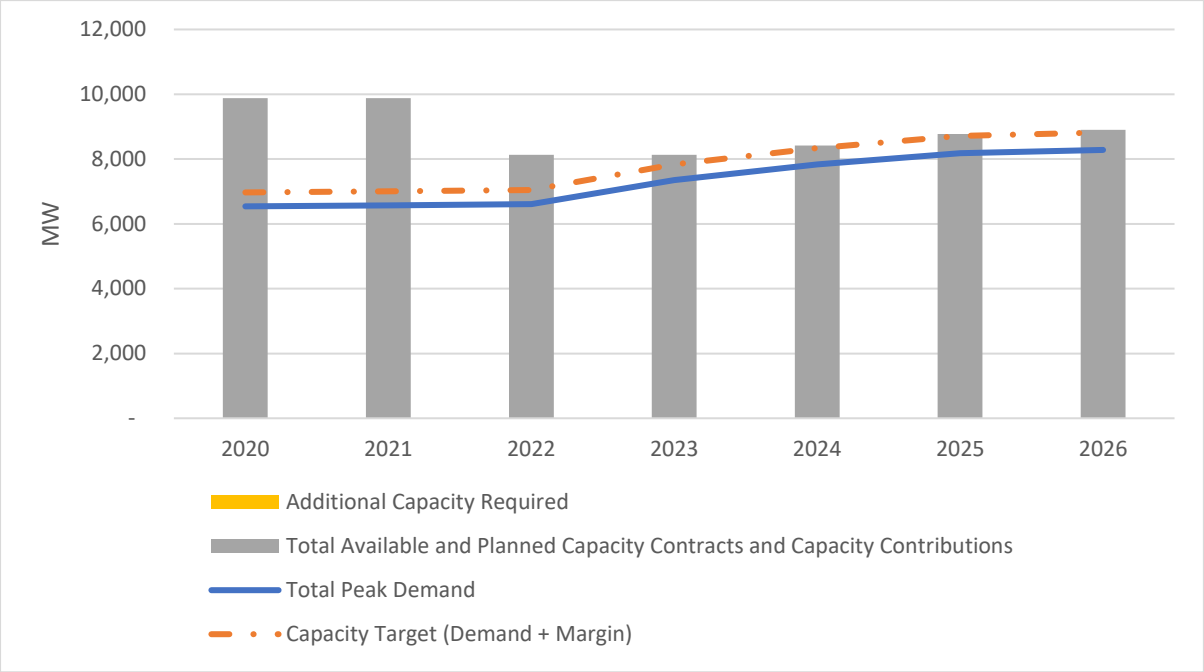
OPWP conducts computer simulations of power system performance to assess LOLH under a wide range of conditions that fluctuate randomly. The simulations are the basis for determining the expected level of LOLH and the adequacy of generation to meet the statutory standard. Generally, the number and type 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 occurrences 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 2020 to 2026. 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.

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. Figure 5 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, as described below.

Figure 5 Resource Adequacy in the Expected Demand Scenario - MIS



	2020	2021	2022	2023	2024	2025	2026
Expected Demand Scenario				**MW**			
Peak Demand	6,540	6,570	6,650	7,300	7,740	8,090	8,490
Duqm Export/Import (+/-) [a]	-	-	-	105	140	149	-138
Total Peak Demand	6,540	6,570	6,650	7,405	7,880	8,239	8,352
Capacity Target (Demand + Margin)	**6,970**	**7,000**	**7,080**	**7,890**	**8,390**	**8,770**	**8,890**
Total Available and Planned Capacity Contracts and Capacity Contributions	**9,877**	**9,880**	**8,126**	**8,131**	**8,413**	**8,773**	**8,903**
Additional Capacity Required	-	-	-	-	-	-	-

[a] While the 400 kV MIS - Duqm Interconnect is expected to be completed by June 2024 allowing MIS supply, discussions are ongoing to supply Duqm with an in-kind exchange arrangement from PDO in 2023.

In the initial years of the forecast period, from 2020 to 2022, 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. However, the costs of additional capacity were largely offset by the value of fuel savings enabled by the highly efficient generators that were added. In 2022 the capacity surplus will begin to diminish, reaching a state of balance with forecasts in 2023.

For 2022, OPWP has identified that, due to the impact of COVID-19 and global economic recession on the demand forecast, the completion of Power 2022 procurement cycle has faced delays. Under the Expected Case demand scenario, currently contracted capacity along with contributions from contracted RE projects and non-firm resources are sufficient to meet the capacity target in 2022 and 2023.

In June 2023, it is anticipated that the first phase of the North-South Interconnect project (including from Izki to Nahadah in the PDO system, and from Suweihat in the PDO system up to the Duqm Power System) will be completed. As such, Figure 5 accounts for additional demand requirements of the Duqm Power System

(Expected Case) that can be met by utilising capacity in the MIS. By 2026, and with the development of new RE projects in the Duqm Power System with capacity contributions exceeding peak demand requirements, the MIS can expect to start benefitting from exports from the Duqm Power System.

In 2024, Barka II IWPP will reach the end of its P(W)PA term. The long-term capacity needs through 2026 will be met by the possible Power 2024 procurement process and the Spot Market. The procurement target for Power 2024 is dependent upon the conclusions from the review of the capacity procurement framework, capacity awarded under Power 2022, and the capacity target for procurement through the Spot Market. OPWP plans to initiate the Power 2024 procurement only after finalising the outcome of Power 2022 and in accordance with the development of demand.

Mitigation Options for the High Case Demand Scenario

In the High Case demand scenario, the capacity requirement in 2023 is about 830 MW higher than under the Expected Case scenario, and about 1,950 MW higher in 2026. Similar to the Expected Case above, the High Case also accounts for supply requirements to the Duqm Power System, also under the High Case for that demand area. The High Case is considered to be a plausible demand 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 3.7%, which is lower than any 7-year growth period between 2003 and 2016.

Figure 6 illustrates resource adequacy for this scenario. In 2022, planned contracts are sufficient to meet the capacity target, but in 2023 there is a deficit of nearly 590 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 plants that represent generators with expiring P(W)PAs in 2022 and may participate in the Spot Market as uncontracted generation. Other contingency resources, including GCCIA purchases, import from the PDO system, and/or temporary generation, may be required if spot market resources are not sufficient.

OPWP anticipates that up to 1,475 MW may be available from the Spot Market in 2023. The feasibility to extend permits or other necessary conditions for plant operation would alter this assessment accordingly, as would changes in the assessment of market prices. The other mitigation options indicated are also quite feasible, though potentially more costly. Oman's GCCIA neighbours indicate surplus capacity on their systems during this period, which OPWP could access as capacity purchases.

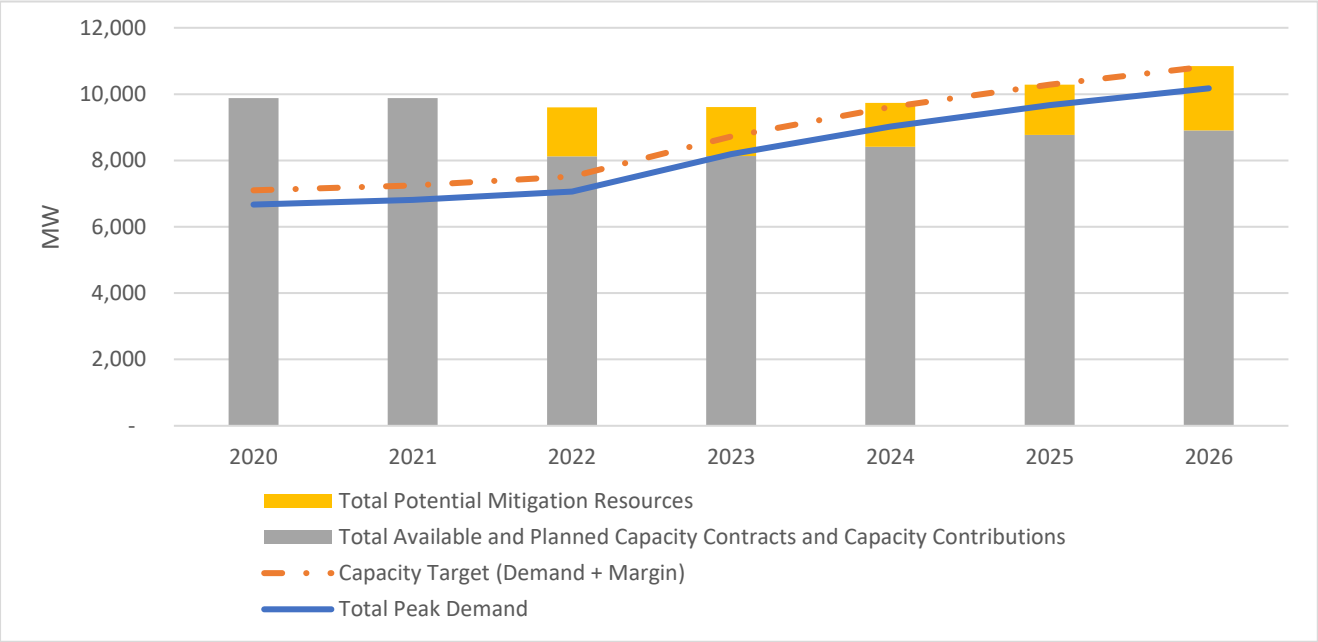
In order to meet resource requirements in 2024 and 2025 under the High Case scenario, a greater reliance on resources under Power 2024 may be required. The level of remaining available spot market capacity will have reduced relative to 2023, due to Power 2024 awards and because we have already allocated a portion of uncontracted capacity in the resource plan. It becomes more challenging to meet the capacity target, and higher cost contingency resources must be utilised such as temporary generation, and as-yet unconfirmed resources such as Demand Response. There may be a prospect of surplus capacity being available from existing captive power plants at industrial facilities, which may be contracted or enter the Spot Market. OPWP intends to evaluate this prospect.

In 2026, additional resources would be required under the High Case to meet capacity targets. Contingency resources would not be adequate, although the potential Demand Response resources would likely increase somewhat. In addition to this, new gas-fired capacity would be required in 2026. OPWP has considered the potential for the next round of procurement to be in 2026 or 2027, depending on the need for capacity. Under this High Case scenario, a Power 2027 procurement round would enable new gas-fired capacity as Early Power in 2026, if the procurement process is started by 2022. The amount of capacity may be adjusted in consideration of needs in 2027 and 2028, existing contract expirations in those years, the competition process to be developed for the procurement round, and developments in the Spot Market. These decisions would need to be confirmed on the basis of peak demand out-turns in 2020, 2021 and 2022, and the reassessed capacity needs at the time.

OPWP currently envisions that procurements for guaranteed capacity would occur approximately every two years. The timing will depend on the need for capacity, the scope and timing of expiring contracts, lessons learned in the Power 2022 and possible Power 2024 procurements, capacity contributions from the Spot Market, and other factors such as the objective to foster competition in the procurement. A significant amount of capacity is scheduled to come out of contract in 2028 (Barka III and Sohar II IPPs) and in 2029 (Sur IPP). This will be taken into account in the plan for the next major procurement round in the future.

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 and other industrial zones.

Figure 6 Mitigation Options for the High Case Demand Scenario – MIS



	2020	2021	2022	2023	2024	2025	2026
High Case Scenario				**MW**			
MIS Peak Demand	6,670	6,810	7,060	8,070	8,860	9,490	10,220
Export to Duqm	-	-	-	118	160	175	-45
Total Peak Demand	6,670	6,810	7,060	8,188	9,020	9,665	10,175
Capacity Target (Demand + Margin)	**7,100**	**7,250**	**7,520**	**8,720**	**9,610**	**10,290**	**10,840**
Total Available and Planned Capacity Contracts and Capacity Contributions	**9,877**	**9,880**	**8,126**	**8,131**	**8,413**	**8,773**	**8,903**
Additional Capacity Required	**-**	**-**	**-**	**589**	**1,197**	**1,517**	**1,937**
Mitigation Strategy for Deficit							
Conduct P2026 Procurement	-	-	-	-	-	-	700
Spot Market Capacity	-	-	1,475	1,475	1,325	1,365	1,245
GCC Interconnection Purchase	-	TBD	TBD	TBD	TBD	TBD	TBD
Demand Response	-	-	-	-	TBD	150	TBD
Captive Power Plants	-	TBD	TBD	TBD	TBD	TBD	TBD
Total Mitigation Resources	**-**	**-**	**1,475**	**1,475**	**1,325**	**1,515**	**1,945**
Total Available and Mitigation Resources	**9,877**	**9,880**	**9,601**	**9,606**	**9,788**	**10,288**	**10,848**
Remaining Capacity Need	-	-	-	-	-	-2	-

Mitigation Options for the Low Case Demand Scenario

In the Low Case demand scenario, the capacity target is around 1,540 MW less than in the Expected Demand scenario by 2026. In order to minimize capacity surpluses in case of low demand growth, OPWP would implement mitigation options such as reducing capacity procurement targets and improving capacity utilisation via exports. Mitigation options are described below, and shown with their impacts in Figure 7:

- **Adjust Procurement Round and Spot Market Targets.** The capacity requirement in 2024 is currently planned to be met through a combination of Spot Market contributions and new contracts via Power 2022 and/or possible Power 2024. The amount from possible Power 2024 will be assessed prior to the launch of the procurement activities. If demand were to track the current Low Case, the capacity requirement for the Spot Market and possible Power 2024 may be less, and the procurement target would be adjusted accordingly.

- **Defer Duqm Solar IPP 2026 Procurement.** OPWP would consider deferring the Solar CSP project, which is in the resource plan but not yet committed, pending feasibility study. This project is expected to have higher cost than the solar PV or wind projects, but may be competitive with other resource options on an economic basis. OPWP plans to procure several solar PV and wind IPPs during this period, which are not yet committed. OPWP is not considering to defer or reduce the capacity levels of these projects as a mitigation option. These projects are expected to provide lower cost energy than existing generators, providing a net reduction to bulk supply costs even when capacity is not required.

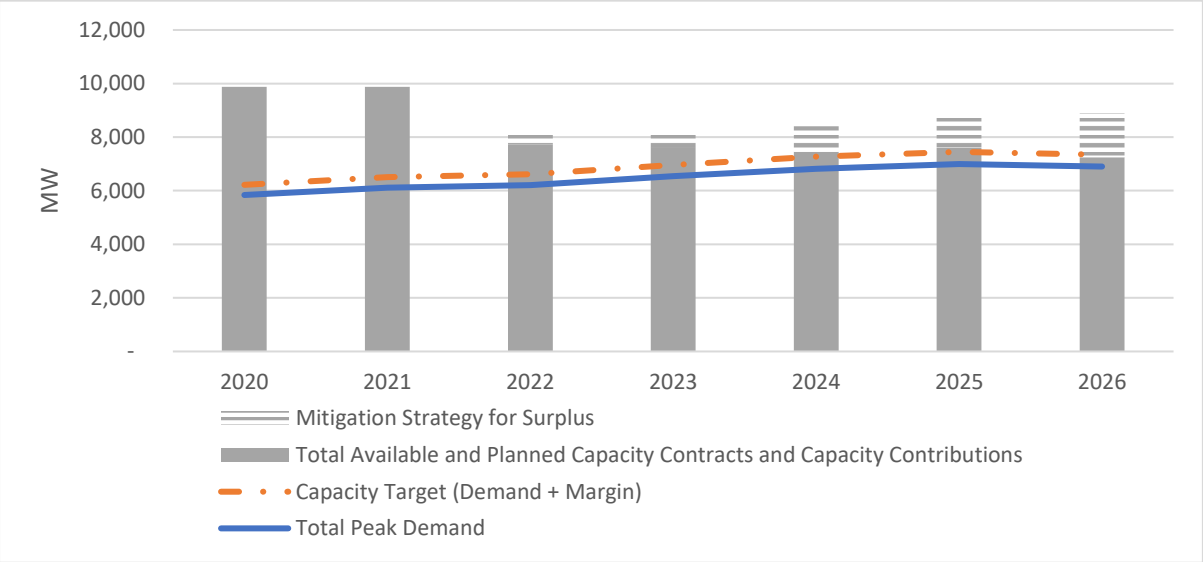
- **GCCIA Interconnection Export.** The GCCIA interconnect via UAE will accommodate up to 400 MW of capacity export. OPWP would explore export contracts with GCC member states, provided they would cover generation costs and the economic value of gas supply as defined by MEM. OPWP exported 400 MW to UAE in 2020 and is currently in negotiations for mutually beneficial trade in 2021.

- **PDO Export.** The North-South Interconnect will permit increased levels of energy trading with PDO beginning in 2023. The potential for export to PDO is currently uncertain. A large share of PDO generation is dedicated to steam generation for oilfields, with electricity as a by-product, and cannot be displaced. Other generators would be candidates for displacement by lower cost energy imports. However, PDO and the other oil developers are also currently considering development of solar PV plants to offset thermal generation. OPWP currently coordinates resource development plans with PDO. Exports to PDO as a capacity mitigation option by OPWP would be explored if needed through this coordination.

- **Exports to Displace Captive Power Generation.** A number of industrial plants have captive generation plants, which they utilise either as a cost-saving measure or to provide a high level of supply security. OPWP would explore opportunities to supply to these industries during periods when costs may be less than their own cost of generation. The potential for such exports in the MIS may be 400 MW or more.

Figure 7 demonstrates that, under a low demand scenario, OPWP has options available to minimize the potential for capacity surpluses and thereby manage costs.

Figure 7 Mitigation Options for the Low Case Demand Scenario - MIS



	2020	2021	2022	2023	2024	2025	2026
Low Case Scenario				**MW**			
Peak Demand	5,840	6,110	6,210	6,530	6,710	6,880	7,080
Export to Duqm	-	-	-	8	112	116	-177
Total Peak Demand	**5,840**	**6,110**	**6,210**	**6,538**	**6,822**	**6,996**	**6,903**
Capacity Target (Demand + Margin)	**6,220**	**6,510**	**6,610**	**6,960**	**7,270**	**7,450**	**7,350**
Total Available and Planned Capacity Contracts and Capacity Contributions	**9,877**	**9,880**	**8,126**	**8,131**	**8,413**	**8,773**	**8,903**
Surplus over Capacity Target	**3,657**	**3,370**	**1,516**	**1,171**	**1,143**	**1,323**	**1,553**
Mitigation Strategy for Surplus							
Defer Duqm Solar IPP 2026	-	-	-	-	-	-	-300
Adjust Procurement Round and Spot Market Targets					-360	-580	-700
GCC Interconnection Export	-	-	-400	-400	-400	-400	-400
PDO Export	-	-	-	-	-100	-100	-150
Export to Displace Captive Power Generation	-	-	-	-100	-100	-100	-100
Total Mitigation Resources	-	-	-400	-500	-960	-1,180	-1,650
Remaining Surplus	3,657	3,370	1,116	671	183	143	-

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 Centre for Statistics & Information reports that the total population in Wilayat Al Duqm, as of 2018, is 14,256[9]. This figure represents an almost 26% growth when compared against 2017 population and is linked to the rapid developments of a new economic and industrial centre.

The Ad Duqm region is currently served by a relatively small integrated generation and distribution system, owned and operated by Tanweer, the Rural Areas Electricity Company. Tanweer owns and operates a 67 MW diesel-fuel fired power plant for supply to this grid area. Tanweer 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 by 2024. Following this, and the future developments of IPPs in the Ad Duqm Power System, it is expected that Tanweer 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.

a. Demand for Electricity

Historical Demand

Historically, all requirements to meet electricity demand in Ad Duqm has been within the jurisdiction of Tanweer. 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 centres, such as Mahout.

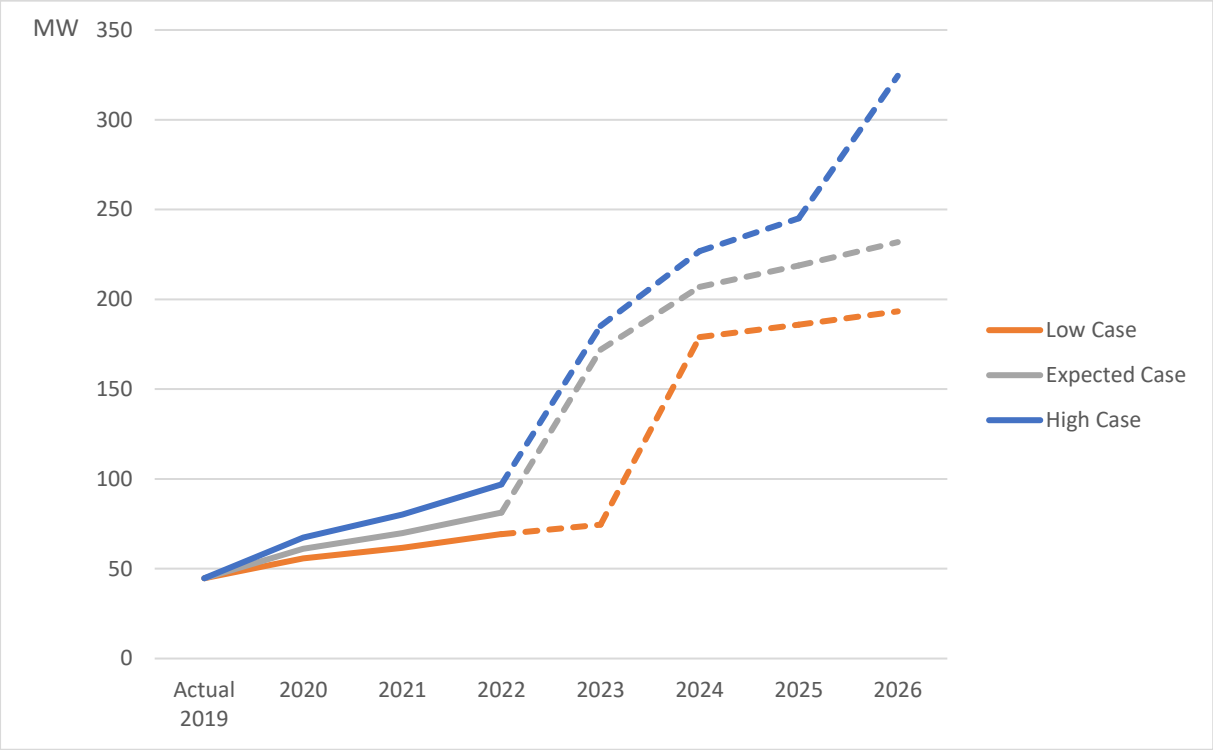
Demand Projections

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 Tanweer up to the year 2022, these demand projections reflect domestic and industrial/commercial developments as received by Tanweer in the form of applications for new connections. From 2023 towards the end of the forecast period, OPWP has included the demand of two large bulk customers in the Expected and High Case scenarios. The Low Case scenario assumes delay in the materialisation of these customers by one year. Furthermore, another large project expected to operate in 2026 has been also considered by OPWP under the High Case scenario. While Tanweer has advised that these projects are confirmed, the timeline of materialisation is uncertain as formal supply applications to Tanweer have yet to be received.

[9] National Centre for Statistics & Information (2020) *Data Portal - Population.*

Figure 8 Electricity Demand Projections – Ad Duqm Power System



	Actual 2019	2020	2021	2022	2023	2024	2025	2026	Average Growth (%)
					MW				
Expected Case	**45**	**61**	**70**	**81**	**172**	**207**	**219**	**232**	**27%**
Change from 2019-2025 Statement (MW)	*-18*	*-10*	*-13*	*-15*	*53*	*38*	*46*	-	
Low Case	**45**	**56**	**62**	**69**	**75**	**179**	**186**	**193**	**23%**
Change from 2019-2025 Statement (MW)	*0*	*7*	*9*	*12*	*-7*	*91*	*92*	-	
High Case	**45**	**67**	**80**	**97**	**185**	**227**	**245**	**325**	**33%**
Change from 2019-2025 Statement (MW)	*-21*	*-18*	*-29*	*-39*	*5*	*23*	*27*	-	

Under the Expected Case scenario, peak demand is expected to grow at an average rate of 27% per year, from 45 MW in 2019 to 232 MW in 2026. The Expected Case scenario 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 2024, 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 33% in peak demand, increasing from 45 MW in 2019 to 325 MW in 2026. This also includes a higher growth scenario in the Mahout demand area.

Alternatively, the Low Case scenario assumes a slower rate of materialisation in prospective projects in the Duqm region, in addition to possible delays in major projects and lower growth rate of demand in Mahout following its interconnect in the year 2024. The Low Case scenario anticipates an average growth rate of 23% in peak demand, increasing from 45 MW in 2019 to 193 MW in 2026.

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. 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.

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 Tanweer, has a capacity of 67 MW and utilises diesel-fired generators.

Resource Development Plan

The existing 67 MW diesel-fired power plant is sufficient to meet growing demands through the year 2020 in the Expected Case scenario. Figure 9 compares the demand trend with supply, including OPWP's resource development plan. As an isolated power system, Tanweer 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 2024, at much lower cost than Tanweer's existing diesel generation plant. To meet the supply gap from 2020 until that time, Tanweer 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 Tanweer diesel power plant. Further, discussions are currently underway with PDO to supply Ad Duqm with electricity starting from 2023, where such energy will then be supplied in-kind to PDO from the MIS.

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. Considering the need to develop a baseload generator to serve the Duqm load centre, OPWP plans to develop a CSP project with thermal storage as the procurement of the clean coal project was not approved to proceed in 2019. The CSP project is planned to provide around 300 MW of firm capacity by 2026.

Wilayat Ad Duqm has substantial potential for wind energy.[10] OPWP's initial plans are to develop around 200 MW of installed capacity in 2025. 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 collected through the Wind Resource Assessment and developed projects, OPWP will continue to monitor and update capacity contribution estimates. These plans are illustrated in Table 6.

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.

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

Table 6 Renewable Energy Development Plan - Ad Duqm Power System

	2020	2021	2022	2023	2024	2025	2026
				MW			
Duqm Wind IPP 2025[a]	-	-	-	-	-	200	200
Duqm Solar IPP 2026[b]	-	-	-	-	-	-	300
Total - Installed Capacity	-	-	-	-	-	**200**	**500**
Total - Capacity Contributions	-	-	-	-	-	**70**	**370**

[a] Estimated capacity contribution for this project is tentatively set at 35%, pending the collection of additional local wind data.

[b] CSP projects are designed with accompanying thermal storage capabilities that allow for dispatchable capacity. Accordingly, the full installed capacity of this project is considered for its' capacity contribution.

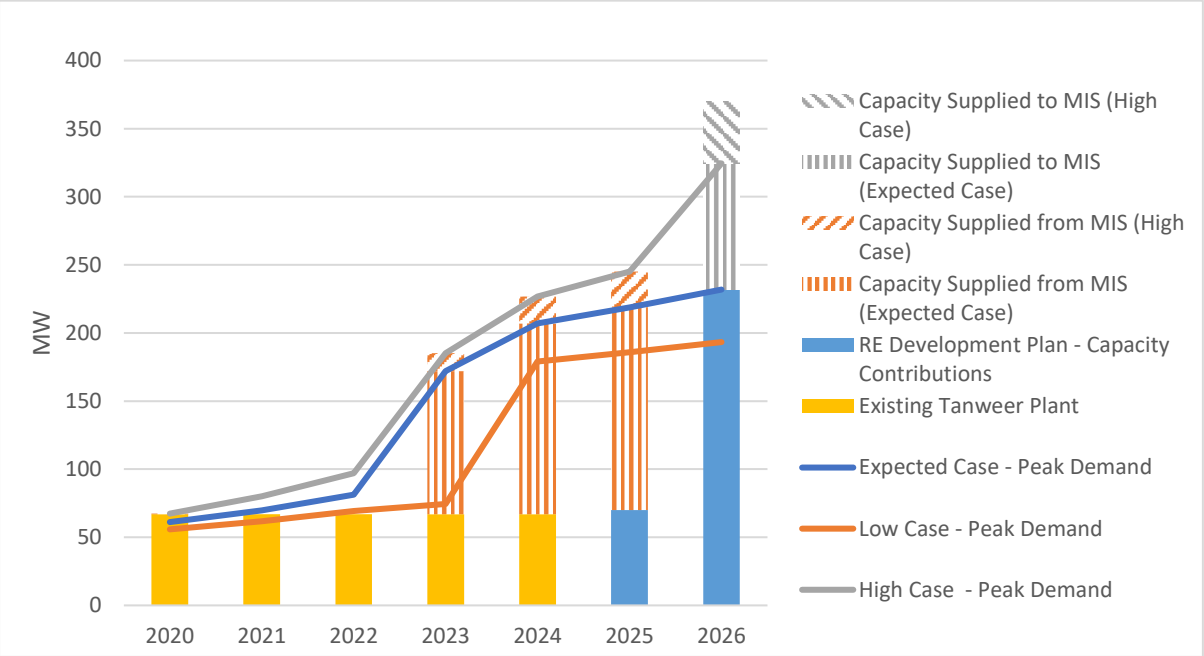
OPWP plans for solar and wind projects in the Ad Duqm Power System are as per the following:

- **Duqm Wind IPP 2025.** OPWP plans to develop a wind power project in the Duqm region for COD in Q1, 2025. OPWP has access to a site in SEZAD and is currently undertaking a pre-feasibility of developing a Wind IPP at the site. As part of OPWP's Wind Resource Assessment Campaign (WRA), two 100 metre wind masts were installed in February 2020 to collect at least one year of wind data prior to release of the RFP (the data collected here will be made available to the public via OPWP's website). OPWP plans to issue the RFQ in Q3 2021 and the RFP in Q1 2022. The installed capacity is nominally estimated at around 200 MW, but will be confirmed following assessment of the measured wind data.

- **Duqm Solar IPP 2026.** OPWP is planning to procure the Sultanate's first solar CSP project for power generation for completion in 2026. Sites are under consideration along the transmission corridor between Duqm and Suweihat, to take advantage of the higher levels of solar radiation in this region compared to the northern governorates. This project is expected to help support grid stability in the Duqm industrial zone, including management of output intermittency of the wind projects planned in that area. The project is preliminarily envisioned to have thermal energy storage and a steam turbine with around 300 MW output capacity. OPWP plans to conduct a feasibility study in 2020 and then to begin the procurement process following regulatory approval.

Figure 9 demonstrates that Tanweer's incremental supply requirement during the interim period from 2020 to 2022 is relatively low: up to 14 MW for the Expected Demand scenario and 30 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 9 Resource Adequacy – Ad Duqm Power System



	2020	2021	2022	2023	2024	2025	2026
Peak Demand				**MW**			
Expected Case	61	70	81	172	207	219	232
Low Case	56	62	69	75	179	186	193
High Case	67	80	97	185	227	245	325
Contracted Capacity							
Existing Tanweer Plant	67	67	67	67	67	-	-
Prospective Capacity							
RE Development Plan - Capacity Contributions	-	-	-	-	-	70	370
Capacity Supplied from (+) / to (-) MIS							
Expected Case	-	-	-	105	140	149	-138
Low Case	-	-	-	8	112	116	-177
High Case	-	-	-	118	160	175	-45
Additional Capacity Required							
Expected Case	-	3	14	-	-	-	-
Low Case	-	-	2	-	-	-	-
High Case	-	13	30	-	-	-	-

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 114,822[11] electricity customers.

The DPS comprises three 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.

a. Demand for Electricity

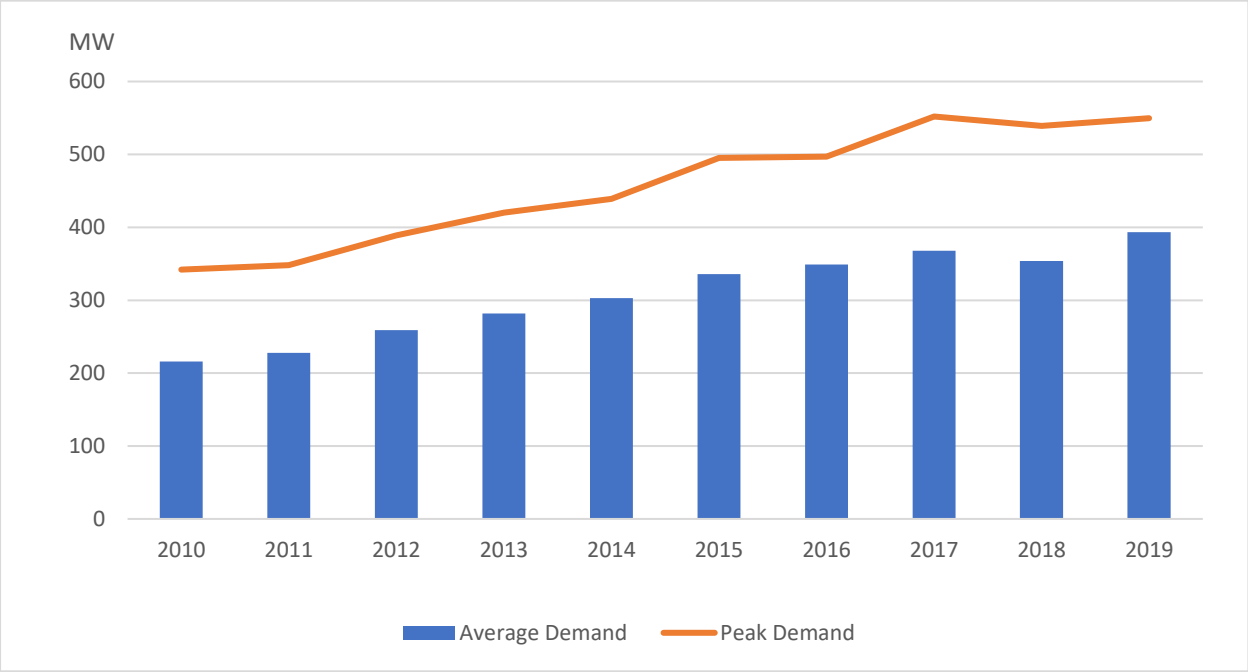
Historical Demand

Average Electricity demand in 2019 grew at relatively higher growth than the historical average demand at around 11% growth over 2018. The average demand increased to 393 MW (corresponding to 3.4 TWh) in 2019. Peak demand was 549 MW, 2% higher than 2018 peak demand. OPWP notes that the high growth in average demand observed in 2019 is likely due to a rebound effect from the previous year, where demand was suppressed as the Dhofar region was impacted by the Mekunu Cyclone.

Figure 10 shows that the average growth rate in annual average demand over the past seven years has been 6.3%, 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 5.2% over the same period.

[11] APSR Annual Report 2018

Figure 10 Historical Electricity Demand – DPS



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Average Growth (%)
Historical Demand											
Average Demand (MW)	**216**	**228**	**259**	**282**	**303**	**336**	**349**	**368**	**354**	**393**	
Growth (%)	-	*5.6%*	*13.6%*	*8.9%*	*7.4%*	*10.9%*	*3.9%*	*5.4%*	*-3.8%*	*11.1%*	**7.0%**
Peak Demand (MW)	**342**	**348**	**389**	**420**	**439**	**495**	**497**	**552**	**539**	**549**	
Growth (%)	-	*1.8%*	*11.8%*	*8.0%*	*4.5%*	*12.8%*	*0.4%*	*11.1%*	*-2.4%*	*1.9%*	**5.5%**

Demand Projections

Demand projections 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 analysis of underlying demand and certain bulk loads, comprising mainly industrial demands, which are assessed on a customer-specific basis.

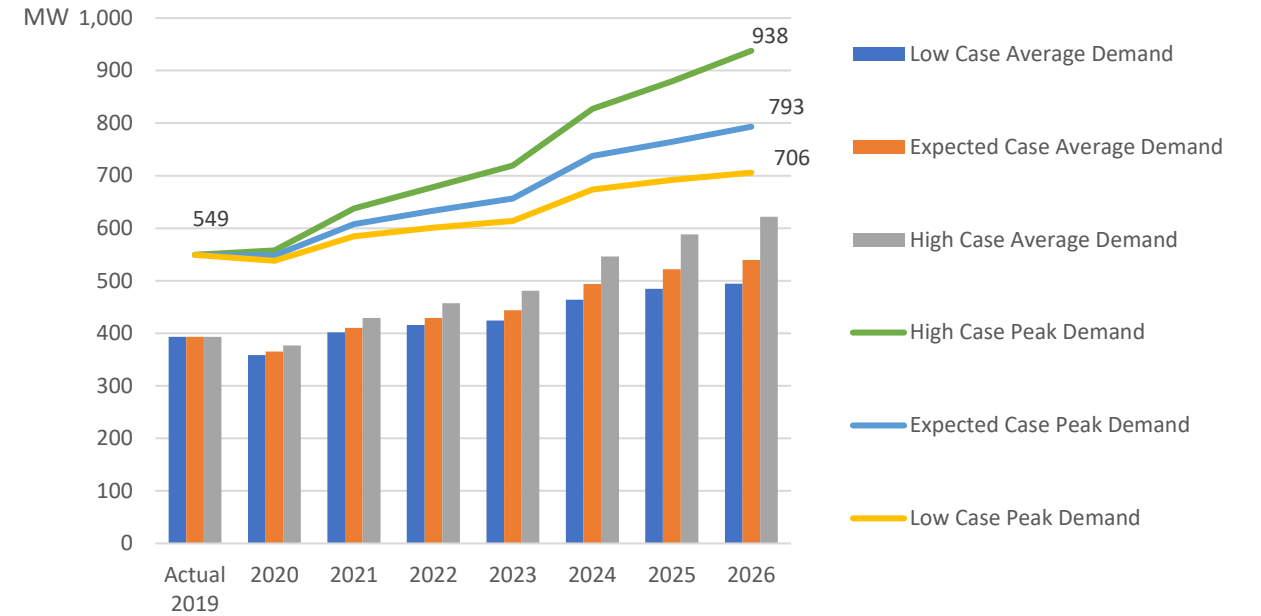
The projections are presented as a range including Low Case, High Case and central Expected Case scenarios. All scenarios are based on an assumption of normal weather. The Low Case and High Case scenarios assume contrasting growth levels, with the same underlying assumptions for economic growth as used for the MIS projections. Demand growth is developed from an econometric model that relates historical DPS demand growth to the GDP growth of the Sultanate. The projections are presented in Figure 11.

Under the Expected Case scenario, peak demand increases at about 5% per year, from 549 MW in 2019 to nearly 800 MW in 2026. Energy consumption is projected to grow from 3.4 TWh (corresponding to 393 MW average demand) in 2019 to 4.7 TWh (539 MW average demand) in 2026, with an average increase of 5% per year. The impacts of the economic recession on 2020 demand in Dhofar are less severe than for the MIS, which is consistent with the DPS econometric model and with demand out-turns through April 2020. The impacts of confirmed bulk load projects are included in the years that they are expected to occur, which is the reason for a large demand growth in 2021. A further sharp increase occurs in 2024, when Saih Al Kahirait, which is currently supplied by Tanweer, will be connected to the DPS.

The High Case scenario projects growth in annual energy demand at 7% per year and peak demand at 8% per year. The Low Case scenario has annual energy demand growth of 3% and peak demand growth of 4%. They are not symmetrical around the Expected Demand scenario, as there is currently more uncertainty with respect to the potential for higher growth.

CRT and Energy Efficiency impacts are embedded in the DPS demand projections as they are for the MIS. However, there is no significant CRT shift expected in DPS as described for the MIS. This is because there are currently no approved plans for large-scale solar PV projects in Dhofar that would shift the generation cost profile.

Figure 11 Electricity Demand Projections – DPS



	Actual 2019	2020	2021	2022	2023	2024	2025	2026	Average Growth (%)
Expected Demand									
Average Demand (MW)	**393**	**365**	**411**	**429**	**444**	**494**	**522**	**539**	**5%**
Underlying Demand	283	239	248	256	267	305	320	335	2%
Bulk Loads	110	126	163	173	177	189	202	204	9%
Annual Energy (TWh)	**3**	**3**	**4**	**4**	**4**	**4**	**5**	**5**	**5%**
Peak Demand (MW)	**549**	**548**	**608**	**633**	**656**	**738**	**765**	**793**	**5%**
Change from 2019-2025 Statement (MW)	*1*	*-55*	*-41*	*-85*	*-111*	*-58*	*-62*	-	-
Low Case Demand									
Average Demand (MW)	**393**	**359**	**402**	**416**	**424**	**464**	**484**	**495**	**3%**
Underlying Demand	283	239	244	248	254	282	290	297	1%
Bulk Loads	110	120	158	168	171	182	194	197	9%
Annual Energy (TWh)	**3**	**3**	**4**	**4**	**4**	**4**	**4**	**4**	**3%**
Peak Demand (MW)	**549**	**538**	**584**	**601**	**614**	**674**	**692**	**706**	**4%**
Change from 2019-2025 Statement (MW)	*31*	*-29*	*-20*	*-53*	*-79*	*-43*	*-55*	-	-
High Case Demand									
Average Demand (MW)	**393**	**376**	**429**	**457**	**481**	**546**	**588**	**622**	**7%**
Underlying Demand	283	242	258	274	295	347	376	407	5%
Bulk Loads	110	135	172	183	186	199	212	214	10%
Annual Energy (TWh)	**3**	**3**	**4**	**4**	**4**	**5**	**5**	**5**	**7%**
Peak Demand (MW)	**549**	**558**	**637**	**678**	**719**	**827**	**879**	**938**	**8%**
Change from 2019-2025 Statement (MW)	*-34*	*-93*	*-84*	*-125*	*-155*	*-99*	*-102*	-	-

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 7 and are as follows:

- **Salalah IWPP:** Contracted capacity of 445 MW. The Salalah IWPP is a CCGT plant comprising of five gas turbines and two steam turbines. It is located in the Mirbat/Taqah region and achieved COD in 2012.
- **Salalah II IPP:** Contracted capacity of 717 MW. Located in Raysut, the facility comprises eight OCGT units with a total capacity of 273 MW and six CCGT units (two blocks of 2 GTs and 1 ST each) with a total capacity of 444 MW.
- **Dhofar I Wind IPP:** The wind farm located in Harweel has an installed capacity of 49.4 MW, comprising of 13 x 3.8 GE wind turbines. Following a similar methodology used for the Solar IPPs, OPWP has estimated a provisional capacity contribution 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 analyse relevant data to update capacity contribution estimates, if needed.

Table 7 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 m^3/d	PWPA	Sembcorp Salalah Power & Water Co. (SAOC)	Operational	CCGT Natural gas fired Fuel oil as back-up	2027
Salalah II IPP	717 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	49.4 MW	PPA	Tanweer	Operational	Wind Turbine	2034

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

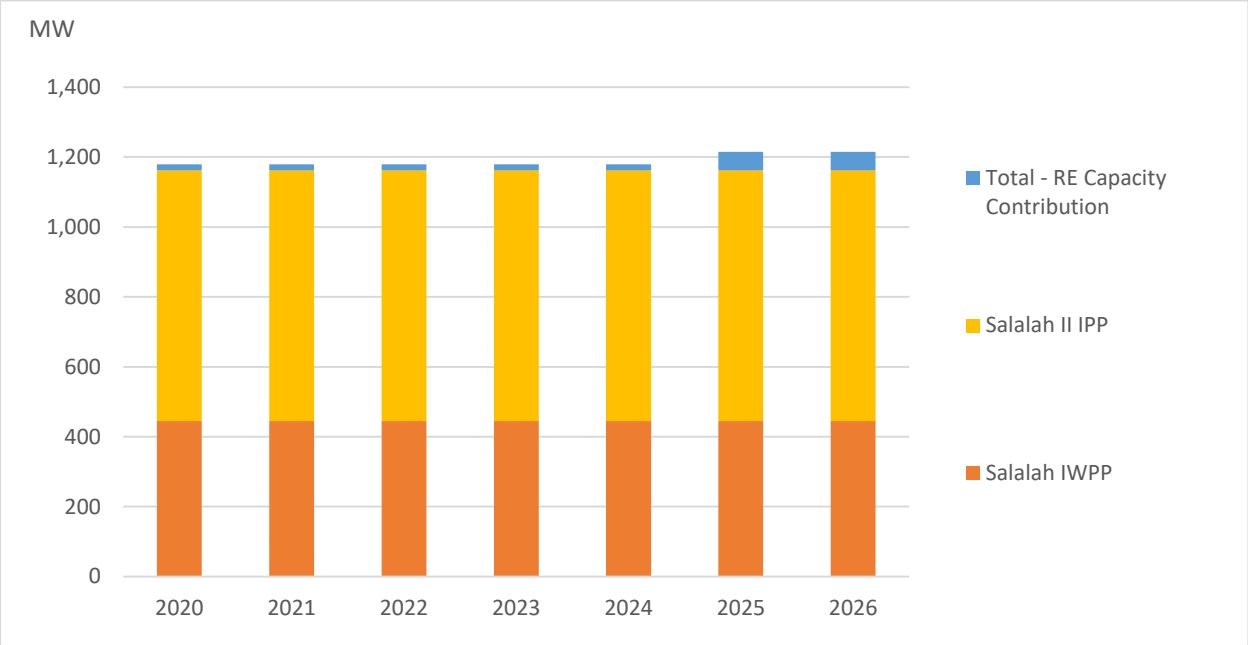
Resource Development Plan

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, currently estimated at 100 MW for 2025 COD. The confirmation of both timing and capacity of the project are subject to the outcome of a Master Plan that is currently underway. This study will support OETC in identifying 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 12 presents the capacity contributions from power generation resources in the DPS.

Figure 12 Capacity Contributions from Generation Resources – DPS



	2020	2021	2022	2023	2024	2025	2026
Contracted Capacity - Thermal				**Net MW [a]**			
Salalah IWPP	445	445	445	445	445	445	445
Salalah II IPP	717	717	717	717	717	717	717
Total - Thermal	**1,162**	**1,162**	**1,162**	**1,162**	**1,162**	**1,162**	**1,162**
Non-firm Contracts - Renewables							
Dhofar I Wind IPP	50	50	50	50	50	50	50
Dhofar II Wind IPP	-	-	-	-	-	100	100
Total - RE Capacity Contribution [b]	**18**	**18**	**18**	**18**	**18**	**53**	**53**
Total Capacity Contribution to Peak Demand	**1,180**	**1,180**	**1,180**	**1,180**	**1,180**	**1,215**	**1,215**

[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] Capacity contribution of 35% is currently assumed for Dhofar I & II Wind IPPs.

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 sets the capacity target for each of the three demand scenarios over the 7-year planning horizon, shown in Figure 13.

Ultimately, OPWP expects that the North-South Interconnect (currently to be integrate the MIS and Ad Duqm Power System by 2024) will be further extended to connect to the DPS. Subsequently, 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.

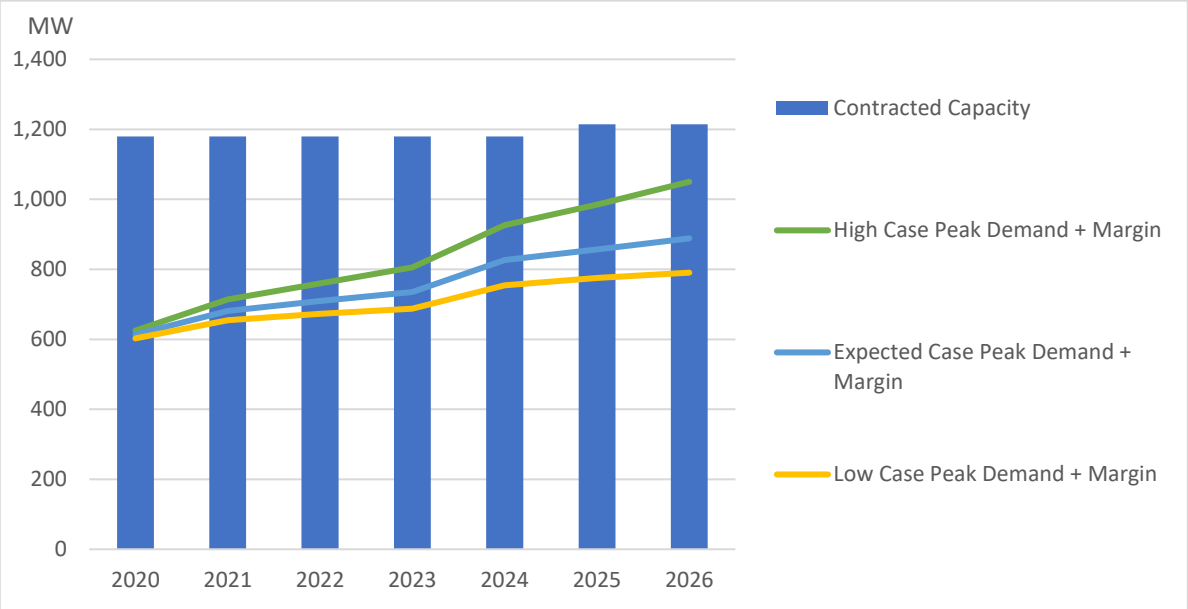
Resource Adequacy and Mitigation Plans

OPWP projects contracted capacity to be sufficient to meet the capacity targets associated with all three demand scenarios throughout the seven-year planning period. Figure 13 and the accompanying table indicate capacity surpluses that reduce gradually with demand growth. By 2026, the capacity surplus reduces to 164 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 has enabled substantial gas savings due to its high efficiency. This project has displaced generation from the older gas turbine plant, and is projected to achieve a net reduction in DPS gas consumption in 2020. This is illustrated further in Section 2.

Figure 13 Resource Adequacy – DPS



	2020	2021	2022	2023	2024	2025	2026
Generation Resources				**Net MW [a]**			
Total Contracted Capacity	**1,180**	**1,180**	**1,180**	**1,180**	**1,180**	**1,215**	**1,215**
Expected Case Demand							
Peak Demand	548	608	633	656	738	765	793
Peak Demand + Margin	614	681	709	735	826	856	888
Additional Capacity Required	-	-	-	-	-	-	-
High Case Demand							
Peak Demand	558	637	678	719	827	879	938
Peak Demand + Margin	625	714	760	806	926	985	1,050
Additional Capacity Required	-	-	-	-	-	-	-
Low Case Demand							
Peak Demand	538	584	601	614	674	692	706
Peak Demand + Margin	603	655	673	688	754	775	790
Additional Capacity Required	-	-	-	-	-	-	-

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 Centre for Statistics & Information reports that the total population is estimated at around 44,857[12], which is expected to grow steadily over the coming years.

a. Demand for Electricity

Demand Projections

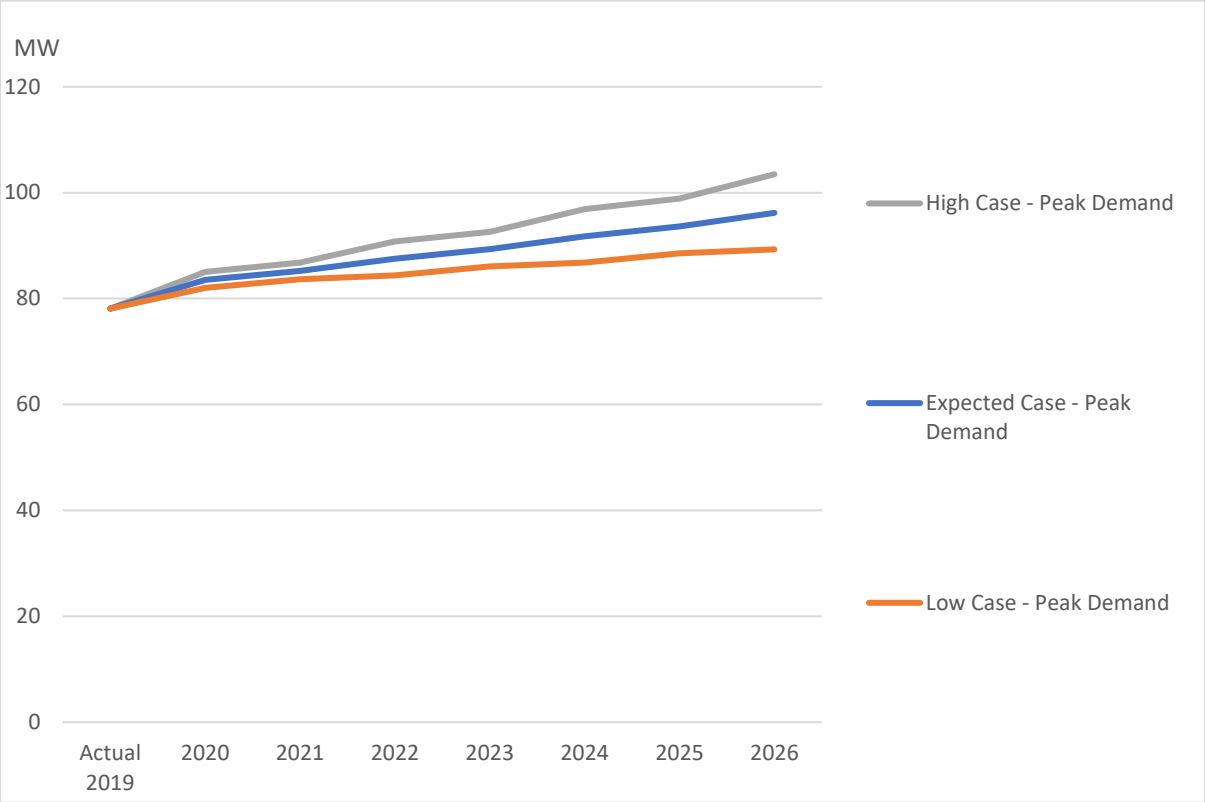
The pace of demand growth in Musandam is driven mainly by projects that aim to boost tourism, economic, and commercial activities. The Expected, Low, and High Case peak demand scenarios for the Musandam Power System have been prepared by Tanweer.

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 materialisation of identified bulk consumers. These three demand scenarios are shown in Figure 14. Across all three scenarios, the growth projections are lower than those in the previous 7-Year Statement. The expected and high case forecast are lower by 3% reflecting the expected lower economic growth compared to previous forecast.

Under the Tanweer Expected Demand forecast, peak demand is expected to grow from 78 MW in 2019 to 96 MW in 2026, an average increase of 3% per year. The Low Case scenario assumes a growth rate of 2% for peak demand, increasing only to 89 MW by 2026. 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 4% per year to reach 103 MW in 2026.

[12] National Centre of Statistics & Information (2020) *Data Portal - Population.*

Figure 14 Electricity Demand Projections – Musandam Power System



	Actual 2019	2020	2021	2022	2023	2024	2025	2026	Average Growth (%)
Peak Demand				**MW**					
Tanweer Expected Case	**78**	**84**	**85**	**88**	**89**	**92**	**94**	**96**	**3%**
Change from 2019-2025 Statement	*-12*	*-10*	*-13*	*-14*	*-19*	*-30*	*-34*	-	-
Tanweer Low Case	**78**	**82**	**84**	**84**	**86**	**87**	**89**	**89**	**2%**
Change from 2019-2025 Statement	*-7*	*-5*	*-8*	*-12*	*-15*	*-28*	*-32*	-	-
Tanweer High Case	**78**	**85**	**87**	**91**	**93**	**97**	**99**	**103**	**4%**
Change from 2019-2025 Statement	*-15*	*-12*	*-14*	*-14*	*-18*	*-29*	*-33*	-	-

b. Power Generation Resources

Sources of Power

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

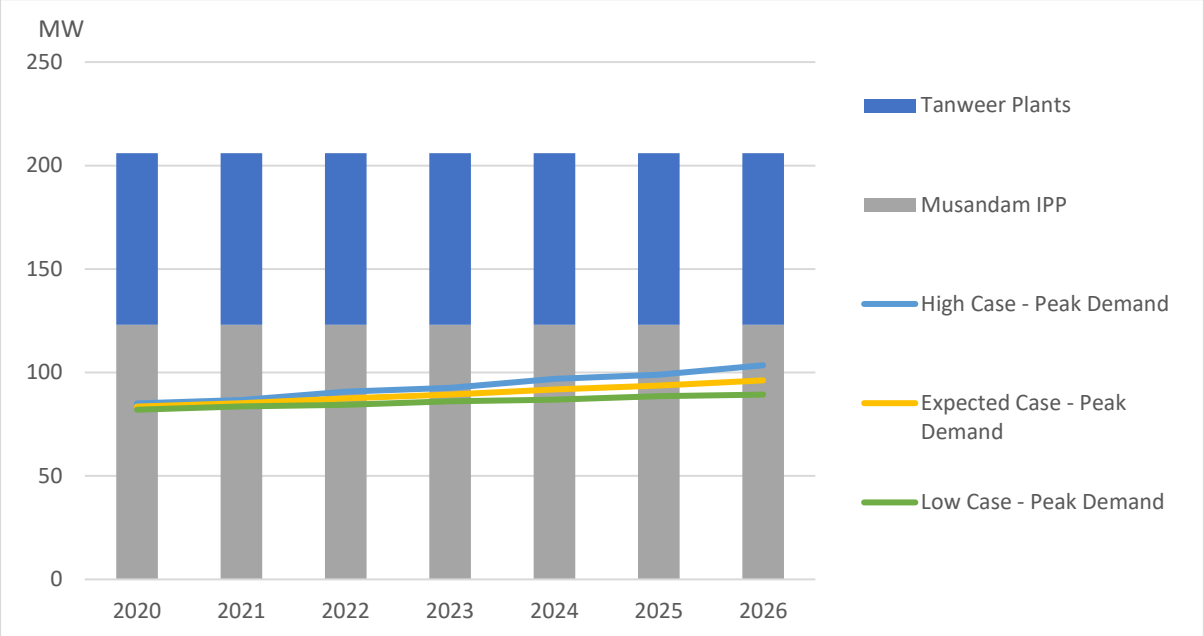
Musandam IPP commenced operation in 2017 operated by a consortium led by Oman Oil Company under a PPA with OPWP. The IPP provides firm capacity of 123 MW using reciprocating engines fuelled primarily by natural gas.

Resource Development Plan

Figure 15 illustrates Musandam's supply/demand balance. The Musandam IPP provide sufficient capacity to meet electrical energy requirements across all three demand scenarios over the coming 7-year planning horizon.

The Tanweer diesel generator will continue to be available to provide additional capacity if needed. No further resources are required during this time period.

Figure 15 Future Power Generation Expansion Plans - Musandam Power System



	2020	2021	2022	2023	2024	2025	2026
Peak Demand				MW			
Expected Case	**84**	**85**	**88**	**89**	**92**	**94**	**96**
Low Case	**82**	**84**	**84**	**86**	**87**	**89**	**89**
High Case	**85**	**87**	**91**	**93**	**97**	**99**	**103**
Contracted Capacity							
Tanweer Plants	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

SECTION 2 FUEL

OVERVIEW

Fuel Diversification Policy

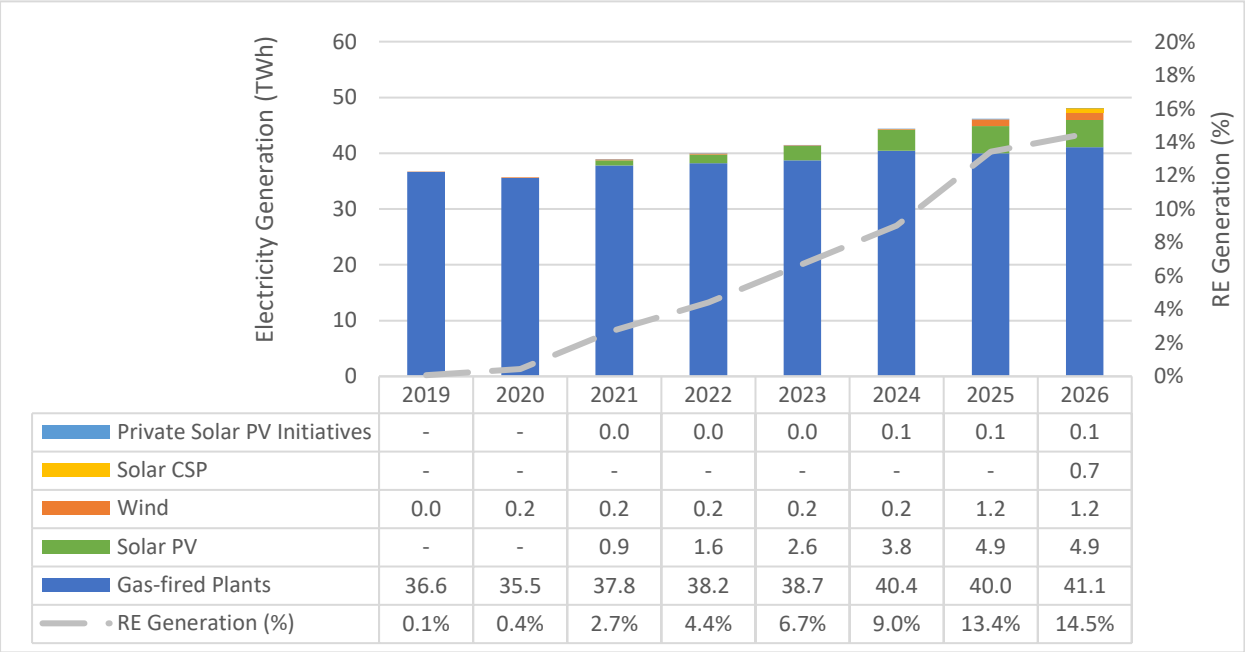
In 2018, OPWP began implementation of a Fuel Diversification Policy initiated by the Government, which set the following targets for the electricity sector:

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

In light of the above, and in parallel to its License obligations, OPWP has already contracted for 550 MW of RE capacity (Ibri II Solar IPP and Dhofar I Wind IPP), and plans to develop another 1,600 MW by 2025, which is expected to exceed the 10% policy target. Furthermore, OPWP continues to support improvements in efficient gas utilisation in the sector.

The impact of these initiatives will become evident as new RE projects are developed and implemented. Figure 16 shows our projection of energy generation shares by fuel type among OPWP-contracted generators. By 2025, more than 13% of generation will be provided by renewable energy sources, primarily solar energy. By 2026, the renewables share will reach 14.5%.

Figure 16 Fuel Shares in Electricity Generation



	2019	2020	2021	2022	2023	2024	2025	2026
Private Solar PV Initiatives	-	-	0.0	0.0	0.0	0.1	0.1	0.1
Solar CSP	-	-	-	-	-	-	-	0.7
Wind	0.0	0.2	0.2	0.2	0.2	0.2	1.2	1.2
Solar PV	-	-	0.9	1.6	2.6	3.8	4.9	4.9
Gas-fired Plants	36.6	35.5	37.8	38.2	38.7	40.4	40.0	41.1
RE Generation (%)	0.1%	0.4%	2.7%	4.4%	6.7%	9.0%	13.4%	14.5%

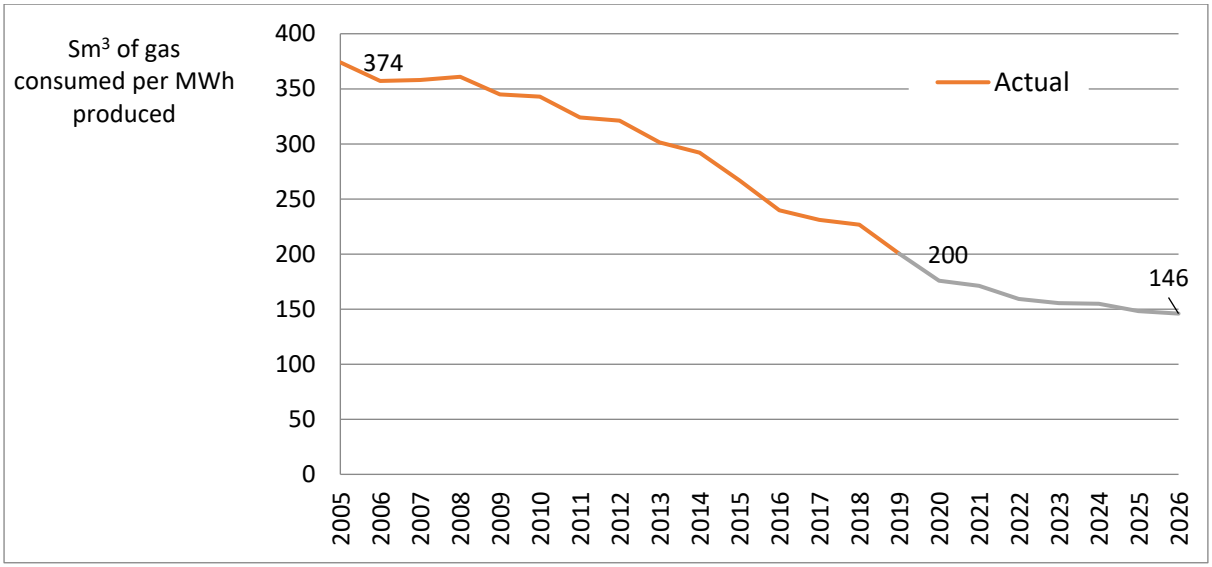
Efficiency in Fuel Utilisation

Since 2005, through the introduction of progressively more efficient generation plants, OPWP has achieved a 47% reduction in the gas required per unit of electricity production, from 374 Sm^3/MWh in 2005 to 200 Sm^3/MWh in 2019. In 2019 alone, improvements in gas utilisation (when compared against gas utilisation rates in 2005) suggest savings in excess of OMR 270 million. This is the result of OPWP's procurement of new state-of-the-art CCGT plants in 2019, and new water desalination plants that shift water production from energy-intensive MSF technology to efficient RO technology. In 2020, we expect a further 12% improvement in gas

utilisation, as shown in Figure 17. This is primarily driven by Ibri and Sohar III IPPs achieving COD in May 2019, and Sohar IV IWP achieving COD in August 2019[13].

After 2021, with the introduction of solar and wind plants, OPWP expects that the gas requirements for electricity generation will fall to around 146 Sm^3/MWh, or 60% less than that required in 2005.

Figure 17 Gas Required per Unit of Electricity Generation – MIS



2.1 MAIN INTERCONNECTED SYSTEM

a. 2019 Fuel Consumption

Total gas consumption at the main power and desalination plants in 2019 was about 6.58 billion Sm^3, equivalent to 18 million Sm^3/d, about 11% less than in 2018. This was due to the start of commercial operation of Sohar III IPP, Ibri IPP, and Sohar IV IWP. As there was no real change in total energy consumption between 2018 and 2019, the improvement of 12% in gas utilisation equates to a similar reduction percentage in gas consumption.

b. Projected Fuel Requirements

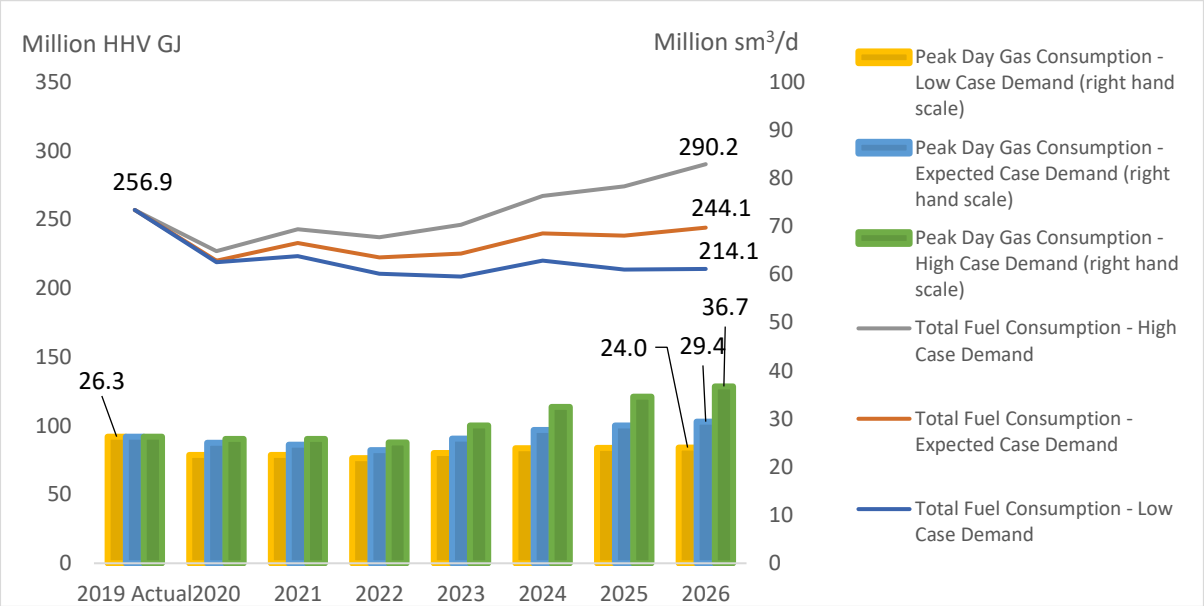
OPWP projects total annual fuel requirements to decrease by around 1% per year from 2019 to 2026 under the Expected Case. This scenario, in addition to the Low Case and High Case scenarios, are illustrated in Figure 16. The projected gas consumption for 2025 is about the same as that reported in the previous 7-Year Statement.

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 18 shows a slight drop in average gas consumption in 2020 compared to 2019. This is due mainly to 2020 being the first full year operation of Ibri and Sohar III IPPs and Sohar IV IWP (which allows fuel-intensive MSF water production to be curtailed). From 2021 to 2026, the introduction of renewable energy projects will restrain the growth in gas requirements even as electricity demand continues to increase.

[13] The commencement of Sohar IV IWP means that Sohar IWPP is no longer considered as a must-run project to ensure water production.

Figure 18 Projected Fuel Requirements – MIS



	2019 Actual	2020	2021	2022	2023	2024	2025	2026	Average Growth (%)
Expected Demand									
Gas Consumption (million Sm³/d)									
Annual Average	18.0	15.4	16.3	15.6	15.8	16.8	16.7	17.1	-1%
Peak Day	26.3	25.0	24.6	23.5	25.9	27.7	28.6	29.4	2%
Total Fuel Consumption (million HHV GJ)[a]	**257**	**220**	**233**	**222**	**225**	**240**	**238**	**244**	**-1%**
Low Case Demand									
Gas Consumption (million Sm³/d)									
Annual Average	18.0	15.3	15.7	14.8	14.6	15.4	15.0	15.0	-3%
Peak Day	26.3	22.5	22.5	21.9	22.9	23.9	24.0	24.0	-1%
Total Fuel Consumption (million HHV GJ)[a]	**257**	**219**	**223**	**210**	**208**	**220**	**214**	**214**	**-3%**
High Case Demand									
Gas Consumption (million Sm³/d)									
Annual Average	18.0	15.9	17.0	16.6	17.3	18.7	19.2	20.4	2%
Peak Day	26.3	25.9	25.8	25.1	28.7	32.5	34.6	36.7	5%
Total Fuel Consumption (million HHV GJ)[a]	**257**	**227**	**243**	**237**	**246**	**267**	**274**	**290**	**2%**

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

2.2 Dhofar Power System

a. 2019 Fuel Consumption

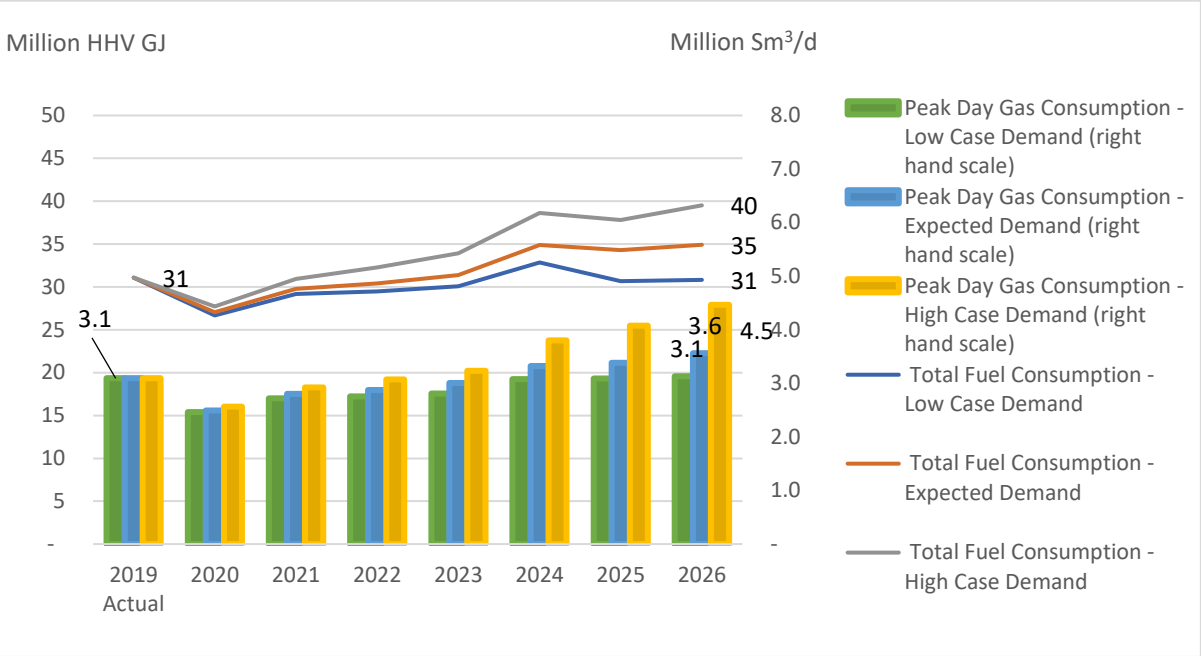
Gas consumption in 2019 was 796 million Sm^3 (equivalent to 2.2 million Sm^3/d), about 7% higher than in 2018, in line with a 7% increase in electricity production. Gas utilisation improved due to transmission grid improvements and resolution of gas supply issues that enabled higher dispatch of Salalah II IPP. Peak daily natural gas consumption was 3.1 million Sm^3 in 2019, which is similar to the 2018 peak.

b. Projected Fuel Requirements

Fuel requirements projections for each of the three demand scenarios are illustrated in Figure 19. The projections include the impact of the Dhofar I Wind IPP (50 MW) at Harweel starting in 2019-2020, and the introduction of Dhofar Wind II IPP in 2025. All cases show a drop in peak gas consumption in 2020, which is the impact of the wind plant.

Total fuel consumption is expected to increase at an annual average of around 2% under the Expected Demand scenario, and by 3% in the High Case, and remain the same under the Low Case scenario. These growth rates in fuel consumption compare to energy demand growth of 5%, 3%, and 7%, respectively. OPWP is developing plans for additional wind IPP capacity, subject to an evaluation of grid stability impacts by OETC, which would reduce the gas requirements.

Figure 19 Projected Fuel Requirements – DPS



	2019 Actual	2020	2021	2022	2023	2024	2025	2026	Average Growth (%)
Expected Demand									
Gas Consumption (million Sm³/d)									
Annual Average	2.2	1.9	2.1	2.1	2.2	2.4	2.4	2.4	2%
Peak Day	3.1	2.5	2.8	2.9	3.0	3.3	3.4	3.6	2%
Total Fuel Consumption (million HHV GJ)[a]	**31**	**27**	**30**	**30**	**31**	**35**	**34**	**35**	**2%**
Low Case Demand									
Gas Consumption (million Sm³/d)									
Annual Average	2.2	1.9	2.0	2.1	2.1	2.3	2.2	2.2	-0.1%
Peak Day	3.1	2.5	2.7	2.8	2.8	3.1	3.1	3.1	0.2%
Total Fuel Consumption (million HHV GJ)[a]	**31**	**27**	**29**	**29**	**30**	**33**	**31**	**31**	**-0.1%**
High Case Demand									
Gas Consumption (million Sm³/d)									
Annual Average	2.2	1.9	2.2	2.3	2.4	2.7	2.7	2.8	3%
Peak Day	3.1	2.6	2.9	3.1	3.2	3.8	4.1	4.5	5%
Total Fuel Consumption (million HHV GJ)[a]	**31**	**28**	**31**	**32**	**34**	**39**	**38**	**40**	**3%**

[a] Based on natural gas HHV of 1,050 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 of Oman. OPWP provides desalinated water to the Public Authority for Water (PAW), the principal "water department", and 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, Batinah North, Ad Dakhiliyah, 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.

The MIS consists of three supply zones, each of which has resources 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 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 resources of desalinated water for this zone are Barka IWPP, 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.[14] The current resources of desalinated water for this zone is Sohar IWPP and Sohar IV IWP.

a. Demand for Water

PAW has provided OPWP with projections of average and peak water demand for the MIS, shown in Figure 20. Peak demand represents the daily demand (including network losses) during the week of highest demand of the year.

PAW has provided a Medium Case scenario only, which is driven fundamentally by population growth, distribution network expansion, and growth in per-capita water consumption. The PAW demand forecasts are derived from the population forecast scenarios published in 2017 by the National Centre for Statistics and Information (NCSI).[15]

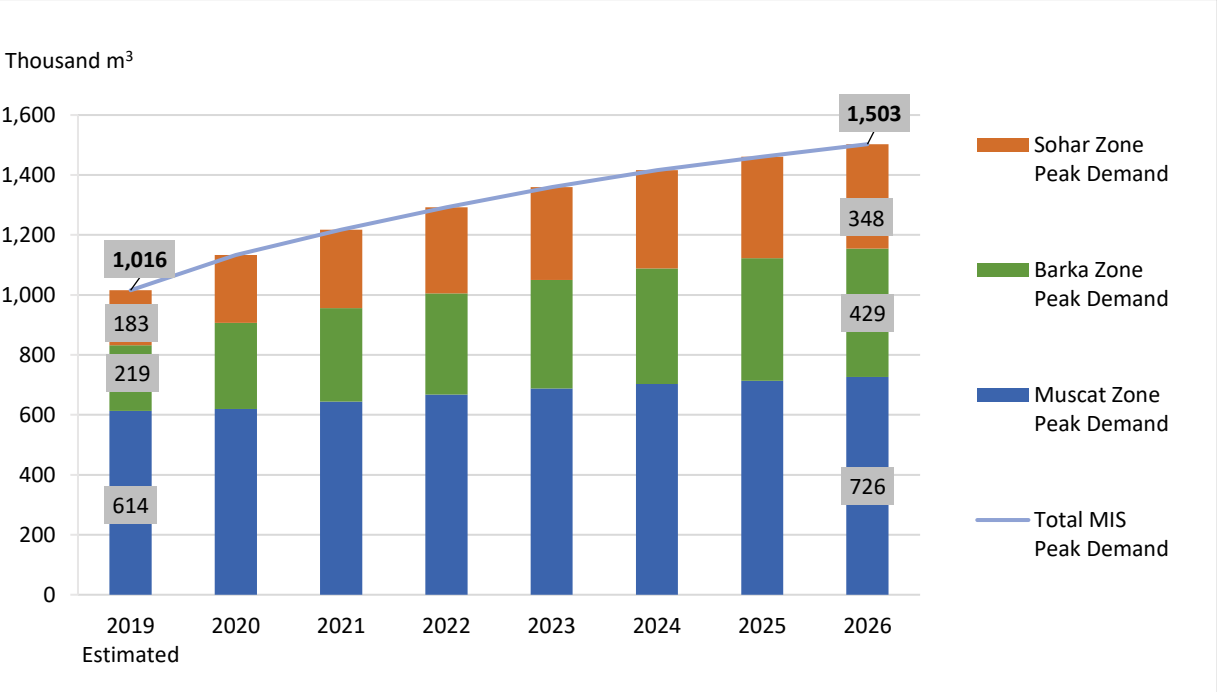
The Medium Case scenario projects average annual growth of about 6% over the forecast horizon to 2026, similar to the rate that was in the previous 7 Year Statement.

PAW also provided the actual data of its water consumption for the year 2019 classified by the governorates, through which the daily average consumption was calculated and the peak estimate was developed. The total average in the MIS in 2019 reached about 876,000 m^3/d, which is lower than the previous PAW forecast by 64,000 m^3/d. PAW considered 2019 outturns in preparing the next 7-year projections, accordingly, the actual demand for 2019 has contributed to the decrease in the projections for 2020 to 2026 compared to the

[14] 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.
[15] National Centre for Statistics and Information, Population Projections in the Sultanate of Oman, March 2017.

projections provided in the previous 7 Year Statement (Issue 13). The total reduction in projected peak demand in 2025, for example, is about 7% (106,000 m^3/d).

Figure 20 Water Demand Projections – MIS



	2019[a]	2020	2021	2022	2023	2024	2025	2026	Average Growth (%)
Medium Case Scenario	Thousand m^3/d								
Muscat zone									
Peak Demand	614	619	644	668	689	703	714	726	2%
Average Demand	541	546	568	589	607	619	629	638	2%
Barka zone									
Peak Demand	219	288	312	337	362	386	408	429	10%
Average Demand	182	239	260	279	299	319	336	353	10%
Sohar zone									
Peak Demand	183	226	262	288	309	328	339	348	10%
Average Demand	153	189	219	241	257	272	281	288	10%
Total MIS									
Peak Demand	**1,016**	**1,133**	**1,218**	**1,293**	**1,359**	**1,416**	**1,461**	**1,503**	**6%**
Change from 2019-2025 Statement	*-80*	*-39*	*-42*	*-52*	*-72*	*-93*	*-106*	-	-
Average Demand	**876**	**974**	**1,046**	**1,109**	**1,164**	**1,210**	**1,246**	**1,280**	**6%**
Change from 2019-2025 Statement	*-64*	*-29*	*-32*	*-40*	*-56*	*-74*	*-83*	-	-

[a] The Average Demand is based on actual 2019 outturns (desalination and underground water supply) while the Peak Demand is estimated using peak factor.

b. Water Supply Resources

The resources of potable water supply include operating water desalination plants, new desalination plants under construction or procurement, and PAW resources. The water desalination resources that are under contract with OPWP in the MIS are summarized in Table 8.

OPWP's contracted resources of desalinated water in the MIS are classified by zones as follows:

Muscat Zone:

- **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.** Owned by Qurayyat Desalination Company and operated under a WPA with OPWP, Qurayyat IWP has contracted desalination capacity of 200,000 m^3/d (44 MIGD), using RO technology. And due to the increase in the water demand in Muscat Zone, Qurayyat IWP is currently operated as "pre-COD" until it achieves its Commercial Operation Date COD.

Barka Zone:

- **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 has added RO capacity 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 utilised 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, Barka IV IWP utilises RO technology with a contracted capacity of 281,000 m^3/d (62 MIGD).

Sohar Zone:

- **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.** Owned by Myah Gulf Desalination Company and operated under a WPA with OPWP, Sohar IV IWP utilises RO technology with a contracted capacity of 250,000 m^3/d (55 MIGD).

Table 8 Water Desalination Plants – 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. (SAOG)	Operational	RO	2034
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)	Operational	RO	2038

In addition to the 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 are shown in aggregate by year in Figures 21A, 21B, and 21C. 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.

c. Resource Adequacy and Development Plan

The expansion plan for water desalination capacity aims to meet peak demand plus reserve margin for security supply. PAW has reviewed and revised the margin to cover the spare capacity to meet level of service, the uncertainty in demand forecast, and the operational outages. In the revised margin, 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 4 years period followed by 2% for the remaining forecast period. Accordingly, the margin used from 2020-2022 is 8% followed by 9% margin for the years 2023-2026.

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 and PAW wellfield resources. Qurayyat IWP is currently delivering commercial water as "pre-COD" until its Commercial Operation Date COD is achieved. For the time being, local resources within the Muscat Zone are not sufficient to meet demand and therefore water transfers from Barka Zone are required to provide for the balance.

The transmission facilities – pump stations and pipeline to Dakhiliyah – relevant to transfers from Barka are currently in the process of a multi-year reinforcement and capacity expansion program. In 2020, the addition of two pumps will increase total capacity from Barka to Seeb (in Muscat Zone) and Ad Dakhiliyah to 349,200 m^3/d. An initial reinforcement project at Al Khoud Main Pumping Station in 2020 will provide a transfer rate of 151,000 m^3/d to Ad Dakhiliyah. This is sufficient to meet Ad Dakhiliyah average demand but is somewhat less than the peak demand level. In 2023, the reinforcement of Al Khoud Main Pumping Station is scheduled for completion, increasing transfer capacity to Ad Dakhiliyah to 438,672 m^3/d. This will enable supply to meet Ad Dakhiliyah peak demand for the remainder of the forecast period. The available transfer capacity to Muscat/Seeb is the total capacity less the transfer to Ad Dakhiliyah. Thus, from 2023 onwards, the available transfer capacity to Muscat/Seeb reduces in step with increases in demand from Ad Dakhiliyah.

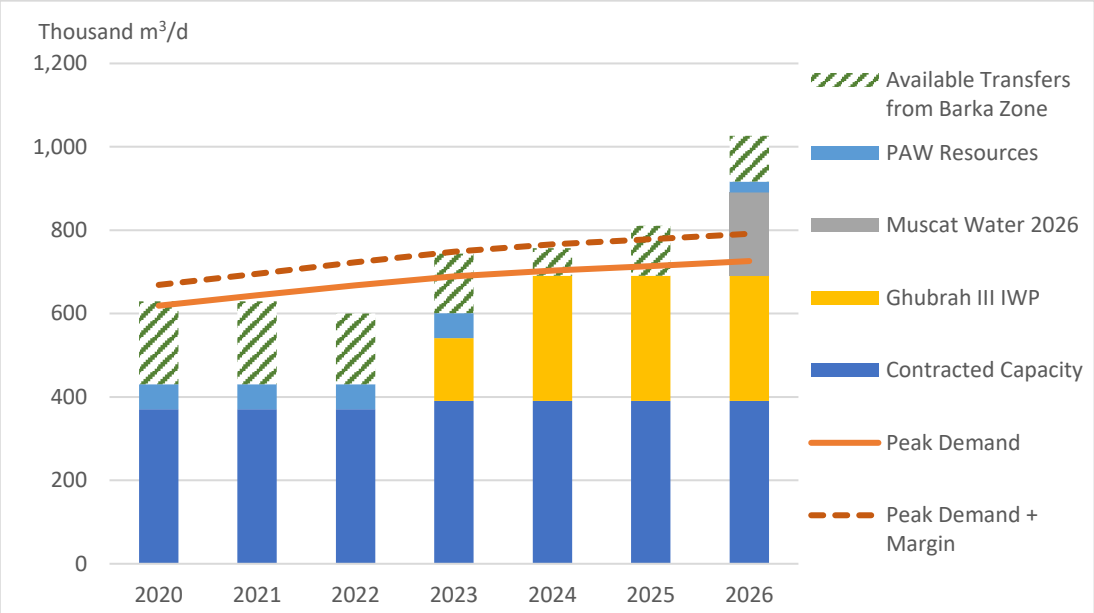
Figure 21A provides a summary of annual water supply requirements and supply sources in the Muscat Zone. For the Muscat Zone, the available Barka transfers capacity is required to meet the peak demand and contribute to reserves over peak demand up through 2022. In 2022, the maximum available transfer capacity from Barka to Seeb reduces to about 165,000 m^3/d. This causes a supply shortfall in the Muscat zone of about 42,000 m^3/d compared to peak demand. In 2023, Ghubrah III IWP early water of 150,000 m^3/d will provide sufficient capacity to meet the peak demand.

OPWP has two projects in progress 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.** Following bid submission in late 2019, OPWP expects to award this project in Q3 2020. The project will have capacity of 300,000 m^3/d, using RO technology. It will be contracted to provide Early Water at 150,000 m^3/d from Q3 2023 and to reach full capacity in Q1 2024 The project will be located on a portion of the site formally occupied by Ghubrah IWPP.

- **Wadi Dayqah IWP.** This project has been designed as a dual-purpose facility to take water from the Wadi Dayqah reservoir for both agricultural and potable water supply. It would include RO plant to provide for potable water. The water provided by this project is considered non-firm as it depends on the level of rainfall. The project is intended to diversify desalinated water sources and provide supply during emergencies. PAW prepared the design concept and requested OPWP to procure the project in Q4 2017. However, further progress on procurement is currently on hold pending a final decision by PAW.

Figure 21 Resource Adequacy and Development Plan – Muscat Zone



	2020	2021	2022	2023	2024	2025	2026
Muscat Zone				Thousand m³/d			
Average Demand	546	568	589	607	619	629	638
Peak Demand	619	644	668	689	703	714	726
Peak Demand + Margin	669	696	723	749	766	778	792
Contracted Capacity							
Ghubrah II IWP	191	191	191	191	191	191	191
Qurayyat IWP	180	180	180	200	200	200	200
Prospective Capacity							
Ghubrah III IWP	-	-	-	150	300	300	300
Wadi Dayqah IWP	-	-	-	-	TBD	TBD	TBD
Muscat Water 2026	-	-	-	-	-	-	200
PAW Resources							
Wells Capacity [a]	60	60	60	60	-	-	26
Total Muscat Zone Capacity	**431**	**431**	**431**	**601**	**691**	**691**	**917**
Reserve over Peak Demand	-188	-213	-237	-88	-12	-23	191
Reserve over Peak Demand + Margin	-238	-265	-292	-148	-75	-87	125
Transfers							
Available Transfer Capacity from Barka to Muscat [b]	198	198	169	143	66	119	110
Required Transfers from Barka to Muscat [c]	188	198	169	88	12	23	-
Muscat Zone Capacity + Available Transfers	**629**	**629**	**600**	**744**	**757**	**810**	**1027**
Reserve over Peak Demand (shortfall)	10	-15	-68	55	54	96	301
Reserve over Peak Demand + Margin (shortfall)	-40	-66	-123	-5	-9	32	235

[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, Ad Dakhiliyah demand will not be fully met by desalination resources until the reinforcement project is completed in 2023.

[c] Transfer required to meet Muscat Peak Demand + Margin, subject to maximum available transfer capacity.

Barka Zone

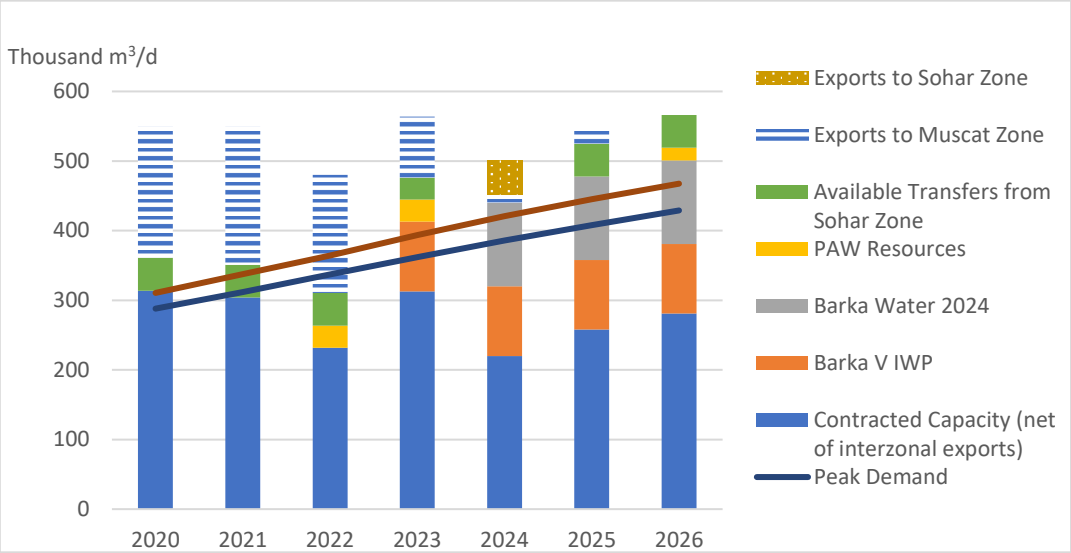
The Barka zone is currently supplied by Barka IWPP (RO, MSF-stand by), Barka II IWPP, Barka IV IWP, and PAW-operated wellfield resources. These resources currently exceed the demand requirements within the Barka Zone and enable transfers to support the needs of the Muscat Zone.

Figure 22 provides a summary of annual water supply requirements and supply sources in the Barka Zone. Transfers from Sohar Zone are needed in 2021 and 2022 to boost the available Barka capacity for transfer to Muscat Zone.

OPWP will procure two projects to provide additional water desalination capacity within the Barka zone: Barka V IWP and Barka Water 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. They are described as follows:

- **Barka V IWP.** The project will have capacity of 100,000 m^3/d, using RO technology. OPWP began the procurement process in 2019. It is scheduled for commercial operation in Q2 2023.
- **Barka Water 2024.** In 2024, the Barka II IWPP PWPA expires, such that 120,000 m^3/d of capacity must be replaced. OPWP is expected to commence procurement soon in order to achieve COD in 2024.

Figure 22 Resource Adequacy and Development Plan – Barka Zone



	2020	2021	2022	2023	2024	2025	2026
Barka Zone				Thousand m³/d			
Average Demand	239	260	279	299	319	336	353
Peak Demand	288	312	337	362	386	408	429
Peak Demand + Margin	311	337	364	394	421	445	468
Contracted Capacity							
Barka I IWPP (RO)	101	101	-	-	-	-	-
Barka I IWPP (MSF- standby only)	91	91	-	-	-	-	-
Barka II IWPP	120	120	120	120	-	-	-
Barka IV IWP	281	281	281	281	281	281	281
Prospective Capacity							
Barka V IWP	-	-	-	100	100	100	100
Barka Water 2024	-	-	-	-	120	120	120
PAW Resources							
Wells Capacity [a]	-	-	32	32	-	-	18
Total Barka Zone Capacity [b]	**502**	**502**	**433**	**533**	**501**	**501**	**519**
Total Supply to Barka zone [c]	**286**	**298**	**311**	**362**	**386**	**408**	**429**
Reserve over Supply to Barka zone	216	205	122	171	115	93	90
Transfers							
Available Transfer Capacity from Sohar to Barka [d]	47	47	47	31	-	47	47
Required Transfer from Sohar to Barka	-	34	47	-	-	-	-
Required Transfer from Barka to Sohar	-	-	-	-	-49	-	-
Max. Transfer Capacity from Barka to Muscat	198	198	198	143	130	119	110
Available Transfer Capacity from Barka to Muscat	198	198	169	143	66	119	110
Required Transfer from Barka to Muscat	-188	-198	-169	-88	-12	-23	0
Barka Zone Capacity +/- Transfers	**361**	**351**	**311**	**476**	**440**	**525**	**566**
Reserve over Supply (shortfall)	75	53	-	114	54	117	137
Reserve over Peak Demand + Margin (shortfall)	50	13	-54	82	19	80	99

[a] The maximum wells capacity in Barka System is around 32 thousand m³/d.

[b] Excluding Barka I IWPP standby capacity.

[c] Due to transmission network constraints, Dhakhiliyah peak demand will not be fully met until the network reinforcement project is completed in 2023. The expected shortfall in Dakhiliyah in 2020, 2021, and 2022 is 2,000, 15,000, and 26,000 m³/d respectively.

[d] Subject to reserves available in Sohar Zone.

Sohar Zone

The Sohar zone is currently supplied by the Sohar IWPP, Sohar IV IWP and PAW-operated wellfield resources.

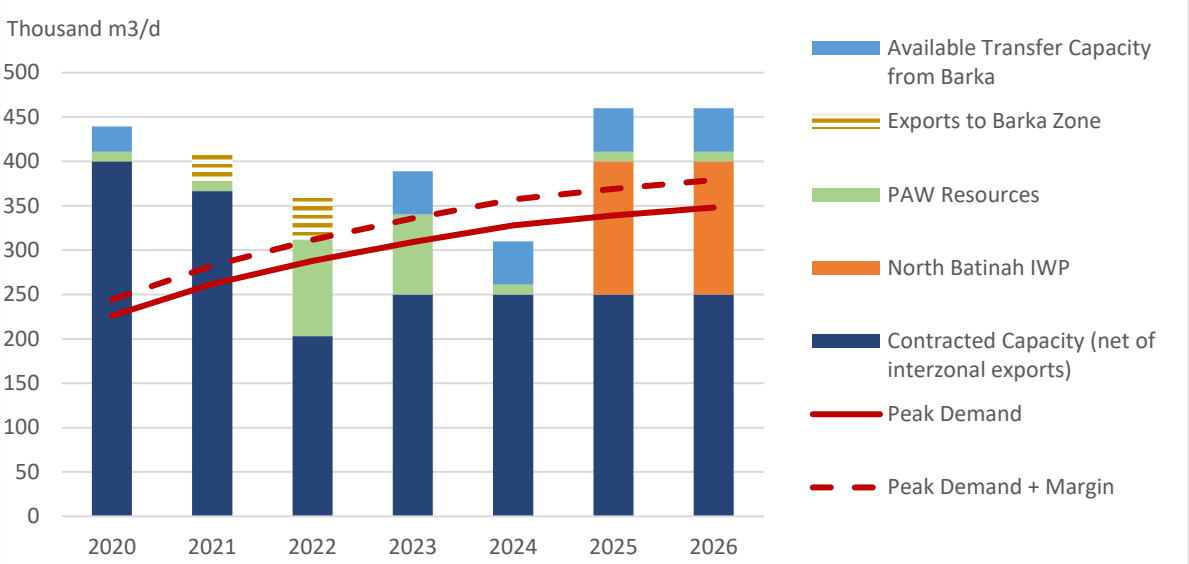
The Sohar IWPP PWPA expires in March 2022, creating a need for additional capacity. OPWP will procure North Batinah IWP with capacity of 150,000 m^3/d, OPWP anticipates COD in Q2 2025.

PAW wells capacities of 74,000 m^3/d and 48,000 m^3/d at least are needed in 2022 and 2023 to meet the peak demand due to the retirement of Sohar IWPP PWPA and before the completion of North Batinah IWP to meet the capacity target. These well extraction rates are significantly higher than in any previous period, and may not be sustainable for extended periods. Hence supply adequacy is vulnerable to unplanned outages or red tide events from 2022 until water supply is available from the new North Batinah IWP.

While initially planned with a COD in Q2 2024, the North Batinah IWP has now been delayed to achieved COD in 2025 as per PAW's direction. This delay is anticipated to lead to some deficit in 2024, however, OPWP expects that the PAW will be able to cover some of the deficit via other mitigations. Data further indicates that a surplus in the Barka Zone of up to 49,000 m^3/d can be transferred to Sohar Zone, but that is subject to the interconnection capacity between the two zones.

Figure 23 indicates the development of the supply balance and resource adequacy. Upon completion of the North Batinah IWP, reserves meet the planning target for the remainder of the forecast period.

Figure 23 Resource Adequacy and Development Plan – Sohar Zone



	2020	2021	2022	2023	2024	2025	2026
Sohar Zone				Thousand m³/d			
Average Demand	189	219	241	257	272	281	288
Peak Demand	226	262	288	309	328	339	348
Peak Demand + Margin	244	283	312	336	357	369	379
Contracted Capacity							
Sohar I IWPP	150	150	-	-	-	-	-
Sohar IV IWP	250	250	250	250	250	250	250
Prospective Capacity							
North Batinah IWP	-	-	-	-	-	150	150
PAW Resources							
Wells Capacity [a]	-	-	98	79	-	-	-
Sohar RO MISC	11	11	11	11	11	11	11
Total Sohar Zone Capacity	**411**	**411**	**359**	**340**	**261**	**411**	**411**
Reserve over Peak Demand	185	149	71	31	-67	72	63
Reserve over Peak Demand + Margin	167	129	47	4	-96	42	32
Transfers							
Required Transfer from Sohar to Barka	-	-34	-47	-	-	-	-
Available Reserve from Barka	28	-	-	83	103	70	90
Available Transfer Capacity from Barka	28	-	-	49	49	49	49
Required Transfer from Barka to Sohar	-	-	-	-	49	-	-
Sohar Zone Capacity +/- Required Transfers	**411**	**377**	**312**	**340**	**310**	**411**	**411**
Reserve over Peak Demand (shortfall)	185	115	24	31	-18	72	63
Reserve over Peak Demand + Margin (shortfall)	167	95	-	4	-47	42	32

[a] In 2022 and 2023, the expected maximum output of the wells capacity includes Batinah North wells, Buraymi wells, and Dhahirah wells after interconnection.

Summary

In summary, and over the coming years up to and including 2023, OPWP notes that the MIS depends heavily on interzonal transfers to meet peak demand in across the different zones, and this is especially relevant for the Muscat Zone. However, despite the interzonal transfers, the Muscat Zone will face challenges in meeting its

peak demand requirements in 2021, which will develop into material shortages in 2022. Margins are stressed during this period across all zones, and OPWP notes that delay in the development of planned projects may very well prohibit the MIS from meeting resource adequacy targets until beyond 2025. However, under the current resource development plan, resource adequacy is expected to be robust from 2025 onwards.

OPWP and PAW will continue to work together to anticipate potential difficulties and to develop supply mitigation plans as necessary.

3.2 SHARQIYAH WATER NETWORK

The Sharqiyah Water Network is developed and operated by PAW, serving Ash Sharqiyah North and Ash Sharqiyah South Governorates, noting that this network 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 RO plants.

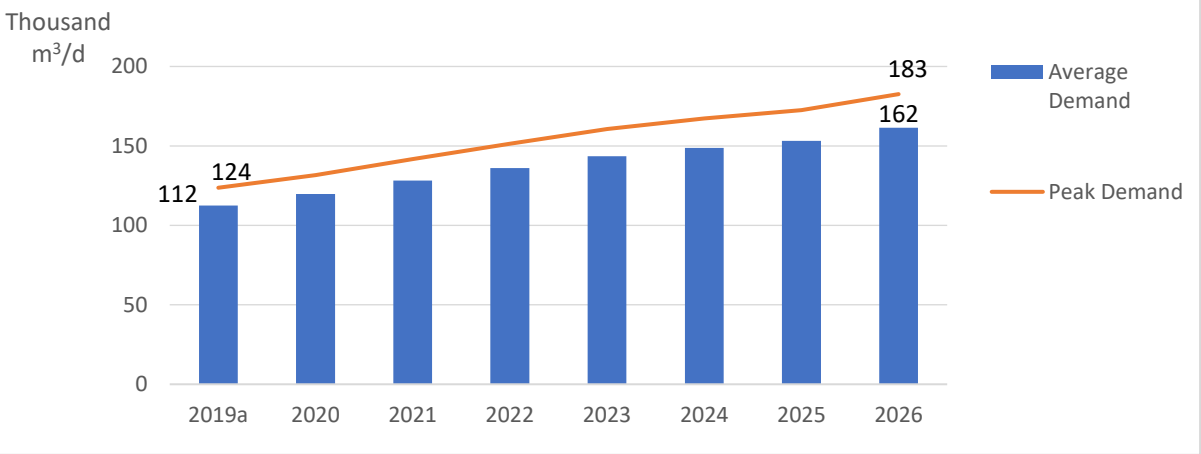
a. Demand for Water

The PAW's water demand forecast for the Sharqiyah Zone is shown in Figure 24. Sharqiyah Zone refers to the area served by the Sharqiyah Water Network that is or will be connected to water desalination plants under contract with OPWP.

The average actual water consumption in Sharqiyah Zone for 2019 has exceeded last 7 Year Statement expected demand by 2,000 m^3/d, bringing the average consumption to about 112,000 m^3/d and the peak consumption to 124,000 m^3/d.

PAW projects average growth for peak and annual average demand at 6% and 5% respectively over the 7-year horizon, which is similar to the forecast provided for the previous 7-Year Statement, Issue 13. As for the annual growth, it is not constant, as it varies from year to year. In pace with the network developments, the peak demand increases by about 8% in 2021, while it increases by only 3% in the year 2025. PAW is extending the Sharqiyah Water Network and increasing transmission capacity to enable full evacuation from Aseelah IWP by 2021.

Figure 24 Water Demand Projections – Sharqiyah Water Network



	2019[a]	2020	2021	2022	2023	2024	2025	2026	Average Growth (%)
Peak Demand	**124**	**132**	**142**	**151**	**161**	**167**	**173**	**183**	**6%**
Change from 2019-2025 Statement	*2*	-	-	*-1*	*-1*	*-2*	*-3*	-	-
Average Demand	**112**	**120**	**128**	**136**	**144**	**149**	**153**	**162**	**5%**
Change from 2019-2025 Statement	*2*	-	-	-	-	*-1*	*-1*	-	-

[a] The Average Demand is based on actual 2019 outturns (desalination and underground water supply) while the Peak Demand is estimated using peak factor.

b. Water Supply Resources

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 through WPAs to provide desalinated water production in the Sharqiyah Zone are summarized in Table 9. OPWP's contracted sources of desalinated water for the Sharqiyah Zone include the following:

- **Sur II IWP**. Owned and operated by Sharqiyah Desalination Company under a WPA with OPWP, Sur II IWP has contracted capacity of 131,000 m^3/d (29 MIGD), using RO technology. This includes the recent 48,000 m^3/d expansion, which was completed in 2017.

- **Aseelah IWP.** Awarded in December 2017 to Al Asilah Desalination Company, to be operated under a WPA with OPWP with contracted capacity of 80,000 m^3/d (17 MIGD), using RO technology, Aseelah 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 utilised, to a limited degree, for water supply when desalinated water capacity is not sufficient to meet the demand in the Sharqiyah Zone.

Table 9 Water Desalination Plants – Sharqiyah Water Network

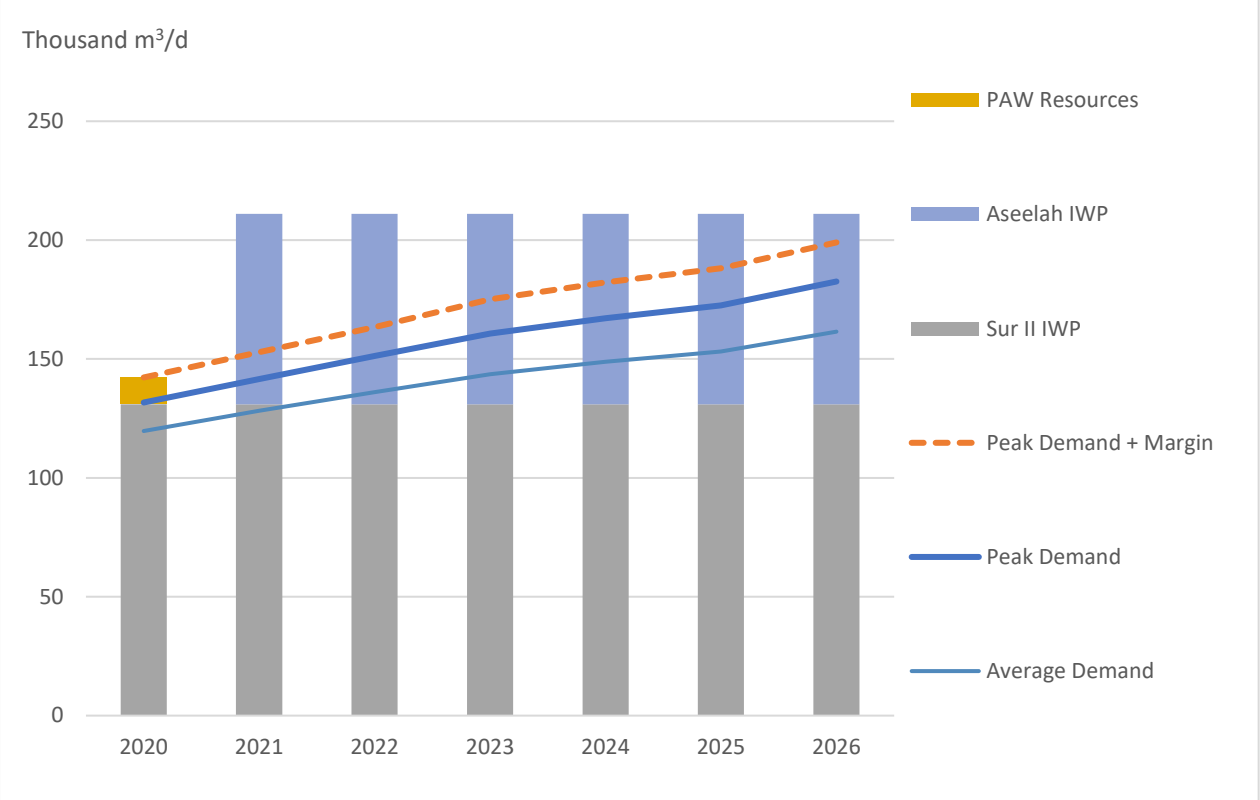
Project Name	Contracted Capacity	Contract Type	Project Company	Project Status	Technology	Contract Expiry
Aseelah IWP	80,000 m^3/d	WPA	Al Asilah Desalination Company (SAOC)	Under construction	RO	2041
Sur II IWP	131,000 m^3/d	WPA	Sharqiyah Desalination Company (SAOG)	Operational	RO	2029

c. Resource Adequacy and Development Plan

The capacity target for the Sharqiyah Zone is set at an 8% margin above forecasted peak demand up to 2022, and with a margin of 9% to 2026, similar the method used to calculate the capacity target for MIS. Figure 25 compares the capacity target to the supply plan.

The figure shows that contracted capacity is not sufficient to meet the capacity target in 2020, PAW wells resources are considered to be utilised during this period. Aseelah IWP is expected to begin operation in Q2, 2021 with a capacity of 80,000 m^3/d. However, due to PAW network constraint only 25% of the capacity will be evacuated until the completion of PAW's network reinforcement project. Additional water desalination capacity in the form of Aseelah IWP will contribute to achieve PAW objective to eliminate the usage of wells capacity and relying on it for emergency supply only.

Figure 25 Resource Adequacy and Development Plan – Sharqiyah Water Network



	2020	2021	2022	2023	2024	2025	2026
Supply Requirements	Thousand m³/d						
Peak Demand	**132**	**142**	**151**	**161**	**167**	**173**	**183**
Peak Demand + Margin	**142**	**153**	**163**	**175**	**182**	**188**	**199**
Contracted Capacity							
Sur II IWP [a]	131	131	131	131	131	131	131
Aseelah IWP [b]	-	80	80	80	80	80	80
Total Contracted Capacity	**131**	**211**	**211**	**211**	**211**	**211**	**211**
Reserve over Peak Demand (Shortfall)	-1	69	60	50	44	38	28
Reserve over Peak Demand + Margin (Shortfall)	-11	58	48	36	29	23	12
PAW Resources Supply [c]	11	-	-	-	-	-	-

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

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

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

3.3 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.

a. Demand for Water

DGW has provided OPWP with the water demand projection for the Governorate of Dhofar, shown in Figure 26. It includes the aggregated potable water demands of the wilayats of Salalah, Taqah and Mirbat.

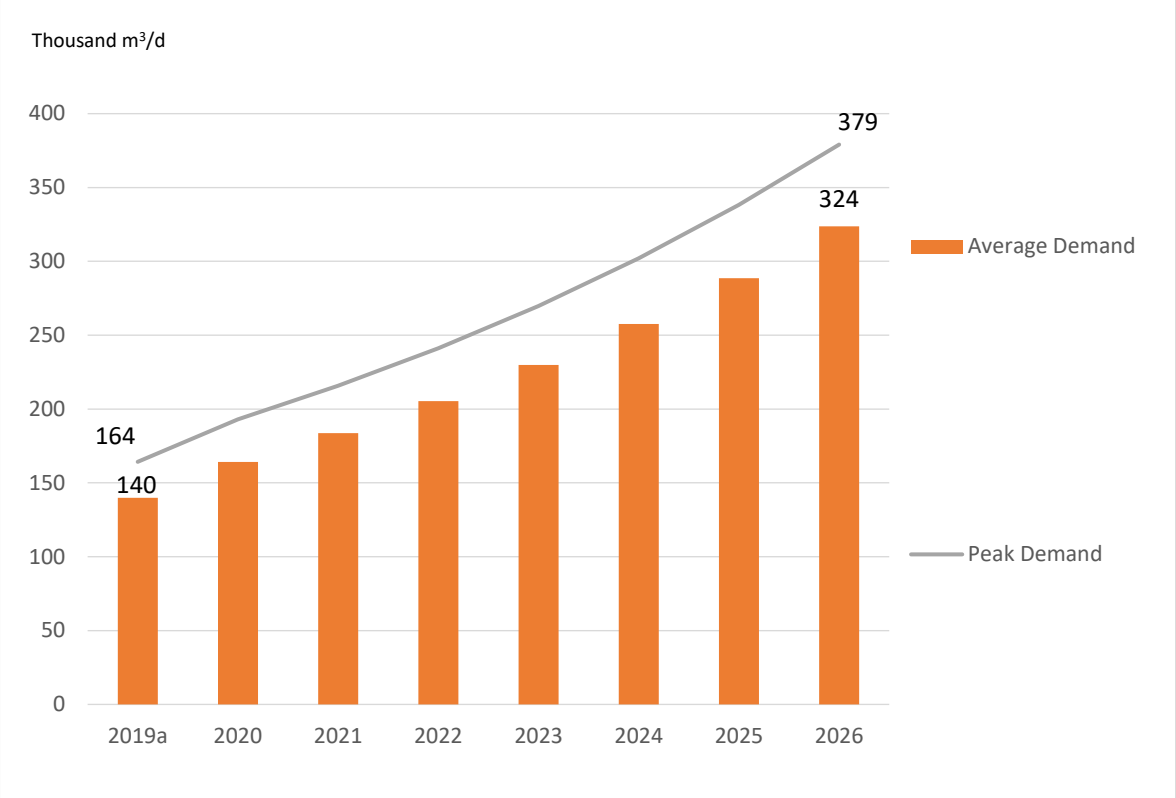
DGW has differentiated the forecast into two demand groups: (1) Cities of Salalah, Taqah, and Mirbat, which comprise demand served by the existing water distribution network; and (2) Jabal, which represents the demand in Jabal areas that are partially connected to the network. The Jabal demand is mainly served by local wells and by tankers. DGW has 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.

DGW has updated the water demand forecast taking into account the reduction in actual 2019 demand compared to the projections provided for the previous 7 Year statement, Issue 13. The reduction in average demand for 2025 is about 23,000 m^3/d and 42,000 m^3/d in peak demand.

The projected growth rate is representing 13% growth per year for both peak and annual demand over the forecast period which is similar to the projected growth in the previous 7 Year Statement, Issue 13. The population growth and the continuous expansion of the water network are among the direct factors that affect the high increase in the water demand in the Dhofar Governorate water network. Also, a large part of the water consumption in the mountains is used for livestock.

This increase in the volume of demand has led to a significant increase in water consumption rates per capita compared to the other zones in the Sultanate.

Figure 26 Water Demand Projections – Dhofar Water Network



	2019[a]	2020	2021	2022	2023	2024	2025	2026	Average Growth (%)
Peak Demand				Thousand m³/d					
Cities	120	143	157	173	191	211	232	256	11%
Jabal	44	50	58	68	79	91	106	123	16%
Total	**164**	**193**	**216**	**241**	**270**	**302**	**338**	**379**	**13%**
Change from 2019-2025 Statement	*-17*	*-11*	*-15*	*-19*	*-25*	*-32*	*-42*	-	-
Average Demand									
Cities	101	120	132	146	161	177	195	215	11%
Jabal	39	44	51	60	69	81	94	109	16%
Total	**140**	**164**	**184**	**205**	**230**	**258**	**289**	**324**	**13%**
Change from 2019-2025 Statement	*-16*	*-11*	*-12*	*-14*	*-16*	*-18*	*-23*	-	-

[a] The Average Demand is based on actual 2019 outturns (desalination and underground water supply) while the Peak Demand is estimated using peak factor.

b. Water Supply Resources

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 10 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 m^3/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 m^3/d to 110,000 m^3/d (which includes 70,000 m^3/d in the cities). DGW plans to utilise desalinated water to meet average and peak demand requirements, and to utilise groundwater from wells only as a reserve for emergency supply. This is also consistent with national policy to limit ground well production to replenish aquifers.

Table 10 Water Desalination Plants – 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

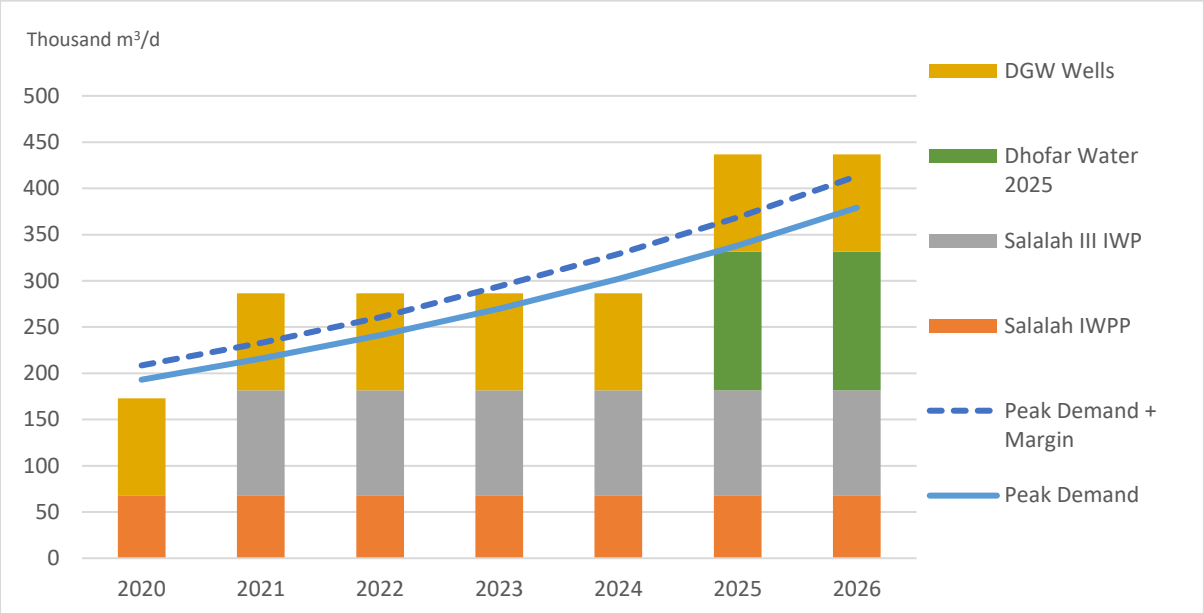
c. Resource Adequacy and Development Plan

The resource adequacy presentation addresses 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 27 shows the demand-supply balance, considering network expansion to include water demand in the Jabal areas. 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 m^3/d 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.

Salalah III IWP capacity will reduced the reliance on DGW wells capacity in 2021 and 2022. DGW has requested OPWP to procure a desalination capacity of 150,000 m^3/d which is expected to begin operation in 2025, subject to regulatory approval.

The desalinated water from Salalah IWPP, Salalah III IWP, and the prospective Dhofar Water 2025 would not be sufficient to meet the network's total water supply needs through to the year 2026. DGW underground water will be required to meet the capacity target for all years, with the exception of 2023 where there is anticipated to be a slight shortfall against the margin, as shown in Figure 27.

Figure 27 Resource Adequacy and Development Plan – Dhofar Cities and Jabal



	2020	2021	2022	2023	2024	2025	2026
Supply Requirements				Thousand m³/d			
Peak Demand - Cities	143	157	173	191	211	232	256
Peak Demand - Jabal	50	58	68	79	91	106	123
Total Peak Demand	**193**	**216**	**241**	**270**	**302**	**338**	**379**
Total Peak Demand + Margin	**209**	**233**	**260**	**294**	**329**	**369**	**413**
Contracted Capacity							
Salalah IWPP	68	68	68	68	68	68	68
Salalah III IWP	-	114	114	114	114	114	114
Total Contracted Capacity	**68**	**182**	**182**	**182**	**182**	**182**	**182**
Prospective Capacity							
Dhofar Water 2025	-	-	-	-	-	150	150
Total Water Desalination Resources	**68**	**182**	**182**	**182**	**182**	**332**	**332**
Reserve over Peak Demand (Shortfall)	-125	-34	-59	-88	-120	-7	-47
Reserve over Peak Demand + Margin (Shortfall)	-141	-51	-79	-112	-147	-37	-82
DGW Resources							
DGW Capacity [a]	105	105	105	105	105	105	105
DGW Groundwater Supply Requirements	**105**	**34**	**59**	**88**	**105**	**7**	**47**
Reserve over Peak Demand (Shortfall)	-20	71	46	17	-15	98	58
Reserve over Peak Demand + Margin (Shortfall)	-36	54	26	-7	-42	68	23

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

SECTION 4 Procurement Activities

4.1 POWER PROJECTS

OPWP's current and near-term procurement activities for power projects include the following, and are summarized in Table 11:

- **Manah I and II Solar IPPs.** OPWP is procuring two solar PV projects at a site in Manah via a single RFP process. Both projects will have installed capacity of 500 MW, subject to site and market evaluations, and the awards will be to different bidders. The RFQ was issued in Q3 2019, and the RFP release is scheduled for Q3 2020. The projects will have successive scheduled CODs: in Q2 2023 for Manah I Solar IPP, and in Q3 2023 for Manah II Solar IPP.

- **Wind IPPs 2025.** 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. Both IPPs are expected to have a combined installed capacity of 300 MW.

- **Solar IPP 2025.** OPWP plans to launch the RFQ process for the third of the series of solar IPP procurements in Q4 2021, to achieve commercial operation in 2025. This project may also have installed capacity of 500 MW or more, subject to site and market evaluations.

- **Power 2024.** OPWP currently plans to initiate a procurement round for new PPAs that would begin operating 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. The total capacity requirement in 2024 will be determined following the outcome of Power 2022 and demand developments up to the point of RFP release as currently planned. The target capacity for procurement in Power 2024 may also be dependent upon the conclusions from the review of the capacity procurement framework.

- **Duqm Solar IPP 2026.** In 2020, OPWP is planning to conduct a feasibility study of a solar CSP plant with thermal storage, to be located in Al Wusta Governorate near to Ad Duqm. If approved, the procurement process would begin in 2021 to achieve COD in 2026. The project is being considered to have output capacity of around 300 MW from the steam turbine.

Two of the projects from the last 7-Year Statement procurement activities list are now excluded: Duqm IPP and Barka WTE IPP. The Duqm Clean Coal IPP procurement process was noted as having been put on hold, and has since been cancelled considering the promising economic potential of renewable energy projects. In 2020, the procurement of the Barka WTE IPP has been put on hold, pending a final decision from the Government.

Table 11 Procurement Activities in 2020-2021 – Power Projects

	System	Capacity	RFQ	RFP	Bids Due	Award Anticipated	SCOD
Manah I Solar IPP [a]	MIS	500 MW	Completed	Q3, 2020	Q4, 2020	Q2, 2021	Q2, 2023
Manah II Solar IPP [a]	MIS	500 MW	Completed	Q3, 2020	Q4, 2020	Q2, 2021	Q3, 2023
Jalaan Bani bu Ali Wind IPP 2025 [b]	MIS	100 MW	Q3, 2021	Q1, 2022	Q3, 2022	Q1, 2023	Q1, 2025
Duqm Wind IPP 2025 [b]	Duqm	200 MW	Q3, 2021	Q1, 2022	Q3, 2022	Q1, 2023	Q1, 2025
MIS Solar IPP 2025	MIS	500 MW	Q4, 2021	Q1, 2022	Q3, 2022	Q4, 2022	Q2, 2025
Power 2024 [c]	MIS	TBD	TBD	TBD	TBD	TBD	TBD
Duqm Solar IPP 2026 [b]	Duqm	300 MW	Q3, 2021	Q1, 2022	Q3, 2022	Q4, 2022	Q1, 2026

[a] Procurement schedule is subject to change depending on the continued developments of the COVID-19 pandemic.

[b] Project procurement is subject to the outcomes of a feasibility study to be undertaken in 2020.

[c] Possible capacity requirement and procurement timeline is likely to identified at a later point, depending upon outturn of demand growth and demand forecast updates, and assessments of capacity contributions from other resources, such as spot market and Power 2022.

Future Procurement Activities

From 2022 to 2026, OPWP plans to continue to procure new solar and/or wind IPPs on an annual basis. Depending upon demand growth and other factors, a third procurement round for existing generator contract renewals or new-build thermal projects may be initiated for operational start in 2026 or 2027 (Power 2026/27).

In addition to procurement of projects via long-term P(W)PAs, OPWP may procure short-term capacity or energy via transactions with neighbouring 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 12:

- **Barka V IWP.** OPWP plans to procure 100,000 m^3/d (22 MIGD) of desalination capacity at Barka for operation beginning in Q2 2023. The release of the RFP for this project was done in Q2 2019 and the award is anticipated to be in Q3 2020.

- **Ghubrah III IWP.** OPWP is procuring new capacity of 300,000 m^3/d (66 MIGD) at Ghubrah, on a portion of the site formerly occupied by Ghubrah IWPP. OPWP released the RFP for this project in Q2 2019 and received bids in December 2019. The Project award is expected in Q3 2020. The Early Water requirement for the project is scheduled for Q3 2023 for 150,000 m^3/d. The SCOD for full capacity is scheduled in Q4 2023.

- **North Batinah IWP.** OPWP initiated the procurement process in 2018 for new IWP capacity of 150,000 m^3/d (33 MIGD). The prequalification process for the project was completed in April 2019. The RFP is expected to be issued in Q1 2021, for award in Q4 2021 and SCOD in Q2 2025.

- **Dhofar Water 2025.** OPWP initiated the procurement process for this project in Q3 2019 for a capacity of 150,000 m^3/d (33 MIGD). Release of the RFP is planned for Q1 2021 and is subject to confirmation of land allocation and availability of transmission infrastructure.

- **Barka Water 2024.** Following the expiration of Barka II PWPA in 2024, OPWP notes that additional capacity will be required to cover the resulting deficit. Accordingly, OPWP will follow the approved procurement strategy by the Authority to procure a capacity of 120,000 m^3/d for COD in Q2 2024.

The Wadi Dayqah IWP and Masirah IWP projects were included in the list of current and near-term procurement activities in the previous 7-Year Statement. The procurement process of Wadi Dayqah IWP has been put on indefinite hold pending final approval by PAW, and Masirah IWP is suspended pending further assessments. PAW will operate Tanweer existing plant and build a new desalination plant with a capacity of 2,200 m^3/d to supply the demand in Masirah Zone.

Table 12 Procurement Activities in 2020-2021 – Water Projects

	System	Capacity	RFQ	RFP	Bids Due	Award Anticipated	SCOD
Barka V IWP	MIS	22 MIGD	Completed	Completed	Completed	Q3, 2020	Q2, 2023
Ghubrah III IWP	MIS	66 MIGD	Completed	Completed	Completed	Q3, 2020	Q1, 2024 [a]
North Batinah IWP	MIS	33 MIGD	1st Round Completed	Q1, 2021	Q2, 2021	Q4, 2021	Q2, 2025
Dhofar Water 2025[b]	Dhofar Water Network	33 MIGD	Q1, 2021	Q2, 2021	Q3, 2021	Q1, 2022	Q1, 2025

[a] Ghubrah III IWP Early Water Q3 2023 with a capacity of 150,000, with full SCOD is planned for Q1 2024.

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

Future Procurement Activities

From 2022 to 2026, OPWP may procure additional water desalination capacity projects. The analysis in section 3.1.C, Resource Adequacy and Development Plan, suggests there may be a need for additional capacity in the Muscat zone around 2026. This will be reassessed in the coming years, as the procurement process would not need to begin until 2022 for a 2026 COD. The Government is currently working on a plan to restructure 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.