الشركة العمانية لشراء الطاقة والمياه (ش.م.ع.م)
OMAN POWER AND WATER PROCUREMENT CO. (SAOC)

# OPWP's 7-YEAR STATEMENT

# (2016 – 2022)

**(Issue 10)**

## June 2016


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# GLOSSARY

| | |
|---|---|
| AER | Authority for Electricity Regulation, Oman |
| BTU/scf | British thermal units per standard cubic foot |
| CCGT | Combined-cycle gas turbine |
| DGC | Dhofar Generating Company |
| DGW | Directorate General of Water (in the Office of the Minister of State and Governor of Dhofar) |
| DPC | Dhofar Power Company (SAOC) |
| DPS | Dhofar Power System |
| GJ | Gigajoule(s) |
| GPDC | Al Ghubrah Power and Desalination Company (SAOC) |
| 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 |
| m3 | Cubic metre(s) |
| m3/d | Cubic metres per day |
| MEDC | Muscat Electricity Distribution Company (SAOC) |
| MIGD | Million imperial gallons per day |
| MIS | Main Interconnected System |
| MISC | Majis Industrial Services Company (SAOC) |
| MJEC | Majan Electricity Company (SAOC) |
| MOG | Ministry of Oil and Gas |
| MSF | Multi-stage flash (desalination technology) |
| MW | Megawatt(s) |
| MZEC | Mazoon Electricity Company (SAOC) |
| OCGT | Open-cycle gas turbine |
| OETC | Oman Electricity Transmission Company (SAOC) |
| OPWP | Oman Power and Water Procurement Company (SAOC) |
| PAEW | Public Authority for Electricity and Water |
| PDO | Petroleum Development Oman (LLC) |
| PPA | Power purchase agreement |
| PWPA | Power and water purchase agreement |
| RAEC | Rural Areas Electricity Company (SAOC) |
| RO | Reverse osmosis (desalination technology) |

| | |
|---|---|
| Sm3 | Standard cubic metre(s) |
| Sm3/d | Standard cubic metres per day |
| Twh | Terra Watt Hours |

# OVERVIEW

This Statement provides a 7-year outlook for power and desalinated water supply in the two main systems of Oman – the Main Interconnected System (MIS) and the Dhofar Power System. It also addresses OPWP's anticipated activities with respect to Ad Duqm and Musandam during this period. OPWP prepares the 7-Year Statement annually in accordance with Condition 5 of its license. This is Issue 10, for the period 2016 to 2022; previous issues and additional information are available on the OPWP website at www.omanpwp.com.

## Demand for Electricity

In the MIS, under the Expected Demand forecast, peak demand is expected to grow at about 8% per year, from 5565 MW in 2015 to 9529 MW in 2022. Energy consumption is expected to grow from about 28 TWh in 2015 to 50 TWh in 2022, also an average annual increase of 8% (corresponding to growth in average demand from 3236 MW to 5714 MW).

Two additional demand scenarios are considered: the Low Case projects 6% annual growth and peak demand at 8266 MW in 2022, nearly 1300 MW below Expected Demand. The High Case projects 10% annual growth and peak demand at 11036 MW in 2022, exceeding Expected Demand by about 1500 MW. Growth rates are somewhat lower than in recent projections, due to current economic conditions. Demand scenarios are differentiated mainly by the pace and timing of resurgent economic growth.

In Dhofar, peak demand is expected to grow at 9% per year, from 495 MW in 2015 to 884 MW in 2022. The Low Case considers 6% growth, reaching 758 MW by 2022, about 130 MW below Expected Demand. The High Case considers higher growth across all economic sectors, with peak demand increasing at 12% per year to 1089 MW in 2022, exceeding Expected Demand by about 200 MW.

## Power Generation Requirements

In the MIS, the major expected developments through 2022 include: (1) addition of two new IPPs at Ibri and Sohar, with aggregate capacity of 3240 MW to be in service in 2018 (Ibri early power) and 2019 (full power at both sites); (2) retirement of the Ghubrah and Wadi Jizzi plants in 2018; (3) extension of contracts at Al Kamil and Barka I to 2021 (subject to approvals); (4) creation of a spot market for electricity trade, to be launched around 2020; (5) transfer of the Manah IPP to the Government in December 2020; (6) contract expirations at four plants in 2021/2022 which may compete for P(W)PA extensions; and (7) development of new IPPs for service in 2021 and 2022.

In Dhofar, the Salalah 2 IPP has started construction, to provide 445 MW upon completion in January 2018.

Construction is progressing on the Musandam IPP, to supply RAECO with net firm capacity of about 123 MW, under a PPA with OPWP. The project is expected to be completed in February 2017.

## Desalinated Water Requirements

Water demand in the northern region (the Interconnected Zone and Sharqiyah Zone) is projected to increase in the range of 5% to 7% per year, from 281 million $m^3$ in 2015 to a range of 390-440 million $m^3$ in 2022.

In the Interconnected Zone, two projects achieved COD in Q1 2016: Muscat City Desalination Plant, at Ghubrah, with capacity of 191,000 $m^3$/d (42 MIGD), and the Barka I capacity addition of 57,000 $m^3$/d (12.5 MIGD). Two

major projects were awarded in 2015: Barka IV Desalination Plant (281,000 $m^3$/d, 62 MIGD) and Sohar III Desalination Plant (250,000 $m^3$/d, 55 MIGD), both for COD in May 2018.

Expected developments over the next seven years include: (1) provision of temporary water (8,000 $m^3$/d, 1.8 MIGD) in 2016 for supply to Qurayyat town; (2) completion of the Qurayyat Desalination Plant (200,000 $m^3$/d, 44 MIGD) in May 2017; (3) retirement of the Ghubrah desalination units in March 2018; (4) potential contract extensions to 2021 at Barka I; (5) prospective new desalination plants with capacity of 300,000 $m^3$/d (66 MIGD) for the Muscat/Seeb area in 2021 and with capacity of 200,000 $m^3$/d (44 MIGD) for the North Batinah area in 2022; and (6) P(W)PA contract expiration at Sohar I in March 2022.

In the Sharqiyah Zone, the principal developments include: (1) addition of 48,000 $m^3$/d (10.6 MIGD) at the Sur IWP, to be completed in Q3 2016, (2) addition of 10,000 $m^3$/d (2.2 MIGD) temporary water supply at Aseelah in 2016; and (3) addition of a new Sharqiyah IWP at Ashkharah (80,000 $m^3$/d, 18 MIGD) for service in 2019.

In Dhofar, DGW projects water demand to grow at 8%, and peak water demand to increase from 139,000 $m^3$/d in 2015 to 229,000 $m^3$/d in 2022. In 2015, OPWP initiated procurement of a new IWP with capacity of 100,000 $m^3$/d (22 MIGD) in 2019. OPWP and DGW are considering a potential second IWP for service in 2021.

OPWP also expects to procure desalination capacity of 60,000 $m^3$/d (13 MIGD) to serve Ad Duqm in 2020, and capacity of 16,000 $m^3$/d (3.5 MIGD) at Khasab in Musandam, also in 2020.

## 2016 Procurement Activities

In 2016, OPWP expects the following procurement activities for the MIS: (1) finalize contract extension agreements with the owners of Al Kamil and Barka I plants; (2) issue tender documents for 800 MW of new IPP capacity for 2021 COD; (3) develop a new procurement methodology allowing existing plants to compete for P(W)PA extensions with new capacity; (4) issue tender documents for the Sharqiyah IWP and for new desalination capacity to serve Muscat/Seeb; and (5) issue tender documents for up to 100,000 $m^3$/d (22 MIGD) of mobile, temporary water capacity.

In Dhofar, OPWP expects to issue tender documents for the Salalah III Desalination Plant, to be in service by 2019. OPWP also expects to execute a PPA with RAECO for a 50 MW wind farm being developed in Harweel in association with MASDAR of Abu Dhabi.

OPWP expects to procure new IWPs at Khasab in Musandam (16,000 $m^3$/d, 3.5 MIGD) and Ad Duqm (60,000 $m^3$/d, 13 MIGD) for service in 2020.

## Fuel Requirements

In the MIS, efficiency improvements in the generation fleet are expected to limit growth in fuel requirements to 4% per year through 2022, despite 8% growth in electricity production. Average gas utilization by the generation fleet ($Sm^3$ consumed per MWh produced) is projected to improve by 25% from 2015 to 2022.

In Dhofar, gas requirements are also projected to increase at 5% per year, as power requirements grow at about 9% per year. Average gas utilization in the Dhofar power system is projected to improve by about 27% during this period.

# SECTION 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 864,500 electricity customers.*

*The MIS comprises a number of power generation facilities, owned and operated by various 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 presently interconnected with the power systems of Petroleum Development Oman (PDO), the Emirate of Abu Dhabi and other Member States of the GCC Interconnection Authority.*

*Several of the power generation facilities connected to the MIS produce desalinated water in conjunction with electricity, to meet the regional requirements of "water departments" responsible for supplying water to customers (including the Public Authority for Electricity and Water (PAEW) and Majis Industrial Services Co. (MISC)). Several water-only desalination plants also supply these water departments.*

*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 PAEW in accordance with Article 78 of the Sector Law.*

## 1.1 DEMAND FOR ELECTRICITY

OPWP evaluates electricity demand at the system level, including transmission and distribution system losses with consumer-level loads. This equates with the output of power generation plants at the delivery point(s) to the power system, excluding the internal power consumption of auxiliary systems.[1] OPWP follows a similar approach with respect to estimating water demand, the output of desalinated water plants, and the consumption of auxiliary systems of combined power and water plants.

[1] 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.

### *Historical Demand*

The power demand in MIS increased significantly in 2015. Peak demand increased by about 8.6% to 5565MW, while average demand increased by 11% to 3156 MW (corresponding to 27.6 TWh of energy).

Looking back over the last 7 years, peak electricity demand in the MIS grew at an average annual rate of about 9%, from 3031 MW in 2008 to 5565 MW in 2015. Energy consumption (and average demand) has grown by about 10% 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 2% to a high of 15%.

### *Demand Projections*

OPWP's 7-year electricity demand projections for the MIS have been developed on the basis of: (1) consultations with the electricity distribution companies and other relevant entities such as large industries; (2) historical growth trends in aggregate and in distribution areas; (3) assessment of past forecasts against out-turns; and (4) quantitative analysis of weather and macroeconomic effects.

The projections cover both energy (also shown as average demand) and peak demand. The latter is most relevant for purposes of assessing capacity requirements. This accords with the basis on which OPWP transacts with power and desalination plants. Energy projections are necessary towards securing the fuel requirement for power generation.

The projections are built up from separate analyses of distribution system demands, which are assessed on a "macro" basis by distribution company zones, and certain bulk loads that are connected directly to the transmission system and which 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 large-scale industrial demands in all MIS regions. The principal growth drivers include population growth, household formation, general economic development and infrastructure expansion.

The growth in demand from grid-connected 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 stand-alone desalination plants and airports.

The projections are presented as a range bounded by Low Case and High Case scenarios, and a central, Expected Demand forecast. They are summarized in Figure 1 below.

The steep fall in oil prices throughout 2015 has made the outlook for electricity demand, and for the general economic growth which drives it, more uncertain than in recent years. Demand growth in 2015 was strong even as economic growth is estimated to have been weak. However, past trends in electricity demand and GDP growth show a lagged relationship: electricity demand growth is driven by economic growth in preceding years as well as in the current year. We expect electricity demand growth to slow in response to the recent economic weakness, and then to accelerate again as the economy improves. The timing of the economic and demand upturns is uncertain.

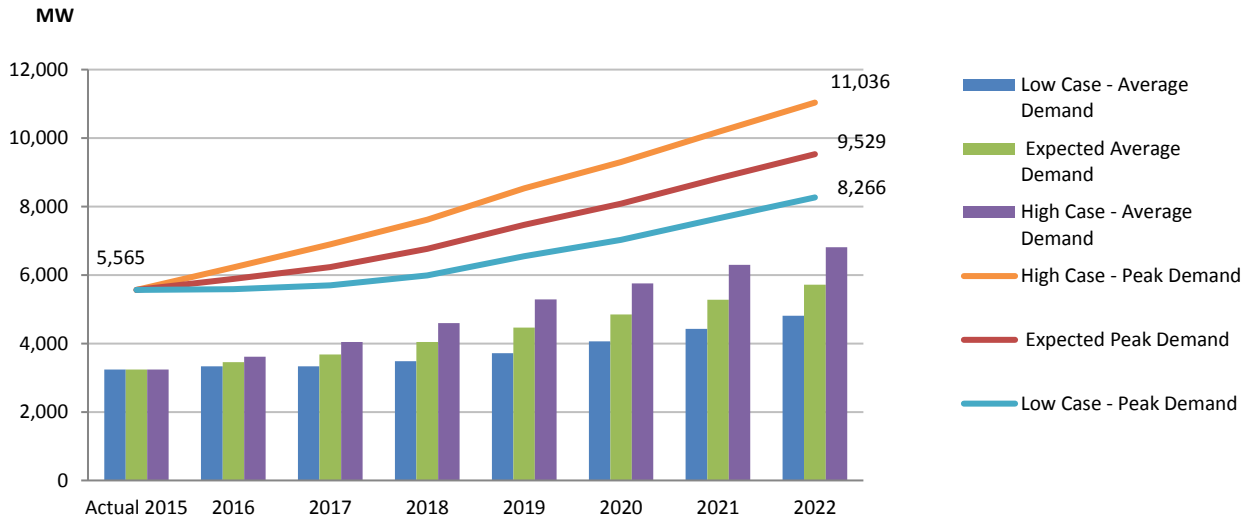
The High Case scenario for electricity demand assumes that global oil prices and the Sultanate's economy improve relatively quickly. The projection assumes a short near-term downturn in underlying demand growth. It also considers the potential effect of warmer-than-average weather in any given year. Industrial output is expected to increase as commodity prices rise, contributing to higher energy (average demand) growth as well. This case would have parallels to the rapid recovery experienced following the brief plunge in oil prices around

2008-2009. On average over the next seven years, this scenario has peak demand growth of 10% per year and energy growth of 11% per year. This High Case scenario is similar to the previous 7-Year Statement in terms of final outcome, except that near-term growth (2016-2018) is substantially less.

The Low Case scenario assumes a steep reduction in demand growth in the near term, followed by a gradual recovery to the Sultanate's long-term growth rate. Industrial output is assumed to remain slow, with unutilized capacity as currently, and then to increase steadily from 2019 onwards. Tariff reform and cost-cutting measures being considered by the Government are also assumed to be implemented and to produce a consumer response. Opposite to the High Case, this scenario also reflects the demand impact of a milder-than-average summer in any given year. On average over the 7-year period, this scenario has peak demand and energy growth of 6% per year. That is substantially lower than the Low Case growth rates from the previous 7-Year Statement (about 8% per year).

The Expected Case scenario is approximately mid-way between the two extremes, and assumes normal weather conditions. It projects peak demand to grow at about 8% per year, from 5565 MW in 2015 to 9529 MW in 2022. Energy consumption is projected to grow at about 8.5% per year, from 28.4 TWh in 2015 to 50.1 TWh in 2022 (in average demand terms, from 3236 MW to 5714 MW). This projection is lower than that of the previous 7-Year Statement, particularly in 2016-2017 when the growth rate may be only around 6%. However, the average growth rate represents a reduction of only 0.5% per year below that of the most recent seven years, indicative of a robust economic recovery following a temporary lull. This is consistent with government development commitments expressed in the recently released 5-year economic plan.

**Figure 1 Electricity Demand Projections –MIS**




| | Actual 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | Ave.% Growth |
|---|---|---|---|---|---|---|---|---|---|
| **Expected Demand** | | | | | | | | | |
| Average Demand (MW) | 3,236 | 3,457 | 3,683 | 4,045 | 4,468 | 4,849 | 5,279 | 5,714 | 8% |
| Distribution Loads | 2,904 | 2,991 | 3,135 | 3,300 | 3,555 | 3,848 | 4,197 | 4,557 | 7% |
| Directly-Connected Loads | 331 | 466 | 548 | 746 | 913 | 1,001 | 1,082 | 1,157 | 20% |
| **Annual Energy (TWh)** | **28** | **30** | **32** | **35** | **39** | **43** | **46** | **50** | **8%** |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Peak Demand (MW)** | **5,565** | **5,885** | **6,229** | **6,764** | **7,470** | **8,084** | **8,818** | **9,529** | **8%** |
| *Change from 2015-2021 Statement (MW)* | *-88* | *-340* | *-568* | *-700* | *-606* | *-691* | *-712* | - | - |
| **Low Case Demand** | | | | | | | | | |
| Average Demand (MW) | 3,236 | 3,333 | 3,333 | 3,479 | 3,717 | 4,064 | 4,424 | 4,811 | 6% |
| Distribution Loads | 2,904 | 2,888 | 2,874 | 2,937 | 3,081 | 3,291 | 3,570 | 3,873 | 4% |
| Directly-Connected Loads | 331 | 445 | 459 | 542 | 636 | 773 | 854 | 938 | 16% |
| **Annual Energy (TWh)** | **28** | **29** | **29** | **30** | **33** | **36** | **39** | **42** | **6%** |
| **Peak Demand (MW)** | **5,565** | **5,587** | **5,695** | **5,987** | **6,547** | **7,023** | **7,655** | **8,266** | **6%** |
| *Change from 2015-2021 Statement (MW)* | *225* | *-127* | *-471* | *-688* | *-636* | *-703* | *-717* | - | - |
| **High Case Demand** | | | | | | | | | |
| Average Demand (MW) | 3,236 | 3,609 | 4,048 | 4,598 | 5,286 | 5,753 | 6,296 | 6,816 | 11% |
| Distribution Loads | 2,904 | 3,077 | 3,403 | 3,685 | 4,074 | 4,468 | 4,901 | 5,326 | 9% |
| Directly-Connected Loads | 331 | 532 | 645 | 913 | 1,212 | 1,285 | 1,396 | 1,489 | 24% |
| **Annual Energy (TWh)** | **28** | **32** | **35** | **40** | **46** | **51** | **55** | **60** | **11%** |
| **Peak Demand (MW)** | **5,565** | **6,223** | **6,899** | **7,616** | **8,530** | **9,301** | **10,180** | **11,036** | **10%** |
| *Change from 2015-2021 Statement (MW)* | *-387* | *-455* | *-409* | *-426* | *-194* | *-236* | *-149* | - | - |

### *Trade and Reserves Sharing with Interconnected Systems*

The MIS is interconnected with the PDO power system at Nizwa through a 132 kV link, and with the power system of the Emirate of Abu Dhabi through a 220 kV link at Mahadha. These interconnections provide reliability benefits through the sharing of generation reserves. Oman also joined the GCC Interconnection Authority (GCCIA) in December 2014, enabling access to the power systems of other Member States via the UAE interconnect. GCCIA membership provides access to generation and operating reserves, with tangible benefits to Oman both for planning and operations. The GCCIA is also developing mechanisms for commercial power trading among Member States. The current MIS demand projections do not include power exports or imports, comprising only the native demands of the MIS.

## 1.2 POWER GENERATION RESOURCES

### *Sources of Power*

In order to meet demand for electricity in the MIS, 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 (and desalination) 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"***. Temporary generation also belongs with this group.

OPWP also purchases power from a number of sources where the contractual arrangements do not provide sufficient reliability for resource adequacy plans. These may be termed collectively as **"non-firm resources"**. They currently include reserve-sharing arrangements with other power systems via interconnection agreements, and capacity exchanges or energy purchases from industries with captive power generation facilities used mainly for self-supply. In these cases no specific capacity is committed to OPWP, and the availability of capacity for use by OPWP at any particular time will generally be subject to the other party's first use. These resources provide reliability benefits to the MIS, in that capacity is generally available according to pre-arranged schedules (though not *committed* as dispatch-able capacity). Importantly, some of these resources may represent prospective contractual opportunities for firm, dispatch-able capacity (such as the interconnects) in the future.

In addition to the resources currently under contract, there are **"prospective resources"** that are under consideration by OPWP. For example, power plants that will fall out of contract during this seven-year period are prospective resources after their contract expiry, in that they may be offered successfully for re-contracting, subject to regulatory approval. This category also includes resources that are under evaluation or for which the tendering process has begun but is not complete.

### *Contracted Capacity*

OPWP's present portfolio of contracted capacity in the MIS comprises thirteen P(W)PAs. Summary details are shown in Table 1 below.

**Table 1 Details of P(W)PAs – MIS**

| Plant | Contracted Capacity[a] | Contract Type | Plant Owner | Plant Status | Plant Type | Contract Expiry[b] |
|---|---|---|---|---|---|---|
| Ghubrah[c] | 430MW<br>167,000 $m^3/d$ | PWPA | Al Ghubrah Power and Desalination Co. (SAOC) | Operational | OCGT/Steam<br>MSF Desalination<br>Natural gas fired<br>(Fuel oil as back-up) | 2018 |
| Rusail | 665 MW | PPA | Rusail Power Co. (SAOC) | Operational | OCGT<br>Natural gas fired<br>(Fuel oil as back-up) | 2022 |
| Wadi Jizzi | 325 MW | PPA | Wadi Al-Jizzi Power Co. (SAOC) | Operational | OCGT<br>Natural gas fired<br>(Fuel oil as back-up) | 2018 |
| Manah | 254 MW | PPA | United Power Co. (SAOG) | Operational | OCGT<br>Natural gas fired<br>(Fuel oil as back-up) | 2020[d] |
| Al Kamil | 271 MW | PPA | Al Kamil Power Co. (SAOG) | Operational | OCGT<br>Natural gas fired<br>(Fuel oil as back-up) | 2017 |
| Barka I | 427 MW<br>91,000 $m^3/d$ | PWPA | ACWA Power Barka (SAOG) | Operational | CCGT<br>MSF Desalination<br>Natural gas fired<br>(Fuel oil as back-up) | 2018 |
| | 45,000 $m^3/d$ | WPA | ACWA Power Barka (SAOG) | Operational | RO | 2018 |
| | 57,000 $m^3/d$ | WPA | ACWA Power Barka (SAOG) | Operational | RO | 2018 |
| Sohar I | 585 MW<br>150,000 $m^3/d$ | PWPA | Sohar Power Co. (SAOG) | Operational | CCGT<br>MSF Desalination<br>Natural gas fired<br>(Fuel oil as back-up) | 2022 |
| Barka II | 677 MW<br>120,000 $m^3/d$ | PWPA | SMN Barka Power Co. (SAOC) | Operational | CCGT<br>RO Desalination<br>Natural gas fired<br>(Fuel oil as back-up) | 2024 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Sohar II | 741 MW | PPA | Al Batinah Power Co. (SAOC) | Operational | CCGT Natural gas fired (Fuel oil as secondary fuel and back-up) | 2028 |
| Barka III | 741 MW | PPA | Al Suwadi Power Co. (SAOC) | Operational | CCGT Natural gas fired (Fuel oil as secondary fuel and back-up) | 2028 |
| Sur | 2000 MW | PPA | Phoenix Power Co. (SAOC) | Operational | CCGT Natural gas fired (Fuel oil as back-up) | 2029 |
| Ibri | 1509 MW | PPA | Ad'Dhahirah Generation Company | Under Construction | CCGT Natural gas fired (Fuel oil as back-up) | 2034 |
| Sohar IV | 1710 MW | PPA | Shinas Power Company | Under Construction | CCGT Natural gas fired (Fuel oil as back-up) | 2034 |

*[a] Contracted capacities are shown as of summer 2014, at reference condition 50°C.The contracted capacities are reported as net of plant auxiliaries except for Ghubrah, Rusail, and Wadi Jizzi which are contracted at gross capacity. Plant capacities are shown elsewhere in this report as evaluated at 45°C, which is more in line with peak demand conditions, and as net output rather than gross output.*
*[b] In all cases except Ghubrah and Wadi Jizzi, the contracts expire prior to the summer period of the year indicated. Ghubrah and WadiJizzi contracts will expire in September 2018.*
*[c] GTs 11, 5, and 8, and ST4 at Ghubrah were retired in 2014.*
*[d] Manah will be transferred from UPC to the Government on 31 December 2020.*

A summary of the generation capacity that is expected to be provided under these P(W)PAs over the 2016-2022 period is set out in Figure 2. This shows total contracted capacity of 7180 MW in 2016, rising to 8968 MW by 2019 before falling back to 7468 MW by 2022 due to contract expirations. The main developments over the 7-year period are:

- **Ghubrah.** The contracts for several GT units have been extended up to 30 September 2018, such that generation capacity is 405 MW from 2016 to September 2018, when the plant will be retired.
- **Wadi Jizzi.** The contracts for several GT units have been extended, and all remaining units have coterminous contract expiration on 30 September 2018. The plant is planned for retirement at that time. The total capacity from Wadi Jizzi is 326 MW.
- **Al Kamil.** OPWP has reached a standstill agreement with the owner on the terms for contract extension from 2017 to 31 December 2021, pending regulatory approval. The total contracted capacity is 280 MW. The plant is expected to be available for further contract extension after 2021.
- **Barka I.** OPWP and the owners are considering extension of the PWPA to 31 December 2021. The expected arrangement would provide contracted capacity of 388 MW during normal operation in CCGT mode without MSF water production. It would also provide that in case of emergency need for production of water, then the MSF facility may be called into operation, and in this operating mode the power capacity would be 435 MW. The plant is expected to be available for further contract extension after 2021.
- **Manah.** The PPA expires in December 2020, at which time ownership of the plant transfers to the Government. OPWP is considering several options for the continued operation of the plant, including a competitive tender for sale of the asset, backed by a multi-year PPA with OPWP. The capacity is 264 MW.

- **Ibri.** Awarded in December 2015 to Ad Dhahirah Generation Company, the plant is under construction and scheduled to deliver early power capacity of 990 MW from April to October 2018 and full power capacity of 1520 MW from 1st April 2019.

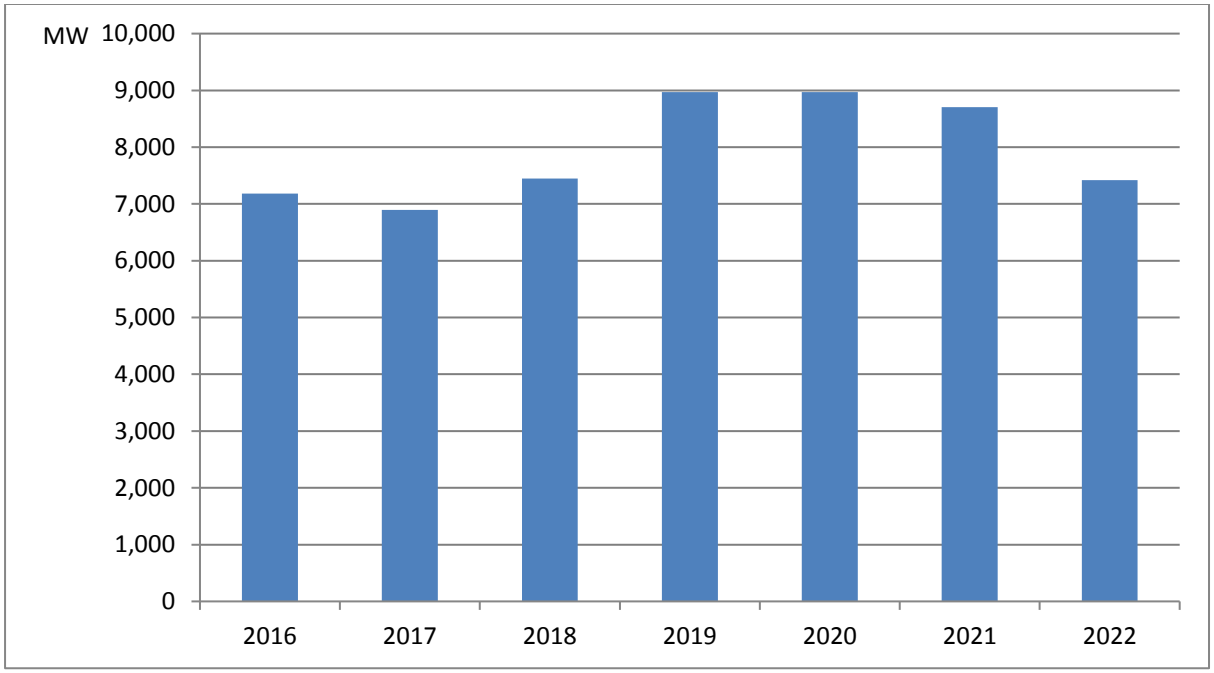
- **Sohar IV** Awarded in December 2015 to Shinas Power Company, the plant is under construction and scheduled to deliver full power capacity of 1720 MW from 1st January 2019.

- **Sohar I.** The PWPA will expire on 31st March 2022. The plant is expected to be available for contracting under a new P(W)PA, although potentially under a power-only operating mode similar to Barka I. The capacity is 597 MW.

- **Rusail.** The PPA will expire on 31st March 2022. The plant is expected to be available for contracting under a new PPA. The capacity is 689 MW.

As indicated above, a number of plants will reach the end of their current contract terms in 2021 and 2022. Their owners will have the opportunity to offer these plants for new long-term PPAs in a competitive tender expected to be issued in 2017.

**Figure 2 Contracted Generation Capacity – MIS**




| Capacity as Currently Contracted | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|---|
| | Net MW [a] | | | | | | |
| Ghubrah | 405 | 405 | 405 | - | - | - | - |
| Rusail | 689 | 689 | 689 | 689 | 689 | 689 | - |
| Wadi Al Jizzi | 326 | 326 | 326 | - | - | - | - |
| Manah[b] | 264 | 264 | 264 | 264 | 264 | - [b] | - [b] |
| Al Kamil[c] | 280 | -[c] | -[c] | -[c] | -[c] | -[c] | - |
| Barka I[c] | 435 | 435 | -[c] | -[c] | -[c] | -[c] | - |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Sohar I | 597 | 597 | 597 | 597 | 597 | 597 | - |
| Barka II | 688 | 688 | 688 | 688 | 688 | 688 | 688 |
| Sohar II | 754 | 754 | 754 | 754 | 754 | 754 | 754 |
| Barka III | 754 | 754 | 754 | 754 | 754 | 754 | 754 |
| Sur | 1988 | 1985 | 1983 | 1982 | 1982 | 1982 | 1982 |
| Ibri IPP | - | - | 990 | 1520 | 1520 | 1520 | 1520 |
| Sohar IV | - | - | - | 1720 | 1720 | 1720 | 1720 |
| **TOTAL** | **7180** | **6897** | **7450** | **8968** | **8968** | **8704** | **7418** |

[a] All capacities are rated on a net basis (i.e. after allowing for auxiliary consumption inside the plants) at 45°C ambient temperature.
[b] The contract with the current owner will expire at the end of 2020, when ownership of the plant transfers to the Government.
[c] Contract extensions to 2021 are currently under negotiation or pending approvals.

### *Non-Firm Resources under Contract*

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

- the 220 kV interconnect with the Abu Dhabi power system at Mahadha;
- the 132 kV interconnect with the PDO power system at Nizwa; and
- the surplus generation of industries (and other parties) with captive power generation facilities used mainly for self-supply.

A 220 kV interconnection between the Oman (MIS) and UAE (Abu Dhabi) power systems was commissioned in 2011 and has been commercially operational since May 2012. In December 2014 Oman officially joined the GCCIA, accessed via this link. Several benefits can be realized from the interconnector and GCCIA membership:

1- Reduced Planning Reserve Requirements, potentially allowing the MIS to maintain a lower reserve margin over peak demand to meet its statutory reliability standard;

2- Reduced Operating Reserve Requirements, allowing fewer units to be in standby operation or maintaining spinning reserves and thus allowing the power system to operate more efficiently in dispatch;

3- Firm support during emergencies up to 6 hours for each incident and up to 18 hours in a year.

4- Opportunities for trading power with other member states, including firm capacity contracts which may be considered for example as an alternative to temporary diesel generation. There may also be opportunities for firm capacity exchanges, exploiting differences in seasonal peak periods between Oman and the other member states.

The existing double circuit link currently supports reliable transfers of up to 400 MW. It is technically capable to carry up to 800 MW in emergencies, and has proven this latter capacity during performance tests. The link is being utilized actively to provide emergency reserves support to the benefit of Oman, the UAE, and other GCCIA member countries.

The MIS is connected with the power system of PDO at Nizwa via a single 132 kV link with a nominal transfer capacity of around 60 MW. The main purpose of this interconnect is to support reserve sharing between the MIS and the PDO system, providing improved reliability in both systems by allowing each system access to unused reserve in the other system in contingency scenarios. Thus, subject to the availability of surplus

generation in the PDO system at the time required, up to around 60 MW of support can be provided to the MIS to help manage contingencies.

Several industries with captive power plants are connected with the MIS and have surplus power that may be purchased by OPWP. OPWP has an agreement with Sohar Aluminium Co. (LLC), whereby Sohar Aluminium exports up to 180 MW to the MIS during the summer, and imports a like amount of energy from OPWP during the winter on an annually determined schedule.[2] The schedule and operations are managed to assure that energy exports balance with energy imports. This arrangement benefits both parties: Sohar Aluminium is better able to schedule the maintenance of its generating units and gains reliability of supply, while OPWP gains an efficient generating resource during the summer and improves the system Load Factor. The agreement with Sohar Aluminium (180 MW) was renewed in 2015 for three years and is expected to be available for future renewal subject to mutual agreement.

### *Prospective Resources*

Toward considering how to meet generation capacity requirements as projected power demand overtakes contracted capacity, OPWP assesses various prospective resources. These resources include the following:

- Contract extensions
- Planned capacity additions, not yet contracted
- Temporary generation from rented, mobile generators
- Capacity purchases from interconnected power systems or industrial self-generation
- Demand response
- Non-P(W)PA committed capacity under the Spot Market
- Renewable energy projects

*Contract Extensions.* Prospective contract extensions correspond to capacity that is scheduled to fall out of contract, but that may be offered to OPWP by the plant owner for a new contract term (subject to satisfaction of relevant regulatory requirements and commercial terms being agreed). OPWP considers such extensions alongside options to contract for new capacity.

In 2015, OPWP extended contracts for the Ghubrah and Wadi Jizzi plants up to 2018. OPWP has reached standstill agreement with the owners of Al Kamil and Barka I for contract extension to 2021, pending regulatory approval. OPWP is currently developing a new capacity procurement methodology that will allow existing generators, those approaching contract expiration, to compete for new long-term contracts. The first capacity procurement to use this new methodology is expected to be for contract terms beginning in 2022.

Table 2 identifies the plants and capacity that are currently scheduled to fall out of contract from 2017 to 2022, showing them as prospective contract extensions. All of these plants, except Manah, are currently expected to compete for new P(W)PA contracts beginning in 2022. For planning purposes, their current capacity is nominally assumed to be what may be offered for extension. However, only capacity offers that are competitive with new generation bids are likely to be extended through the procurement process.

[2] The Sohar Aluminium plant has the capability to export up to about 350 MW under supplementary firing, by special arrangement. This capacity level has not been demonstrated on a sustainable basis but is considered as an emergency reserve in case of temporary need.

Manah is a unique case, because the asset transfers to the Government at the expiration of the current PPA in December 2020. OPWP is considering several options to allow operations to continue under a new PPA, including a possible sale of the asset in a competitive tender.

**Table 2 Prospective Contract Extensions**

| | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|
| | | | Net MW [a] | | | |
| Manah [b] | - | - | - | - | 264 [b] | 264 [b] |
| Al Kamil [c] | 280 [c] | 280 [c] | 280 [c] | 280 [c] | 280 [c] | 280 |
| Barka I [c] | - | 388 [c] | 388 [c] | 388 [c] | 388 [c] | 388 |
| Rusail | - | - | - | - | - | 689 |
| Sohar I | - | - | - | - | - | 597 |
| **TOTAL** | **280** | **668** | **668** | **668** | **932** | **2218** |

[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] After transfer to the Government, Manah is expected to continue in service under a new PPA commencing in January 2021, although ownership options are still under consideration.
[c] Al Kamil and Barka I are currently in the process of negotiations for contract extension to 2021. They will be eligible to bid in a competitive process for new P(W)PAs commencing in 2022.

*Planned Capacity Additions.* OPWP procures new I(W)PP capacity to meet long-term requirements through a competitive process. OPWP plans to issue a tender in 2016 for an IPP with capacity of about 800 MW for COD in 2021.

In addition, following regulatory approval of the new procurement methodology, expected in 2017, OPWP also plans to procure approximately 2700 MW of capacity for operation beginning in 2022. Both out-of-contract generators (indicated in Table 2 above, except Manah) and prospective new entrants may bid for this capacity. The new IPP portion of this new capacity may be in the range of 800 MW to 1300 MW, or possibly more, depending on the level of contract extensions and the outcome of the competition process.

*Temporary Generation.* OPWP currently has no plans to contract for temporary generation. OPWP has rented diesel generators for short periods on occasion to avert the risk of a supply shortage, such as due to project delay. Temporary generation is considered to be a reliable contingency resource that can be procured within a relatively short period of identifying a capacity need.

*Capacity Purchases from Other Systems.* Energy trades or firm capacity purchases from neighboring power systems are important potential contingency resources. OPWP is working with OETC, AER and GCCIA to finalize the access conditions that will facilitate trade agreements. The access conditions will establish rules and procedures that will allow Oman to import, export, or exchange power with the other GCCIA member states. OPWP has arranged a trial capacity exchange in 2016, toward enabling this option as a confirmed alternative to current contingency resources such as temporary diesel generation.

OPWP is also exploring a prospective 400 kV interconnection from Nizwa to Duqm, PDO, and the Dhofar Power System. OPWP, OETC and PDO are working together under a Memorandum of Understanding (MOU) to evaluate costs and benefits of the interconnection, and to define the operating procedures needed to assure that benefits are realized. The expected benefits include fuel savings due to improved dispatch coordination among the power systems, access to areas with renewable energy potential, sharing of spinning reserves (reducing operating costs), and improved grid security. The work being performed under the MOU is intended to support a decision about whether to construct the interconnection, and the recommended timing.

*Demand Response.* OPWP completed a preliminary assessment of Demand Response (DR) in 2015, focusing on large industrial customers. Proof-of-concept trials are planned for 2016, to evaluate potential contracting and scheduling mechanisms. This program aims to yield dispatch-able peak demand reduction on a contractual basis from 2017 onwards.

*Electricity Spot Market.* OPWP is currently developing the detailed market rules for a wholesale electricity spot market. The market is scheduled to begin operational trials in 2019 and commercial operation in 2020. The spot market for electricity will operate alongside the existing system of long-term PPAs and PWPAs. The market rules will be generally modelled on those that have been developed in other countries with certain modifications relevant to Oman.

The spot market is expected to increase the potential for competition in Oman's power generation market, and to provide a mechanism to make available additional capacity that might otherwise not be readily accessible. This may include capacity associated with generators whose long-term supply contracts have expired, or capacity in excess of contractually guaranteed capacity that plant owners have built into their facilities or that may be available under certain operating conditions. Prospective market participants are also expected to include captive power plants and others that are not currently contributing to grid supply. At present, OPWP has not assessed any value to potential additional peak capacity that may be made available via the spot market.

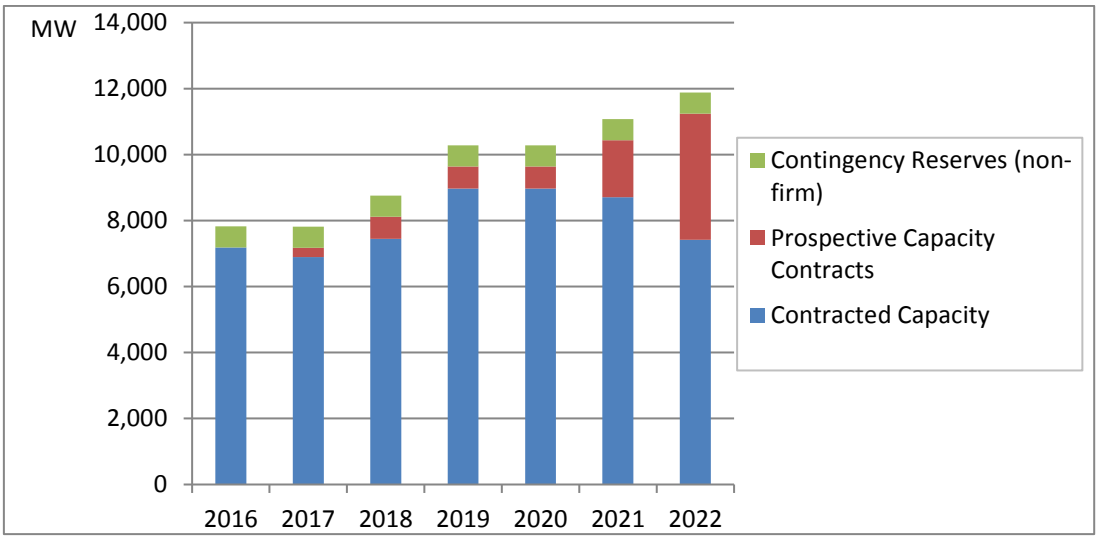
*Renewable Energy.* OPWP currently has no definitive plans to procure renewable energy (RE) projects for the MIS. However, the Government has recently issued an approval in concept for construction of such projects subject to satisfaction of technical and economic assessments. OPWP is working with the AER in 2016 to specify the evaluation terms that will enable large-scale, grid-connected RE projects to participate in competitive tenders for generation supply.

### *Summary*

Figure 3 below provides a summary of OPWP's current plans for generation resources in the MIS for the period 2016 to 2022, including contracted capacity, prospective contracts, and contingency reserves. As described above, contracted capacity in each year considers only existing, contracted resources up to the end of their current contract period. Prospective resources include planned new capacity and potential contract extensions. In future, prospective resources may include capacity purchases via the interconnects, demand response, or temporary generation. OPWP is currently developing procurement processes that would allow demand response and capacity purchases to be considered as firm capacity alternatives to temporary generation. The capacity indicated for each year corresponds to the quantity available as of the onset of the summer peak season in May.

Contingency reserves comprise the non-firm resources, including reserve-sharing over the interconnects, and industrial surplus generation.

## Figure 3 Total Power Generation Resources – MIS




| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|---|
| **Contracted Capacity** | | | | Net MW a | | | |
| Currently Contracted Capacity | 7180 | 6897 | 7450 | 8968 | 8968 | 8704 | 7418 |
| **Prospective Capacity Contracts** | | | | | | | |
| Contract Extensions | - | 280 | 668 | 668 | 668 | 932 | 2218 |
| Prospective New IPP I | - | - | - | - | - | 800 | 800 |
| Prospective New IPP II | - | - | - | - | - | - | 800 |
| Short-term Resources [b] | - | TBD [b] | TBD [b] | TBD [b] | TBD [b] | TBD [b] | TBD [b] |
| **Total – Contracted + Prospective** | **7180** | **7177** | **8118** | **9636** | **9636** | **10436** | **11236** |
| **Contingency Reserves (non-firm)** | | | | | | | |
| Reserve-Sharing Agreements | | | | | | | |
| PDO Interconnection | 60 | 60 | 60 | 60 | 60 | 60 | 60 |
| GCC Interconnection | 400 | 400 | 400 | 400 | 400 | 400 | 400 |
| Surplus Generation Agreements | | | | | | | |
| Sohar Aluminum Co. [c] | 180 | 180 | 180 | 180 | 180 | 180 | 180 |
| **Total Contingency Reserves** | **640** | **640** | **640** | **640** | **640** | **640** | **640** |
| **All Resources** | **7820** | **7817** | **8758** | **10276** | **10276** | **11076** | **11876** |

[a] All the MW figures are at 45 deg. C

[b] TBD: To be determined, This represents potential firm capacity resources that may be contracted if needs arise, or subject to economic benefit. They include Demand Response, capacity purchases (such as import from GCCIA member states), and temporary generation.

[c] Sohar Aluminum can deliver around 350 MW for a short period with special arrangement

## 1.3 ADDITIONAL POWER GENERATION REQUIREMENTS

### *Statutory and Regulatory Requirements*

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

The generation security standard stipulated by the AER sets a maximum duration of power outage for the system, termed Loss-of-Load Hours ("LOLH"). OPWP must enter into agreements for enough *contracted capacity* to ensure that expected demand does not exceed available contracted capacity for more than 24 hours in any year. This LOLH measure considers relevant uncertainties such as the reliability of generation units. On a short-term basis, OPWP must demonstrate to the AER that such agreements are in place. 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).

It is important to note that for purposes of the 24-hour LOLH standard, only contracted capacity is considered. Other resources, such as the surplus generation of industries and reserve sharing arrangements with interconnected systems, provide a degree of reserve margin and will generally contribute to reliability of supply. However, they are not considered for purposes of meeting the 24-hour LOLH standard and are viewed instead as providing security against contingencies.

### *Capacity Requirements*

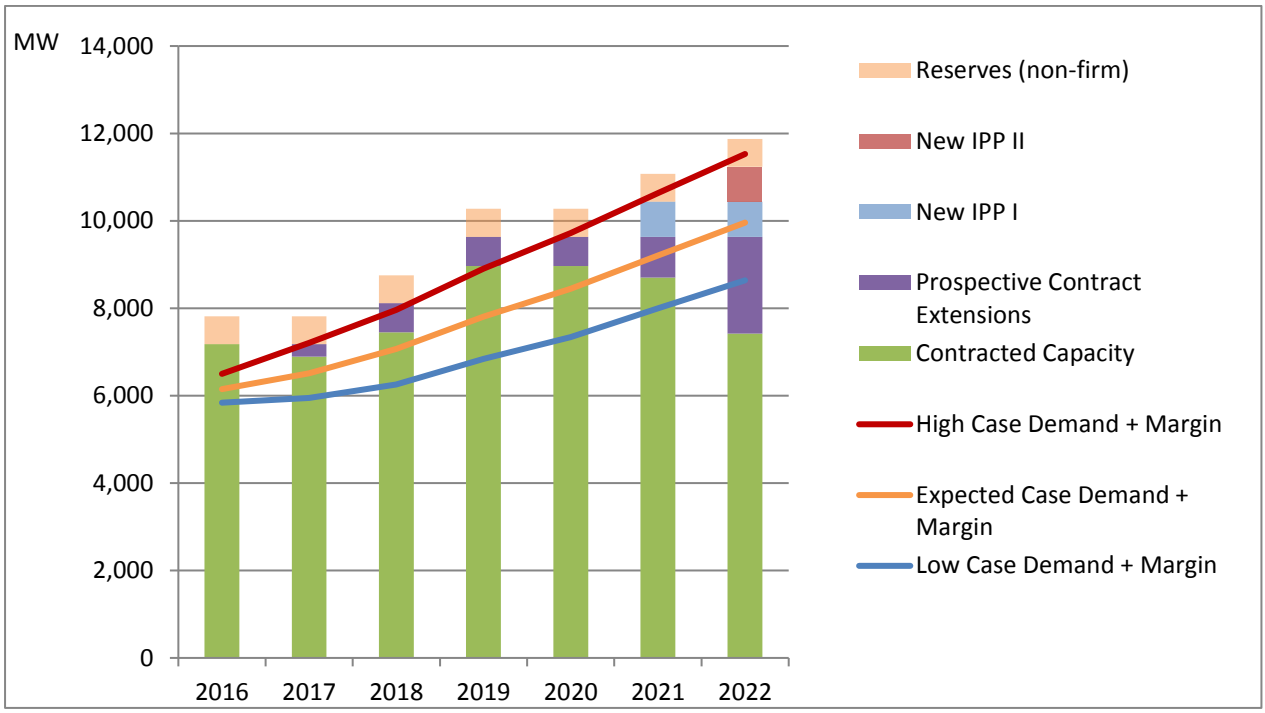
During the 7-year planning horizon, the 24-hour LOLH standard corresponds to a reserve margin requirement of about 4.5% in the MIS. That is, in each year OPWP should have sufficient contracted capacity to exceed peak demand by at least 4.5%. Figure 4 below compares generation resources to capacity targets (peak demand plus 4.5%) associated with each of the three demand scenarios. The table associated with Figure 4 indicates whether additional capacity is needed to meet the target, in the rows marked "Deficit (Additional Capacity Required)".

Under the Expected Demand scenario, contracted capacity should exceed the sum of peak demand and the margin required to meet the 24 LOLH standard (i.e., the capacity requirement). A deficit implies a need to acquire additional resources. Non-firm contracted resources are not considered in assessing available capacity to meet Expected Demand.

### *Capacity Balance from 2016 to 2017*

In 2016 the contracted capacity (7180 MW) is sufficient to meet requirements under all three demand scenarios. In 2017, contracted capacity is also sufficient under the Expected Demand and Low Case scenarios, while in the High Case scenario there is a very modest deficit of 33 MW (provided the expected contract extension at Al Kamil). This is within the range of contingency resources, which can be arranged in 2017 if the deficit is confirmed.

## Figure 4 Future Power Generation Capacity Requirements – MIS




| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|---|
| **Generation Resources** | | | | MW | | | |
| Contracted Capacity | 7180 | 6897 | 7450 | 8968 | 8968 | 8704 | 7418 |
| Prospective Contract Extensions | - | 280 | 668 | 668 | 668 | 932 | 2218 |
| Prospective New IPP I | - | - | - | - | - | 800 | 800 |
| Prospective New IPP II | - | - | - | - | - | - | 800 |
| Reserves (non-firm) | 640 | 640 | 640 | 640 | 640 | 640 | 640 |
| **Total – Contracted + Prospective** | **7,180** | **7,177** | **8,118** | **9,636** | **9,636** | **10,436** | **11,236** |
| **Total - All Resources** | **7,820** | **7,817** | **8,758** | **10,276** | **10,276** | **11,076** | **11,876** |
| **Expected Demand Scenario** | | | | | | | |
| Peak Demand | 5,885 | 6,229 | 6,764 | 7,470 | 8,084 | 8,818 | 9,529 |
| Capacity Required (Demand + Margin) | 6,150 | 6,510 | 7,070 | 7,810 | 8,450 | 9,210 | 9,960 |
| **Deficit (Additional Capacity Required)** | | | | | | | |
| *Above Current Contracts* | - | - | - | - | - | *506* | *2,542* |
| *Above Current + Extensions* | - | - | - | - | - | - | *324* |
| *Above Current + All Prospective* | - | - | - | - | - | - | - |
| *Above Current + All Prospective + Reserves* | - | - | - | - | - | - | - |
| **Low Case Scenario** | | | | | | | |
| Peak Demand | 5,587 | 5,695 | 5,987 | 6,547 | 7,023 | 7,655 | 8,266 |
| Capacity Required (Demand + Margin) | 5,840 | 5,950 | 6,260 | 6,840 | 7,340 | 8,000 | 8,640 |
| **Deficit (Additional Capacity Required)** | | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *Above Current Contracts* | - | - | - | - | - | - | *1,222* |
| *Above Current + Extensions* | - | - | - | - | - | - | - |
| *Above Current + All Prospective* | - | - | - | - | - | - | - |

| **High Case Scenario** | | | | | | | |
|---|---|---|---|---|---|---|---|
| Peak Demand | 6,223 | 6,899 | 7,616 | 8,530 | 9,301 | 10,180 | 11,036 |
| Capacity Required (Demand + Margin) | 6,500 | 7,210 | 7,960 | 8,910 | 9,720 | 10,640 | 11,530 |
| **Deficit (Additional Capacity Required)** | | | | | | | |
| *Above Current Contracts* | - | *313* | *510* | - | *752* | *1,936* | *4,112* |
| *Above Current + Extensions* | - | *33* | - | - | *84* | *1,004* | *1,894* |
| *Above Current + All Prospective* | - | *33* | - | - | *84* | *204* | *294* |
| *Above Current + All Prospective + Reserves* | - | - | - | - | - | - | - |

### *Capacity Balance from 2018 to 2020*

This is a period in which new capacity becomes available, two plants are retired, and Barka I may be extended. In 2018, the early power phase of the Ibri IPP is contracted for the summer months. Total contracted capacity of 7450 MW (without Barka I or Al Kamil) is sufficient for both Expected Demand and Low Case scenarios. If contract extensions are secured as expected, then capacity is sufficient under the High Case as well. In the unlikely event that the Ibri early power phase were late, capacity would be sufficient under both Expected Demand and Low Case scenarios if the contract extensions are executed, else temporary capacity would be needed.

The Ghubrah and Wadi Jizzi plants are scheduled to retire after the summer of 2018, while the new Sohar IV IPP is scheduled to begin commercial operation in January 2019, followed by Ibri IPP at full power capacity in April 2019. The net addition, bringing the total to 9636 MW including prospective extensions, is sufficient to secure capacity requirements under Expected Demand and Low Case scenarios through the end of 2020. In the High Case scenario, 2020 shows a modest deficit of 84 MW, which is well within the range of available contingency reserves.

### *Additional Capacity Requirement in 2021 and 2022*

In 2021, a deficit of 506 MW emerges under the Expected Demand scenario, although the prospective contract extensions are sufficient to meet this capacity need.[3] Under the High Case scenario, a deficit of 1004 MW remains after the contract extensions are included. This exceeds the scope of potential short-term resources that could be procured with reasonable confidence.

OPWP plans to procure a new IPP with capacity of about 800 MW to meet this requirement.[4] The plant is further justified on the basis of expected fuel savings. OPWP plans to locate the new facility at a site that will support the Muscat load center and displace the dispatch of existing open cycle generation units, allowing them to shift to peaking service.

By March 2022 and assuming prior extensions, four power stations reach the expiry of their P(W)PAs, resulting in a capacity loss of 1954 MW, while electricity demand continues to grow. Under the Expected Demand scenario, this results in a net deficit of nearly 1500 MW after considering the Manah extension and new 2021

[3] The prospective extensions include Al Kamil, Barka I, and arrangements for continued operation at Manah.
[4] Larger capacity would be required if Manah, Al Kamil, or Barka I were not extended through 2021.

IPP. The deficit is much higher under the High Case, at about 3000 MW. To address this deficit, OPWP expects to procure about 2700 MW under a competitive tender in which the four plants with expiring contracts will also be eligible to bid their capacity. This would be expected to provide sufficient capacity to meet requirements through 2023, assuming a portion of the High Case requirements would be met by short-term resources if needed. The capacity requirement will be reevaluated prior to procurement as demand out-turns and updated expectations influence the demand projection.

#### *Low Case Scenario*

Under the Low Case scenario, contracted capacity exceeds capacity requirements throughout the forecast horizon until 2022. Should demand begin to track this scenario, OPWP would reconsider the scope of the capacity procurement described above for 2022. However, the IPP procurement for 2021 COD would be expected to proceed unhindered, justified on the basis of expected system efficiency improvements and fuel savings.

## 1.4 DESALINATED WATER REQUIREMENTS

In the northern regions of the Sultanate, OPWP provides desalinated water to two "water departments": PAEW and MISC. Their respective service areas and requirements for desalinated water are defined as follows:

- PAEW – in respect of the demand for potable water in the Governorates of Muscat, Al Buraymi, Al Batinah North, Al Batinah South, Ad Dakhiliyah, Ad Dhahirah, Ash Sharqiyah North and Ash Sharqiyah South; and
- MISC – in respect of backup supply to the MISC desalination plant, for process water used by industry in the Sohar Industrial Port area.

PAEW and MISC provide the water demand projections in respect of the following geographic zones:

- The ***"Interconnected Zone"*** includes the potable water demands of the Governorates of Muscat, Al Batinah North, Al Batinah South, Buraymi, Ad Dakhiliyah, and Ad Dhahirah[5] which are served by PAEW, and the process water demand of the Sohar Industrial Port area which is served by MISC.[6] The existing principal sources of desalinated water for this zone are Ghubrah Power and Desalination Plant, Barka I and Barka II Power and Desalination Plants, and Sohar I Power and Desalination Plant.
- The ***"Sharqiyah Zone"*** includes the potable water demands of the Ash Sharqiyah North and Ash Sharqiyah South Governorates excluding Masirah wilayat. The existing principal source of water for this zone is the Sur Desalination Plant.

### *Interconnected Zone – Demand for Water*

The projected peak water demand for the Interconnected Zone is shown in Figure 5. Peak demand represents the average daily demand (inclusive of network losses) during the week of highest demand of the year.

[5] The current scenario considers a connection to Dhahirah by 2018 and it is considered to be supplied from the Main Interconnected Zone, while keeping limited production from the Masarrat well field, when both the new Sohar-Dhahirah transmission and new Sohar plant come in operation.
[6] MISC has provided OPWP with a demand projection through 2022. MISC is currently supplying its customers from its own RO plant. From 2015 to 2022, OPWP is requested to provide backup desalinated water supply in case of plant outage at the Majis RO plant.

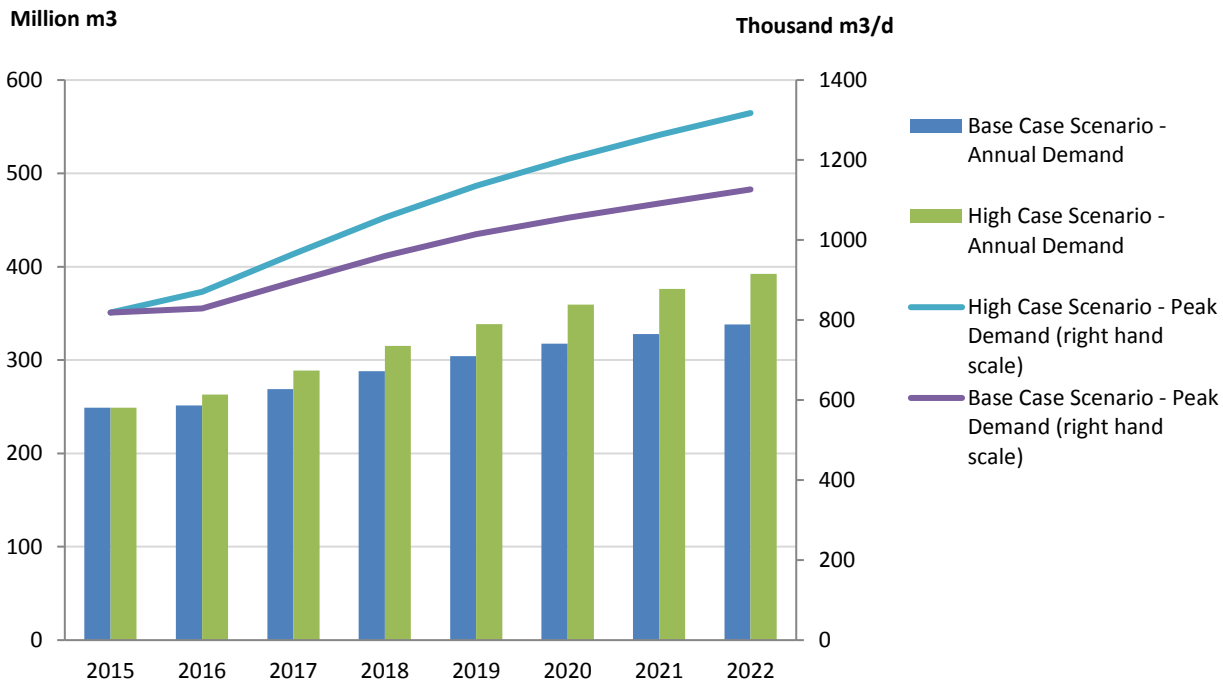
PAEW has provided two demand scenarios – Base and High – which together capture uncertainty in demand growth. Both forecast scenarios are driven fundamentally by population growth, distribution network expansion, and growth in per-capita water consumption. The demand forecast is based on the most recent official population forecast for the Sultanate, published by the National Center for Statistics and Information (NCSI) in April 2015.

The PAEW forecast for 2016 to 2022 is unchanged from the previous projection (published in OPWP's previous 7-Year Statement, Issue 9) for both demand scenarios. Only the estimate of 2015 consumption shows a change: preliminary out-turns indicate demand exceeded the forecast value by about 11%. Over the last four years, demand out-turns have consistently exceeded projections, with average annual growth of nearly 10%. The PAEW forecast projects the growth rate to drop to 5% in the Base Case, but allows a shallower drop in the High Case. OPWP and PAEW continue to monitor demand out-turns and evaluate their implications for the forecast period.

The Base and High scenarios differ primarily in the near-term pace of population growth, and the related effect on water demand. The High scenario assumes higher near-term growth. Apart from the population trend, the assumptions for network expansion and special projects are similar to the Base scenario. The High scenario projects an average growth in water demand of about 8% over the forecast horizon to 2022.

The High scenario is relevant considering the repeated upward revisions to water demand forecasts in recent years, as actual demand has outstripped previous projections. This has been due to a combination of unexpectedly high population growth and accelerated network expansion by PAEW in response to requests from wilayats for network water supply. The High scenario aims to establish a plausible upper bound to water demand in order to plan for adequate supply.

**Figure 5 Water Demand Projections – Interconnected Zone**



| PAEW Forecast | 2015 Est.[a] | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | Ave.% Growth |
|---|---|---|---|---|---|---|---|---|---|
| **Peak Water Demand** | Thousand $m^3/d$ | | | | | | | | |
| **Base Case Scenario** | 819 | 829 | 895 | 961 | 1,014 | 1,055 | 1,092 | 1,127 | 5% |
| *Change from 2015-2021 Statement* | 83 | - | - | - | - | - | - | | |
| **High Case Scenario** | **819** | **870** | **965** | **1,056** | **1,136** | **1,203** | **1,263** | **1,318** | 7% |
| *Change from 2015-2021 Statement* | *83* | - | - | - | - | - | - | | |
| **Total Annual Demand** | Million $m^3$ | | | | | | | | |
| **Base scenario** | **249** | **251** | **269** | **288** | **304** | **318** | **328** | **338** | 4% |
| **High scenario** | **249** | **263** | **289** | **315** | **339** | **359** | **376** | **392** | 7% |

[a] The estimate of 2015 water demand is based on actual out-turns for the majority of the year.

### *Interconnected Zone – Water Supply Sources*

The supply sources available to meet water demand include existing water desalination plants, new desalination plants under construction or procurement, and PAEW sources. They are described below. Figure 6 shows the output capacity of all contracted and planned sources in comparison to peak demand and capacity targets.

OPWP's contracted sources of desalinated water for the Interconnected Zone include the following:

- **Ghubrah Power and Desalination Plant**, owned and operated by GPDC under a PWPA with OPWP. The Ghubrah Desalination Plant comprises five MSF units with a current capacity of 140,000 $m^3/d$ (31 MIGD). The PWPA will expire in March 2018, before the peak season. All desalination units are expected to be decommissioned at that time.

- **Barka I Power and Desalination Plant**, owned by ACWA Power Barka and operated under a PWPA with OPWP. The Barka I plant 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 2015-2016. The supply contracts for Barka I expire in April 2018, and contract extensions to 2021 are currently agreed among the parties, but pending regulatory approval.

- **Barka II Power and Desalination Plant**, owned by SMN Power Barka and operated under a PWPA with OPWP. The Barka II plant has a capacity of 120,000 $m^3/d$ (26 MIGD) using RO technology.

- **Sohar I Power and Desalination Plant**, owned by Sohar Power Company and operated under a PWPA with OPWP. Sohar I has a desalination capacity of 150,000 $m^3/d$ (33 MIGD), using MSF units. The PWPA will expire in March 2022.

- **Muscat City Desalination Plant**, 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 Desalination Plant**, under construction by the owner, Qurayyat Desalination Company, will be operated under a WPA with OPWP with contracted capacity of 200,000 $m^3/d$ (44 MIGD), using RO technology, with scheduled commercial operation to begin in May 2017.

- **Barka IV Desalination Plant**, awarded in November 2015 to Barka Desalination Company, will be operated under a WPA with OPWP with contracted capacity of 281,000 $m^3/d$ (62 MIGD), using RO technology, with scheduled commercial operation to begin in May 2018.

- **Sohar III Desalination Plant**, awarded in November 2015 to Myah Gulf Desalination Company, will be operated under a WPA with OPWP with contracted capacity of 250,000 $m^3$/d (55 MIGD), using RO technology, with scheduled commercial operation to begin in May 2018.

- **Qurayyat Temporary Water Project**, awarded in January 2016 to Muscat Water LLC, will be operated under a WPA with OPWP with contracted capacity of 8,000 $m^3$/d (1.8 MIGD), using RO technology, with scheduled commercial operation to begin in June 2016. The contract will be for two years, and allows for extension for another four years. This project provides water supply to Qurayyat town until completion of PAEW's Wadi Dayqah project.

In addition to the foregoing sources that are under contract to OPWP, PAEW has its own sources of water available in the Interconnected Zone that offset the need for water desalination capacity. These include (1) well fields in Muscat and other regional wells[7], (2) a mobile RO plant that is currently located at Ghubrah, with capacity of 23,000 $m^3$/d (5 MIGD), (3) a contract for supply of 20,000 $m^3$/d (4.4 MIGD) from the MISC RO plant in Sohar to 2017, (4) Al Masarrat well field which is expected to supply 10,000 $m^3$/d beginning in 2018, and (5) the Wadi Dayqah surface water reservoir, which is expected to provide capacity of 67,000 $m^3$/d (15 MIGD) beginning in 2019[8]. The production capacity from these sources is shown in aggregate by year in Figure 6.

### *Interconnected Zone – Capacity Target and Prospective Resources*

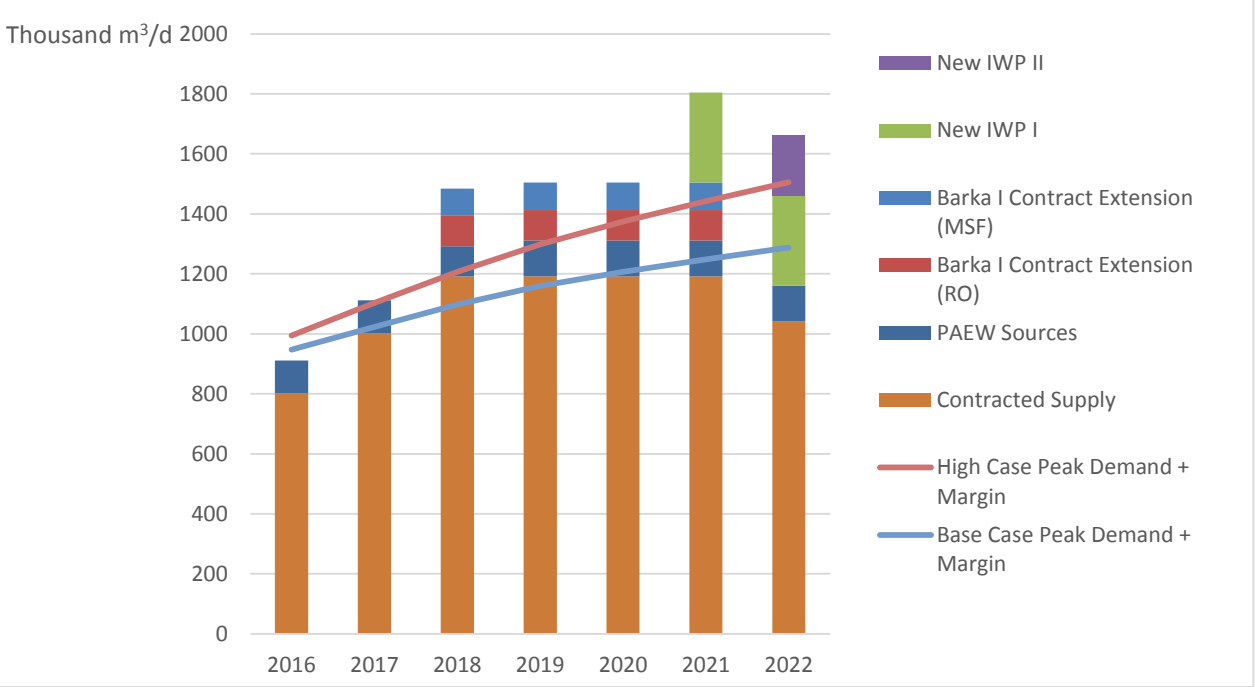
The expansion plan for water desalination capacity aims to meet peak demand, plus a 14% margin for supply security. The purpose of the reserve margin is to provide additional water capacity for recovery of the transmission and distribution networks in the event of a failure of the networks or a failure of supply from a desalination plant.[9] This represents a system security measure that is analogous to the generation security standard used to assess power generation capacity requirements. After an emergency, the water volumes in the PAEW reservoirs may be at a low level and will need to be replenished. Therefore, the capacity available to be drawn from desalination plants must be higher than normal demand, to allow for reservoir replenishment in the event of an emergency.

[7] Well production from these sources is projected to be reduced from 76,500 $m^3$/d in 2015 to 42,000 $m^3$/d by 2019 in line with national policy to provide for the recharge of aquifers. The reserved capacity of wells may be made available during short-term emergencies. The capacities refer to peak yields. Production from wells is less during non-peak periods.

[8] PAEW has assessed the average capacity of the Wadi Dayqah project for drinking water purposes at 67,000 $m^3$/d. The balance of productive capacity is reserved for agricultural irrigation. In an emergency, for short durations, the agricultural supply may be diverted for drinking water, with total capacity up to 125,000 $m^3$/d.

[9] PAEW established the security standard, in accordance with international practice, to be that the 24-hour peak demand on the system should be available for supply within a 21-hour period. The 24-hour peak capacity requirement available in a 21-hour period corresponds to (24/21) x peak demand = 1.143 x peak demand, hence a 14.3% reserve margin.

## Figure 6 Desalinated Water Capacity Requirements – Interconnected Zone




| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|---|
| **Interconnected Zone** | | | Thousand m³/d | | | | |
| **Supply Requirements** | | | | | | | |
| Base Case Peak Demand | 829 | 895 | 961 | 1014 | 1055 | 1092 | 1127 |
| High Case Peak Demand | 870 | 965 | 1056 | 1136 | 1203 | 1263 | 1318 |
| Base Case Peak Demand + Margin | 948 | 1023 | 1098 | 1159 | 1206 | 1248 | 1288 |
| High Case Peak Demand + Margin | 995 | 1103 | 1207 | 1298 | 1375 | 1443 | 1506 |
| **Contracted Capacity** | | | | | | | |
| Ghubrah Power and Desalination Plant | 140 | 140 | - | - | - | - | - |
| Barka I Power and Desalination Plant | 193 | 193 | - | - | - | - | - |
| Barka II Power and Desalination Plant | 120 | 120 | 120 | 120 | 120 | 120 | 120 |
| Sohar I Power and Desalination Plant | 150 | 150 | 150 | 150 | 150 | 150 | -[d] |
| Muscat City Desalination Plant[a] | 191 | 191 | 191 | 191 | 191 | 191 | 191 |
| Qurayyat Temporary Plant[b] | 8 | 8 | -[b] | -[b] | -[b] | -[b] | - |
| Qurayyat Desalination Plant | - | 200 | 200 | 200 | 200 | 200 | 200 |
| Barka IV Desalination Plant | - | - | 281 | 281 | 281 | 281 | 281 |
| Sohar III Desalination Plant | - | - | 250 | 250 | 250 | 250 | 250 |
| **Total Contracted Capacity** | **802** | **1002** | **1192** | **1192** | **1192** | **1192** | **1042** |
| Peak Yield of PAEW Sources (Non OPWP) | 110 | 110 | 100 | 119 | 119 | 119 | 119 |
| **Total Contracts and PAEW Resources** | **912** | **1112** | **1292** | **1311** | **1311** | **1311** | **1161** |
| **Reserve over Base Peak Demand + Margin (shortfall)** | **-36** | **89** | **194** | **152** | **105** | **63** | **-127** |
| **Reserve over High Peak Demand + Margin (shortfall)** | **-83** | **8** | **85** | **13** | **-64** | **-132** | **-345** |
| **Prospective Capacity Contracts** | | | | | | | |
| Barka I Contract Extension (MSF as standby capacity) | - | - | 91 | 91 | 91 | 91 | -[c] |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Barka I Contract Extension (RO) | - | - | 102 | 102 | 102 | 102 | -[c] |
| New IWP I | - | - | - | - | - | 300 | 300 |
| New IWP II | - | - | - | - | - | - | 200 |
| **All Resources Capacities** | **912** | **1112** | **1485** | **1504** | **1504** | **1804** | **1661** |

[a]The Muscat City Desalination plant is expected to begin commercial operation in March 2016.
[b]The supply contract includes an option for up to four years extensions at the same capacity level.
[c]Contract extensions to 2021 are currently agreed but pending regulatory approval. MSF capacity is intended for standby (reserve capacity in case of emergency). There may be prospect for further extension subject to agreement and regulatory approval.

Figure 6 provides a year by year summary of water supply requirements in the Interconnected Zone, and the supply sources planned to meet them. Available sources of supply are considered in the context of peak demand (Base and High Scenarios), and in the context of capacity targets (peak demand plus reserve margin for both scenarios).

A need for additional capacity is indicated by a negative value for the Reserve over Capacity Target, shown for both the Base and High Case demand scenarios. Supply sources fall short of both capacity targets in 2016, but are sufficient to meet the PAEW forecast of peak demand. In 2017, when the Qurayyat Desalination Plant begins operation, total available capacity is projected to meet the capacity target for both PAEW demand scenarios.

From 2018 to 2019, new capacity at Barka IV and Sohar III is sufficient to meet targets in both scenarios despite retirement of the old Ghubrah units.

In 2020, a deficit emerges against the High Case capacity target, although contracted capacity is sufficient to meet the Base Case capacity target until 2022. Considering the rapid growth in demand in recent years, OPWP and PAEW consider that the High Case capacity target should be adopted with respect to plans for capacity additions. Transmission constraints between the Sohar, Barka, and Muscat demand zones also influence water supply planning. They comprise limitations in pipeline or pumping capacity that may constrain the flow of water from areas of capacity surplus to areas of deficit. PAEW has plans in place for transmission upgrades that will relieve these constraints over time.

OPWP is considering the following capacity additions, referred to as prospective contracts:

- **Barka I contract extension.** The water supply agreements with ACWA Power Barka expire in March 2018. Contract extension agreements to December 2021 are currently agreed, although pending regulatory approval. Barka I has 91,200 $m^3$/d (20 MIGD) of water capacity from MSF units, and 102,000 $m^3$/d (22.5 MIGD) from RO units. Water production from MSF units is quite costly compared to RO technology. During the extension period, the MSF units are expected to be maintained as standby capacity, and operated only under conditions of emergency need.

  **New IWP in 2021.** Additional capacity is required in the Muscat zone in 2021, shown as 300,000 $m^3$/d (66 MIGD). Sites are under consideration with PAEW.

- **New IWP in 2022.** Additional capacity will be required in the North Batinah region in 2022, for which OPWP and PAEW are considering an IWP of capacity 200,000 $m^3$/d (44 MIGD). This capacity would serve demand growth in the North Batinah-Dhahirah region.

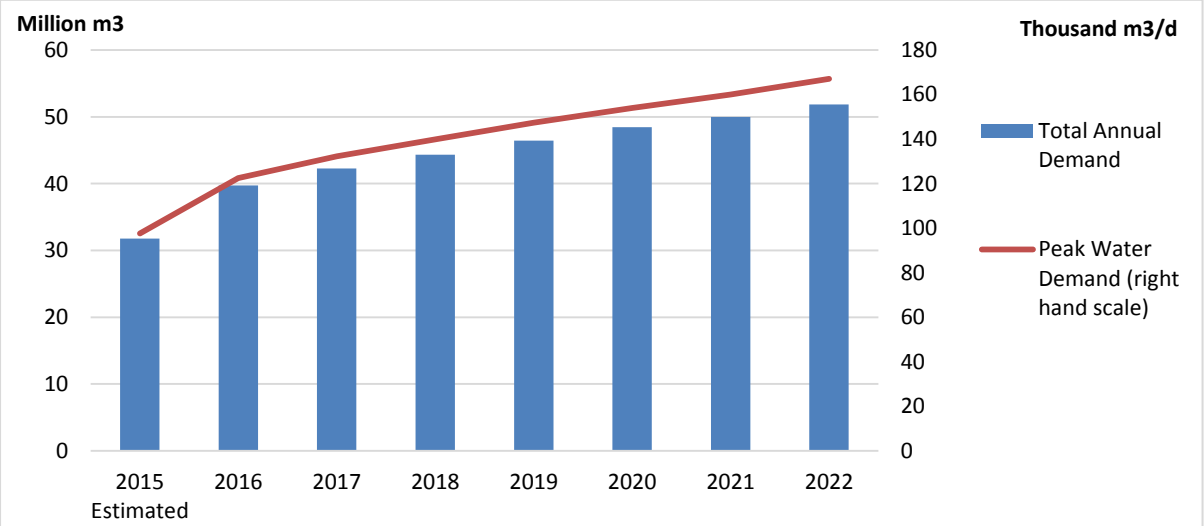
In addition to these plans for new capacity, in response to a PAEW request, OPWP is evaluating requirements toward procuring up to 100,000 $m^3$/d (22 MIGD) of mobile water desalination capacity plants. These plants are available as modular units, similar to those contracted recently for the temporary projects at Qurayyat and Aseelah. They may be mounted either on land transport vehicles or sea-going barges,

providing mobility to various sites according to need. OPWP is evaluating sites and requirements for connection facilities and has issued an Expression of Interest (EOI) solicitation to assess the availability and cost of such mobile resources. Subject to findings and MOF approval, OPWP may issue a tender toward making capacity available in 2017. Mobile plants are considered as a temporary supply resource which can be removed or relocated once permanent supply becomes available. The amount of capacity to be procured will be subject to government and regulatory approval. The term of supply is also yet to be specified.

### *Sharqiyah Zone – Demand for Water*

The PAEW forecast of water demand for the Sharqiyah Zone is shown in Figure 7. The forecast is unchanged in most years, in comparison to the forecast provided for OPWP's previous Seven Year Statement, showing only a modest increase for 2016. The average growth in peak demand remains at 8% per year over the seven-year horizon.

**Figure 7 Water Demand Projections – Sharqiyah Zone**




| PAEW Forecast | 2015 Estimated | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | Ave.% Growth |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Thousand m3/d | | | | | |
| **Peak Water Demand** | 97 | 123 | 132 | 140 | 147 | 154 | 160 | 167 | 8% |
| *Change from 2015-2021 Statement* | - | 4 | - | - | - | - | - | | |
| | | | | Million m3 | | | | | |
| **Total Annual Demand** | **32** | **40** | **42** | **44** | **46** | **48** | **50** | **52** | **7%** |
| *Change from 2015-2021 Statement* | - | *1* | - | - | - | - | - | | |

PAEW has not provided a High Case demand scenario for the Sharqiyah zone. PAEW's consideration of demand uncertainty is based principally on population growth trends. PAEW reports that the Sultanate's official population forecast does not support a higher population trend scenario for wilayats of the Sharqiyah Zone. The PAEW forecast includes only a Base scenario.

### *Sharqiyah Zone – Water Supply Sources*

In Sharqiyah Zone, the supply sources available to meet water demand include existing water desalination plants, new desalination plants under construction or procurement, and PAEW sources. They are described below. Figure 8 shows the output capacity of all contracted and planned sources in comparison to peak demand and capacity targets.

OPWP's contracted sources of desalinated water for the Sharqiyah Zone include the following:

- **Sur Desalination Plant**, owned and operated by Sharqiyah Desalination Company with a capacity of 83,000 $m^3$/d (18 MIGD), using RO technology, under a WPA with OPWP. Additional capacity of 48,000 $m^3$/d (10.6 MIGD) is currently under construction, and is expected to be available in September 2016.

- **Aseelah Temporary Plant**, awarded in January 2016 to Muscat Water LLC, will be operated under a WPA with OPWP with contracted capacity of 10,000 $m^3$/d (2.2 MIGD), using RO technology. This plant is scheduled to begin commercial operation in July 2016. The contract has duration of four years and allows for extension for another two years.

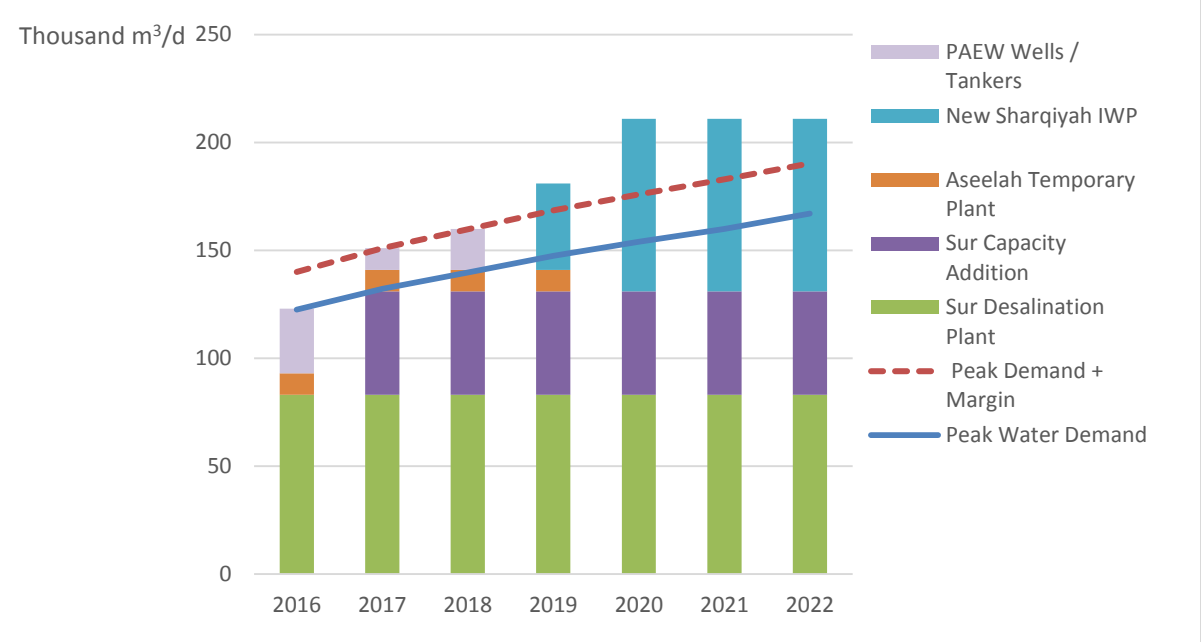
In addition to the capacity under contract to OPWP, PAEW has wells at several locations. They may be employed for water supply to a limited degree when desalinated water capacity is not sufficient to meet demand.

### *Sharqiyah Zone – Capacity Target and Prospective Resources*

The capacity target for the Sharqiyah Zone includes a margin of 14% over peak demand, as for the Main Interconnected Zone. Figure 8 below compares the capacity target to the sum of supply sources.

In 2016, the sources of desalinated water capacity are not sufficient to meet demand until the capacity expansion at Sur Desalination Plant is completed in September. Before then, PAEW wells and tanker deliveries will meet the balance of needs. The supply deficit arose as a result of the unexpected pace of demand growth, which developed after commitments had been made to the Sur expansion. OPWP contracted for temporary supply at Aseelah to address the deficit beginning in 2016, and continuing until permanent supply is scheduled to become available in 2019. The capacity of the Aseelah temporary plant was limited to 10,000 m3/d (2.2 MIGD) due to constraints on the capacity of the PAEW distribution network. In 2017 and 2018, contracted desalination capacity is projected to be sufficient to provide for peak demand, though is not sufficient to meet the 14% margin that comprises the capacity target.

## Figure 8 Future Desalinated Water Capacity Requirements– Sharqiyah Zone




| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|---|
| **Supply Requirements** | | | | Thousand m3/d | | | |
| Peak Water Demand | 123 | 132 | 140 | 147 | 154 | 160 | 167 |
| Peak Demand + Margin | 140 | 151 | 160 | 169 | 176 | 183 | 190 |
| **Contracted Desalination Capacity** | | | | | | | |
| Sur Desalination Plant | 83 | 83 | 83 | 83 | 83 | 83 | 83 |
| Sur Capacity Addition | -[a] | 48 | 48 | 48 | 48 | 48 | 48 |
| Aseelah Temporary Plant | 10 | 10 | 10 | 10 | - | - | - |
| **Total Contracted Capacity** | **93[a]** | **141** | **141** | **141** | **131** | **131** | **131** |
| **PAEW Wells/ Tankers [b]** | **30** | **10** | **19** | **-** | **-** | **-** | **-** |
| **Total Capacities** | **123** | **151** | **160** | **141** | **131** | **131** | **131** |
| Reserve over Peak Demand + Margin (Shortfall) | -17 | 0 | 0 | -28 | -45 | -52 | -59 |
| Reserve over Peak Demand (Shortfall) | 1 | 19 | 20 | -6 | -23 | -29 | -36 |
| **Prospective Capacity Contracts** | | | | | | | |
| New Sharqiyah IWP | - | - | - | 40 | 80 | 80 | 80 |
| **All Resources** | **123** | **151** | **160** | **181** | **211** | **211** | **211** |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Reserve over Peak demand + Margin (Shortfall) | -17 | 0 | 0 | 13 | 35 | 28 | 21 |

[a] Excluding Sur capacity addition. The COD is expected in September, 2016 after the summer peak demand period
[b] PAEW wells or tankers supply are considered only as an emergency supply in the near term

OPWP and PAEW selected the site for a new IWP at Al Ashkharah in 2015. OPWP has initiated the procurement process for capacity of 80,000 $m^3$/d (18 MIGD), and expects to award the project toward the end of 2016. It will be developed in two phases, providing 40,000 $m^3$/d (9 MIGD) prior to the summer peak of 2019 and full capacity of 80,000 $m^3$/d (18 MIGD) prior to the summer peak of 2020.

From 2019 to 2022, with the addition of this new Sharqiyah IWP, contracted supply is expected to exceed the capacity target.

## 1.5 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 most recent examples of combined development of power and desalination capacity are the Salalah IWPP in Dhofar and the Barka II Power and Desalination Plant 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 is currently considering that there is a need both for power and water desalination capacity in 2022, and will consider the merits of co-location. An evaluation of sites and infrastructure requirements is underway in 2016.

## 1.6 PROCUREMENT ACTIVITIES

OPWP's current and near-term procurement activities for the MIS include the following projects, summarized in Table 3 below:

- **Sharqiyah IWP.** A new desalination plant is planned at Ashkharah in the Sharqiyah region, with capacity of 80,000 $m^3$/d (17.6 MIGD). This project is expected to be developed in two phases of 40,000 $m^3$/d (8.8 MIGD). The first phase is to be completed in 2019 and the final phase to be completed in 2020. OPWP plans to tender the project in Q1 2016 for award in Q4 2016.

- **Manah IPP**. OPWP is currently evaluating the options available toward continuing operations at the Manah power station after asset ownership transfers to the Government in December 2020. OPWP is considering several options, including sale of the asset, supported by a PPA with OPWP for a multi-year term.

- **New IPP for 2021 COD.** OPWP plans to procure around 800 MW for January 2021 COD as a new IPP, via the existing procurement methodology. Prospective sites and infrastructure requirements are being evaluated in collaboration with stakeholders such as OGC and OETC. OPWP expects to select the site and to initiate the procurement process with a request for qualifications (RFQ) in Q3 2016, subject to regulatory approval.

- **Additional Power Generation Capacity for 2022 COD.** OPWP plans to procure about 2700 MW of generation capacity for operation in 2022, in a procurement process that would begin in 2017. This tender would proceed under a new procurement methodology that allows existing, out-of-contract plants to compete for new P(W)PAs with bidders for new IPP plants. The new procurement methodology is currently under development. The aggregate capacity of plants that will be out-of-contract in 2022 is about 1900 MW, although potentially not all of this capacity will participate in the tender. OPWP expects that at least 800 MW of the total capacity need would be procured as new IPP capacity.

- **Mobile Water Desalination Capacity.** PAEW has requested OPWP to prepare a tender for up to 100,000 $m^3/d$ (22 MIGD) of mobile water desalination capacity plants that can be located according to need. Such plants may be modular in nature, and mounted either on land transport vehicles or sea-going barges. The cost of water production, feasibility and mobility of such plants are closely related to the availability of connection facilities to the water distribution and electricity networks. OPWP has issued a request for Expressions of Interest (EOI) from the market, to obtain information in preparation for obtaining MOF and regulatory approval for capacity procurement. The scope of capacity procurement remains subject to government approvals. If approved, at least a portion of the capacity would have COD in 2017.

- **New IWP for 2021 COD.** PAEW has identified a need for new IWP capacity of 300,000 $m^3/d$ (66 MIGD) in 2021 to serve growing demand primarily the Muscat zone. OPWP plans to initiate the procurement process in 2016, following site selection in collaboration with PAEW.

- **New IWP for 2022 COD.** Additional capacity of about 200,000 $m^3/d$ (44 MIGD) is needed in the North Batinah region in 2022, when the existing Sohar I MSF units reach the end of their contract. OPWP expects to initiate the procurement process in 2017.

OPWP has also recently completed procurement of several projects which are now under construction. They include Ibri IPP (1520 MW), Sohar III IPP (1720 MW), Barka IV Desalination Plant (62 MIGD), Sohar III Desalination Plant (55 MIGD), and temporary water desalination plants at Qurayyat (1.8 MIGD) and Aseelah (2.2 MIGD).

### Table 3 MIS Procurement Activities in 2016-2017

| | 2021 New IPP | Manah IPP[a] | 2022 Power Capacity | Sharqiyah IWP | Mobile Water | 2021 New IWP | 2022 New IWP |
|---|---|---|---|---|---|---|---|
| **Capacity** | 800 MW | 264 MW | 2700 MW[b] | 17.6 MIGD | TBD[d] | 66 MIGD | 44 MIGD |
| **RFQ** | Q3 2016 | Q4 2017 | Q3 2017 | Q4 2015 | Q3 2016 | Q4 2016 | Q4 2017 |
| **RFP** | Q1 2017 | Q1 2018 | Q1 2018 | Q1 2016 | Q4 2016 | Q2 2017 | Q2 2018 |
| **Bids Due** | Q2 2017 | Q3 2018 | Q2 2018 | Q3 2016 | Q1 2017 | Q1 2018 | Q1 2019 |
| **Award Anticipated** | Q3 2017 | Q1 2019 | Q3 2018 | Q4 2016 | Q2 2017 | Q3 2018 | Q3 2019 |
| **COD** | Jan 2021 | Jan 2021[a] | Jan 2022[b] | Q2 2019; Q2 2020[c] | Q3-Q4 2017[d] | Q2 2021 | Q2 2022 |

[a] The procurement activity refers to the existing Manah IPP, tendering for continued operation under a new PPA commencing in January 2021. If this option were selected, the tender process may begin in late 2017.
[b] The capacity refers to the aggregate value of multiple awards. They are expected to include new P(W)PAs for existing plants that fall out of contract in 2021 and 2022, as well as new IPP capacity. All project awards would have COD by January 2022.
[c] COD will occur in two phases.
[d] To be determined. The amount of capacity is pending further evaluation and subject to government approval. COD may vary by location.

### *Future Procurement Activities*

From 2018 to 2022, OPWP anticipates the following procurement actions for the MIS:

- **New MIS IPP(s).** More capacity is likely to be required in 2024; the procurement process would begin around 2019. Similarly, OPWP would expect to initiate a subsequent procurement process in 2022 to meet new capacity needs in 2027. Plants with contracts that expire during these periods may participate in the competitions.

- **New MIS IWP(s).** Additional desalination capacity may also be required for operation in 2024 for the Interconnected Zone. Similarly, additional capacity for the Sharqiyah Zone may be required around the same time period. Such projects would imply procurement activities should start around 2019.

- **Demand Response.** OPWP expects Demand Response (DR) to become an economical and effective resource toward meeting capacity requirements, competitive with peaking generation resources. OPWP plans to develop the contracting and operational procedures through initial trials in 2016 and 2017, and then to expand the DR program with large electricity consumers, targeting measurable reductions to their contributions to system coincident peak demand.

- **Capacity and Energy Trades with Neighboring Power Systems.** OPWP has no explicit plans to procure capacity from neighboring systems (such as GCCIA members) during this period, apart from a trial exchange in 2016. OPWP is currently developing the capability for such trades in case of need, such as by specifying access conditions and contracting arrangements in advance. These preparations would facilitate a capacity import in potential scenarios such as a lengthy unplanned outage at a power station, construction delay of a new IPP, or unexpectedly high demand growth.

- **Capacity Purchase through the Spot Market.** OPWP plans to launch the electricity spot market around 2020, and is currently developing the commercial mechanisms intended to incentivize generators to offer capacity outside of the P(W)PA model. While capacity development by P(W)PAs will continue, OPWP expects the spot market to provide a parallel route for capacity procurement.

- **Renewable Energy Projects.** OPWP expects solar energy projects, wind farms, and potentially other renewable energy (RE) projects to complement gas-fired generation in the Sultanate in the near future. Although OPWP has no current commitments to RE project development in the MIS, a methodology is under development with the AER that would allow RE projects to compete with conventional generation projects at economic prices.

## 1.7 FUEL REQUIREMENTS

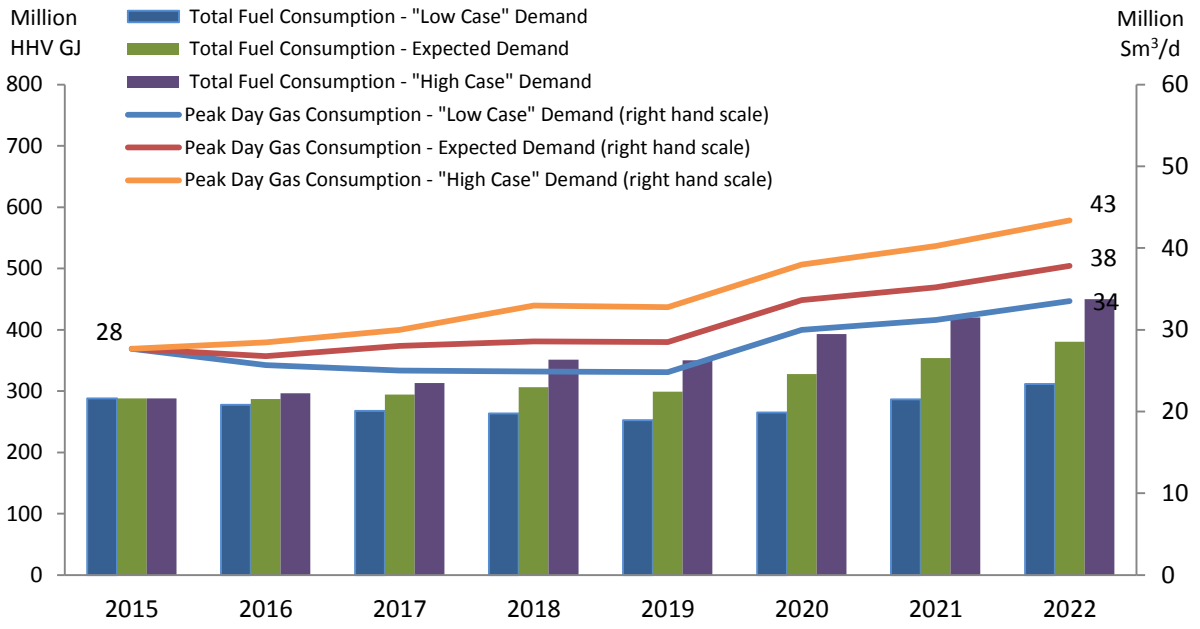
### *2015 Fuel Usage*

The primary fuel resource for power generation and associated water production in the MIS is natural gas, supplied to power and desalination plants by the Ministry of Oil & Gas (MOG). Total gas consumption at the main power and desalination plants in 2015 was about 7.4 billion $Sm^3$, equivalent to 20.2 million $Sm^3/d$, about 4% more than in 2014. The peak daily gas consumption in 2015 was 27.7 million $Sm^3$, slightly lower than in 2014. The modest 4% growth in gas requirements contrasts with a significant 13% increase in electricity generation over the same period.

### *Projected Fuel Requirements*

OPWP has projected fuel requirements of the MIS over the 2016-2022 forecast horizon for each of the three demand scenarios, as shown in Figure 9 below.

**Figure 9 Projected Fuel Requirements – MIS**



| | Actual 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | Ave.% Growth |
|---|---|---|---|---|---|---|---|---|---|
| **Expected Demand** | | | | | | | | | |
| **Gas Consumption (million Sm³/d)** | | | | | | | | | |
| Annual Average | 20.2 | 20.1 | 20.6 | 21.5 | 21.0 | 22.9 | 24.8 | 26.7 | 4% |
| Peak Day | 27.7 | 26.8 | 28.0 | 28.6 | 28.5 | 33.6 | 35.2 | 37.8 | 5% |
| **Diesel Fuel Consumption (million litres)** | - | - | - | - | - | - | - | - | |
| **Total Fuel Consumption (million HHV GJ)[a]** | 288 | 287 | 294 | 306 | 299 | 328 | 354 | 381 | 4% |
| *Gas* | 288 | 287 | 294 | 306 | 299 | 328 | 354 | 381 | 4% |
| *Diesel Fuel* | - | - | - | - | - | - | - | - | |
| **Low Case Demand** | | | | | | | | | |
| **Gas Consumption (million Sm³/d)** | | | | | | | | | |
| Annual Average | 20.2 | 19.4 | 18.8 | 18.5 | 17.7 | 18.6 | 20.1 | 21.8 | 1% |
| Peak Day | 27.7 | 25.7 | 25.0 | 24.9 | 24.8 | 30.0 | 31.2 | 33.5 | 3% |
| **Diesel Fuel Consumption (million litres)** | - | - | - | - | - | - | - | - | |
| **Total Fuel Consumption (million HHV GJ)[a]** | 288 | 278 | 268 | 264 | 252 | 265 | 287 | 311 | 1% |
| *Gas* | 288 | 278 | 268 | 264 | 252 | 265 | 287 | 311 | 1% |
| *Diesel Fuel* | - | - | - | - | - | - | - | - | |
| **High Case Demand** | | | | | | | | | |
| **Gas Consumption (million Sm³/d)** | | | | | | | | | |
| Annual Average | 20.2 | 20.7 | 22.0 | 24.6 | 24.6 | 27.5 | 29.5 | 31.6 | 7% |
| Peak Day | 27.7 | 28.4 | 30.0 | 33.0 | 32.8 | 38.0 | 40.3 | 43.4 | 7% |
| **Diesel Fuel Consumption (million litres)** | - | - | - | - | - | - | - | - | n/a |
| **Total Fuel Consumption (million HHV GJ)[a]** | 288 | 296 | 313 | 351 | 350 | 393 | 420 | 450 | 7% |
| *Gas* | 288 | 296 | 313 | 351 | 350 | 393 | 420 | 450 | 7% |
| *Diesel Fuel* | - | - | - | - | - | - | - | - | |

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

Overall fuel consumption is expected to increase at an average rate of about 4% per year over the next seven years. Under the Low Case demand scenario, fuel consumption increases at an average of 1% per year, whilst in the High Case demand scenario, it grows at an average rate of 7% per year. In each of the three scenarios, the rate of growth in fuel consumption is well below that of electricity demand.

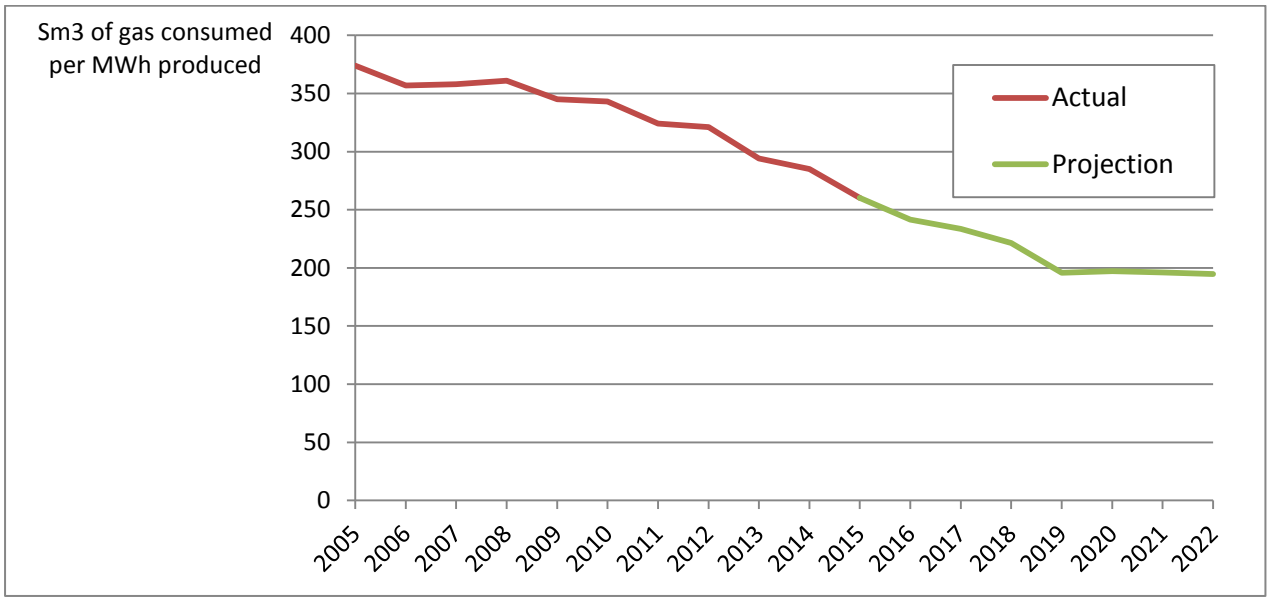
### *Gas Utilization*

Continuing improvements in the efficiency of power supply have held back the growth rate in fuel requirements. Since 2005, through the introduction of progressively more efficient generation plants, the average fuel consumption per unit of electricity production in the MIS has dropped from 374 $Sm^3$/MWh to 260 $Sm^3$/MWh in 2015, an improvement of 30%. Over the next seven years, OPWP expects that an increasing share of power generation will be provided by the most efficient plants, contributing to a further 25% improvement in MIS gas utilization by 2022 as indicated by Figure 10 below. Another significant contributor is the shift from MSF to RO technology for water desalination. This is expected to allow some of the combined power and water plants to be operated less intensively in favor of the newer and more efficient power-only IPPs.

OPWP and OETC continue to cooperate for continuous improvement in generation dispatch operations, to take full advantage of the newer generation plants while honoring the network security constraints that assure reliable power supply. OETC is in the process of developing a 400 kV transmission backbone and new dispatch

control technology that together will support more efficient dispatch, while OPWP will contribute advanced system simulation to support economic dispatch decision-making.

**Figure 10 Gas Required per Unit of Electricity Generation – MIS**




### *Gas Availability*

OPWP consults with MOG on a regular basis, in order to confirm the future availability of gas for power generation (and associated water production) and to co-ordinate planning.

MOG has indicated that future gas supply is constrained, but with assurances that the power sector has a priority for future gas allocations. While MOG has committed to gas supply for the planned capacity additions in Salalah, Ibri and Sohar, gas availability for later plants is not assured.

Should further required gas allocations not be available to the power and water sector, then (in addition to pursuing fuel-efficiency improvement options) OPWP would likely need to:

- bring forward plans to procure new generation capacity based on a fuel other than gas;
- discuss with the Government the feasibility of importing gas specifically for use in power generation (and associated water production); and/or
- make use of optional arrangements included in the Barka III and Sohar II PPAs for dispatch on liquid fuel instead of gas.

OPWP will continue to consult closely with MOG with regard to all of these matters.

# SECTION 2 DHOFAR POWER SYSTEM

*The Dhofar Power System covers the city of Salalah and surrounding areas in the Governorate of Dhofar, serving around 92,500 electricity customers.*

*The Dhofar Power System comprises two generation facilities, the 220 kV/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).*

*The Dhofar Power System is interconnected with the power system of Petroleum Development Oman (PDO) 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.*

*The Directorate General of Water (DGW) is the principal entity responsible for potable water supply and distribution in the Governorate of Dhofar, apart from small, private networks. A single water desalination plant is the principal source of water supply to the DGW transmission system, although DGW also has significant groundwater resources available with sufficient capacity to meet the majority of water requirements if necessary.*

*OPWP's role in the Dhofar Power System is similar to its role in the MIS, which is to procure economically the power and desalinated water required by DPC and DGW, respectively, in bulk from generation/production facilities connected to the Dhofar Power System. OPWP is required to ensure that sufficient power generation resources are available to meet DPC electricity demands. OPWP is also required to procure bulk water supply at the request of water departments including DGW, and, wherever beneficial, to co-procure desalinated water with power generation in joint facilities.*

## 2.1 DEMAND FOR ELECTRICITY

### *Historical Demand*

Electricity demand growth in 2015 was similar to the forecast of the last 7-Year Statement. Average demand increased by 12% to 336 MW (corresponding to 2.94 TWh). The peak demand was 495 MW,[10] an increase of 13% over the 2014 peak demand.

The average annual growth rate in peak demand over the past 5-7 years has been between 9% and 10%, while single-year growth has reached as high as 15%. The ten-year average growth rate is also about 9%. This rapid development rate has been common among all principal consumer sectors.

### *Demand Projections*

OPWP's 7-year electricity demand projections for the Dhofar Power System have been developed in a similar manner as for the MIS. The projected demands 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

[10] DPC reported the net peak demand for the Dhofar Power System as 495 MW at 24:00 pm (midnight) on Monday, June 16th, 2015.

and desalination plants. They are built up from separate analyses of underlying demand and certain bulk loads, comprising mainly industrial demands, that are assessed on a specific load-wise basis.

The projections are presented as a range including Low Case, High Case and central, Expected Demand forecast scenarios. The Expected Demand scenario is based on an assumption of "normal" weather. The Low Case and High Case scenarios differ in their assumptions for economic growth, and reflect the potential effects of weather conditions on demand.

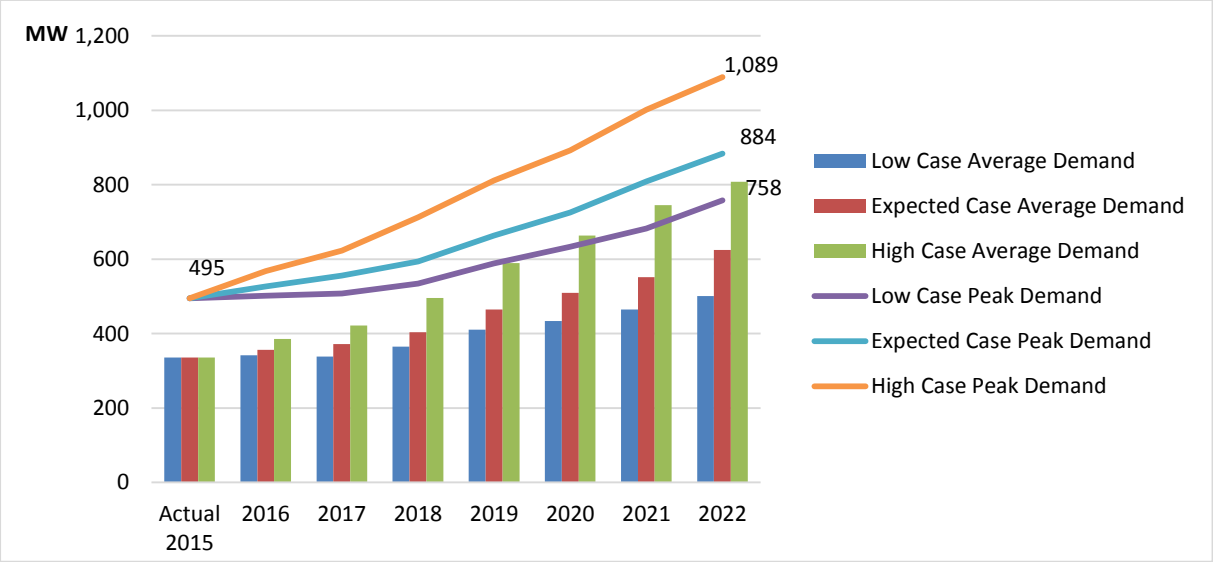
The projections are summarized in Figure 11.

Under the Expected Demand scenario, peak demand is expected to grow at about 9% per year, from 495 MW in 2015 to 884 MW in 2022. Energy consumption is projected to grow from 2.9 TWh (corresponding to 336 MW average demand) in 2015 to 5.5 TWh (625 MW) in 2022, also an average increase of around 9% per year. This projection is lower than that of the previous 7-Year Statement, particularly in 2016-2017 when the growth rate may be only around 5% to 6%. However, the average 7-year growth rate represents a reduction of only 0.5% per year below that of the most recent seven years.

Similar to MIS, the High Case scenario for electricity demand assumes a modest near-term reduction in the growth rate of underlying demand, followed shortly by a return to high growth levels. It also considers the potential effect of warmer-than-average weather in any given year. On average over the next seven years, this scenario has peak demand growth of 12% per year and energy growth of 13% per year. The difference between the High Case and Expected Demand is greater than that between the Low Case and Expected Demand, mainly due to bulk loads. Whereas both Expected Demand and the Low Case show relatively steady incremental growth in bulk loads, the High Case also includes several larger bulk load customers that have applied for connections but have not yet received approval or committed to construction.

The Low Case scenario assumes much lower demand growth in the near term, followed by a gradual recovery to the long-term growth rate. This scenario also reflects the demand impact of a milder-than-average summer in any given year. On average over the 7-year period, this scenario has peak demand and energy growth of 6% per year.

## Figure 11 Electricity Demand Projections – Dhofar Power System




| | Actual 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | Ave.% Growth |
|---|---|---|---|---|---|---|---|---|---|
| **Expected Demand** | | | | | | | | | |
| Average Demand (MW) | 336 | 357 | 372 | 404 | 465 | 510 | 551 | 625 | 9% |
| Underlying Demand | 256 | 273 | 290 | 309 | 332 | 356 | 385 | 415 | 7% |
| Bulk Loads | 80 | 84 | 81 | 95 | 134 | 153 | 166 | 210 | 15% |
| **Annual Energy (TWh)** | **2.9** | **3.1** | **3.3** | **3.5** | **4.1** | **4.5** | **4.8** | **5.5** | **9%** |
| **Peak Demand (MW)** | **495** | **527** | **556** | **594** | **663** | **725** | **809** | **884** | **9%** |
| *Change from 2015-2021 Statement (MW)* | 3 | -12 | -44 | -59 | -48 | -51 | -30 | n/a | |
| **Low Case Demand** | | | | | | | | | |
| Average Demand (MW) | 336 | 342 | 338 | 365 | 410 | 434 | 465 | 501 | 6% |
| Underlying Demand | 256 | 264 | 271 | 284 | 299 | 313 | 329 | 346 | 4% |
| Bulk Loads | 80 | 78 | 67 | 80 | 112 | 121 | 136 | 155 | 10% |
| **Annual Energy (TWh)** | **2.9** | **3.0** | **3.0** | **3.2** | **3.6** | **3.8** | **4.1** | **4.4** | **6%** |
| **Peak Demand (MW)** | **495** | **502** | **508** | **534** | **589** | **634** | **683** | **758** | **6%** |
| *Change from 2015-2021 Statement (MW)* | 41 | 11 | -42 | -56 | -46 | -49 | -46 | n/a | |
| **High Case Demand** | | | | | | | | | |
| Average Demand (MW) | 336 | 385 | 421 | 496 | 589 | 664 | 745 | 808 | 13% |
| Underlying Demand | 256 | 283 | 311 | 336 | 367 | 405 | 449 | 496 | 10% |
| Bulk Loads | 80 | 103 | 111 | 160 | 222 | 259 | 296 | 312 | 22% |
| **Annual Energy (TWh)** | **2.9** | **3.4** | **3.7** | **4.3** | **5.2** | **5.8** | **6.5** | **7.1** | **13%** |
| **Peak Demand (MW)** | **495** | **568** | **623** | **713** | **811** | **893** | **1002** | **1089** | **12%** |
| *Change from 2015-2021 Statement (MW)* | -39 | -29 | -30 | -9 | 11 | 8 | 37 | n/a | |

## 2.2 POWER GENERATION RESOURCES

### *Sources of Power*

The Dhofar Power System has two sources of contracted generation capacity in operation and a third under construction, as well as one source of contingency reserves.

### *Contracted Capacity*

The Dhofar Power System is comprised of the following power generation resources which are contracted capacity:

- **Raysut New Power Station (NPS),** owned and operated by Dhofar Generation Company (DGC), under a PPA with OPWP. The NPS is located in Raysut and comprises eight OCGT units with a total net capacity of 273 MW.

- **Salalah IWPP,** operated by the owner, Sembcorp Salalah Power and Water Company, under a PWPA with OPWP. The Salalah IWPP is a CCGT plant comprising five gas turbines and two steam turbines with combined net capacity of 445 MW. It is located in Taqa and began operation in 2012.

- **Salalah II IPP,** owned by Dhofar Generation Company (DGC), and currently under construction. The plant will operate under a PPA with OPWP when it is completed in January 2018. It is located at Raysut, at a site adjacent to the Raysut NPS, and is contracted to provide capacity of 445 MW.

### *Prospective Contract*

RAECO is in the process of tendering a 50 MW wind farm project, in partnership with MASDAR of Abu Dhabi, which will operate under a PPA with OPWP. The project, comprising an array of wind turbines, will be located near Harweel, and is expected to be operational in 2017. Considering the potential intermittency of this resource, it is not currently considered as firm capacity. This position may be altered with experience of the project's electricity output. OPWP has evaluated hourly wind data collected at the site, and simulated the project's likely production profile and contribution to the Dhofar Power System.

### *Contingency Reserves*

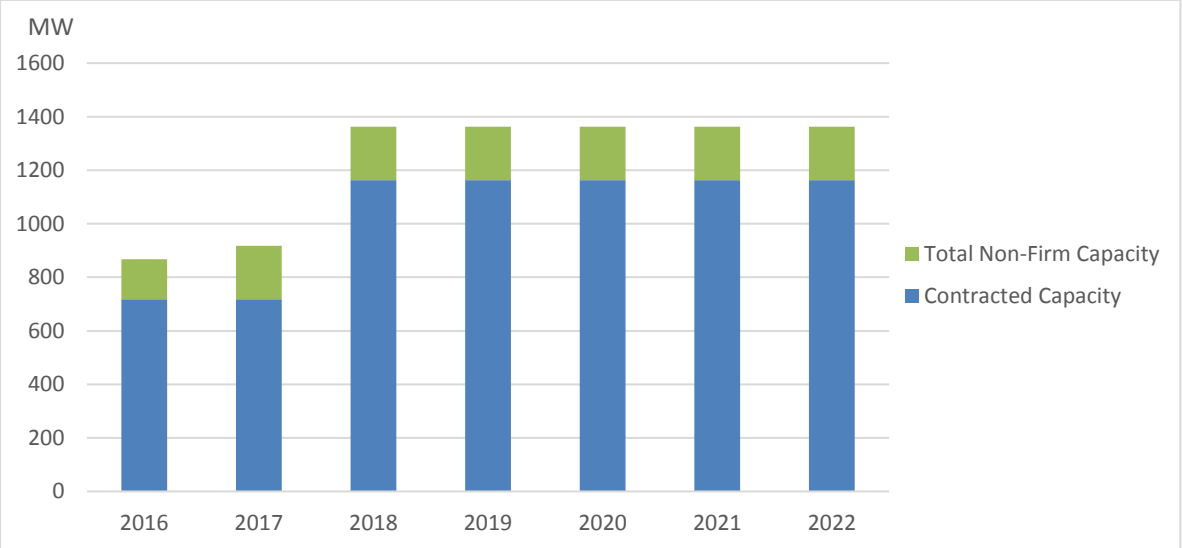
An interconnection with the PDO Power System (via a 132 kV link between Thumrait and Harweel) was completed in 2012. Its purpose is to support reserve-sharing between the two systems, providing improved reliability by allowing each system access to unused reserve in contingency scenarios.

The nominal transfer capacity of the interconnection is around 150 MW. The transfer capacity of the interconnection is not considered for resource adequacy purposes (such as LOLH calculations), but rather as contingency reserves.

### *Summary*

Figure 12 provides a summary of power generation resources for the Dhofar Power System.

**Figure 12 Total Power Generation Resources – Dhofar Power System**




| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|---|
| **Contracted Capacity** | Net MW [a] | | | | | | |
| Raysut NPS | 273 | 273 | 273 | 273 | 273 | 273 | 273 |
| Salalah IWPP | 445 | 445 | 445 | 445 | 445 | 445 | 445 |
| Salalah II IPP | - | - | 445 | 445 | 445 | 445 | 445 |
| **Total – Contracted Capacity** | **718** | **718** | **1163** | **1163** | **1163** | **1163** | **1163** |
| **Prospective Resource** | | | | | | | |
| Wind Project (non-firm) | - | 50 | 50 | 50 | 50 | 50 | 50 |
| **Contingency Reserves** | | | | | | | |
| PDO Interconnect | 150 | 150 | 150 | 150 | 150 | 150 | 150 |
| **Total Non-firm** | **150** | **200** | **200** | **200** | **200** | **200** | **200** |
| **TOTAL ALL RESOURCES** | **868** | **1686** | **2576** | **2576** | **2576** | **2576** | **2576** |

*[a] All capacities are rated on a net basis (i.e. after allowing for auxiliary consumption inside the plants) at 35°C ambient temperature.*

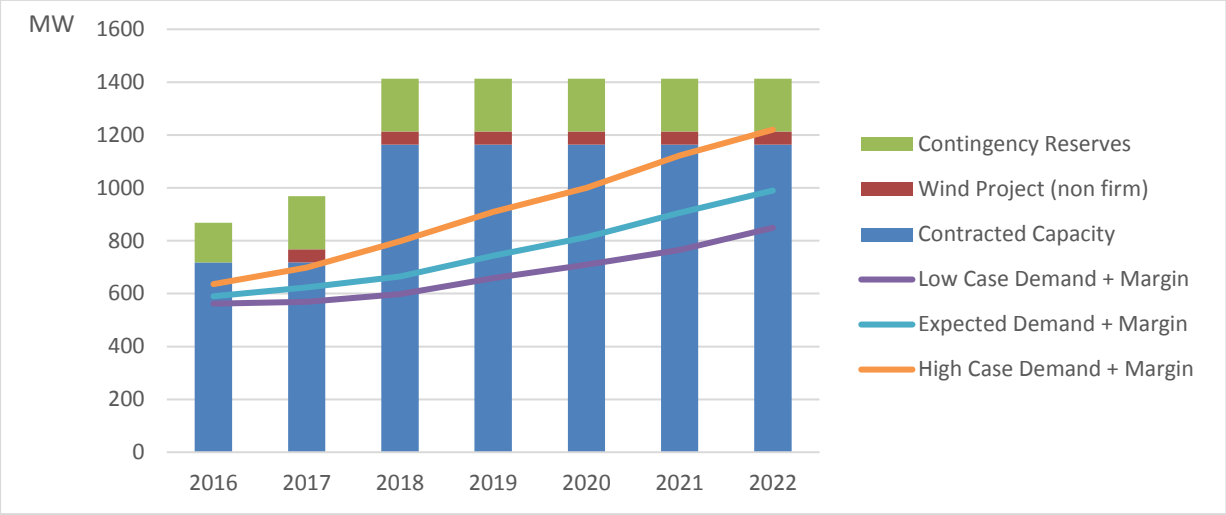
## 2.3 ADDITIONAL POWER GENERATION REQUIREMENTS

### *Statutory and Regulatory Requirements*

Similarly to its role in the MIS, OPWP is required by the Sector Law and its license to ensure the adequacy of generation resources in the Dhofar Power System 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 Dhofar Power System, a reserve margin of about 12% over peak demand is necessary to achieve the 24 LOLH standard, considering the size of the system, characteristics of generation resources, and limited access to security reserves. This establishes the capacity target for each of the three demand scenarios over the 7-year planning horizon, shown in Figure 13.

## Figure 13 Future Power Generation Capacity Requirements – Dhofar Power System




| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|---|
| **Generation Resources** | | | | | | | |
| Contracted Capacity | 718 | 718 | 1163 | 1163 | 1163 | 1163 | 1163 |
| Wind Project (non firm) | - | 50 | 50 | 50 | 50 | 50 | 50 |
| Contingency Reserve (non-firm) | 150 | 200 | 200 | 200 | 200 | 200 | 200 |
| Total Non-Firm Capacity | 150 | 250 | 250 | 250 | 250 | 250 | 250 |
| **Expected Demand** | | | | | | | |
| Peak Demand | 527 | 556 | 594 | 663 | 725 | 809 | 884 |
| Total Contracted Capacity Required | 590 | 623 | 665 | 743 | 813 | 906 | 990 |
| **Deficit (Additional Capacity Required)** | | | | | | | |
| Above Current Contracts | - | - | - | - | - | - | - |
| Above Current + Prospective | - | - | - | - | - | - | - |
| **High Case Demand** | | | | | | | |
| Peak Demand | 568 | 623 | 713 | 811 | 893 | 1002 | 1089 |
| Total Contracted Capacity Required | 636 | 698 | 798 | 909 | 1000 | 1122 | 1220 |
| **Deficit (Additional Capacity Required)** | | | | | | | |
| Above Current Contracts | - | - | - | - | - | - | 57 |
| Above Current + Prospective | - | - | - | - | - | - | 57 |
| Above Current + Prospective + Reserves | - | - | - | - | - | - | - |
| **Low Case Demand** | | | | | | | |
| Peak Demand | 502 | 508 | 534 | 589 | 634 | 683 | 758 |
| Total Contracted Capacity Required | 562 | 569 | 598 | 659 | 710 | 765 | 849 |
| **Deficit (Additional Contracted Capacity Required)** | | | | | | | |
| Above Current Contracts | - | - | - | - | - | - | - |
| Above Current + Prospective | - | - | - | - | - | - | - |

### *Capacity Balance from 2016 to 2017*

Contracted capacity is projected to be sufficient to meet the capacity target associated with all three demand scenarios throughout this period.

### *Capacity Balance from 2018 to 2022*

Salalah 2 IPP is scheduled to begin commercial operation in January 2018, with sufficient capacity to meet the capacity target through 2022 under the Expected Demand and Low Case scenarios. In the High Case scenario, it secures the capacity target in all years until 2022, in which a deficit of 57 MW emerges.[11] OPWP considers that temporary generation could be contracted to mitigate this deficit should it be confirmed as likely to occur.

OPWP concludes that contracted capacity is adequate and there is not a need to procure additional IPP capacity for the Dhofar Power System until after 2022. If the projected Expected Demand growth rate continues, the next plant addition may be required in 2024. However, OPWP is also evaluating the merits of connecting the Dhofar Power System with the MIS via 400 kV transmission line, through a cooperative study with OETC and PDO. Among other benefits, this link would secure the DPS by contributing reserves available on the MIS and PDO System. This development could delay the need for new capacity on the DPS by at least one year.

## 2.4 DESALINATED WATER REQUIREMENTS

#### *Dhofar Water Network - Demand for Water*

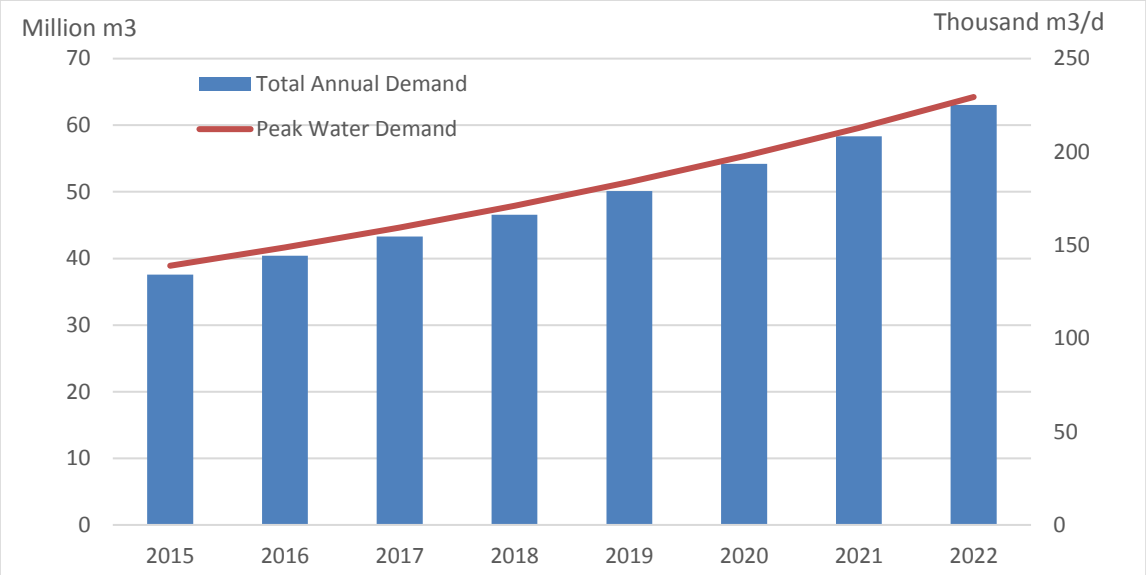
The Directorate General of Water (DGW) in the Office of the Minister of State and Governor of Dhofar has provided OPWP with the water demand projection for the Governorate of Dhofar, shown in Figure 14. It includes the aggregated potable water demands of the wilayats of Salalah, Taqa and Mirbat.

This DGW forecast is significantly higher than the forecast provided for the previous OPWP 7-Year Statement. The difference lies in the scope of demand being considered. Previous DGW forecasts have considered only revenue water in the main towns of Salalah, Taqa and Mirbat. The current forecast adds non-revenue water and the demand from communities that are not currently connected to the DGW distribution network. DGW plans to expand its network to supply these communities during the forecast period. The estimate of 2015 peak water demand, based on partial-year out-turns, exceeds last year's 2015 forecast by 58% due to the expanded scope of water demand being considered. The corresponding increase in total annual demand is 23%.

The projected annual growth rate is similar to previous projections: 7% per year for peak demand and 8% for total annual demand over the forecast period.

[11] The wind farm is not assumed to contribute firm capacity to the capacity requirement.

**Figure 14 Water Demand Projections – Dhofar (Salalah/Taqa/Mirbat)**




| DGW Forecast | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | Ave.% Growth |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | *Thousand m³/d* | | | | |
| **Peak Water Demand** | 139 | 149 | 160 | 171 | 184 | 198 | 213 | 229 | *7%* |
| *Change from 2015-2021 Statement* | *51* | *53* | *56* | *59* | *62* | *66* | *70* | - | |
| | | | | | *Million m³* | | | | |
| **Total Annual Demand** | 38 | 40 | 43 | 47 | 50 | 54 | 58 | 63 | *8%* |
| *Change from 2015-2021 Statement* | *7* | *7* | *7* | *7* | *7* | *8* | *8* | - | |

The wilayat of Salalah represents about 87% of the water consumption in 2015. This share is projected to decline somewhat over the next seven years due to higher growth rates in the wilayats of Mirbat and Taqa. The respective growth rates for the wilayats of Salalah, Mirbat and Taqah are 6%, 19%, and 15% per year during this period.

### *Dhofar Water Network - Water Supply Sources*

The Salalah Power and Water Desalination plant (Salalah IWPP), owned by Sembcorp Salalah Power and Water Company and operated under a PWPA with OPWP, is the only source of desalinated water for the Dhofar water system. The Salalah IWPP has a capacity of 68,190 $m^3$/d (15 MIGD), using RO technology, and was commissioned in March 2012. The plant began supplying water in January 2013 upon completion of the DGW interconnection facility, and from that time forward it has been producing almost continuously at peak capacity.

In addition to this desalination capacity, DGW uses groundwater sources to meet the balance of water demand. DGW estimates that groundwater supplies have a total capacity of up to around 100,000 to 110,000 $m^3$/d. Consumers prefer the consistently high quality of desalinated water supply. DGW plans to limit its use of wells to the quantity required when demand exceeds the available supply of desalinated water. This is also consistent with national policy to limit groundwater production in order to replenish aquifers.

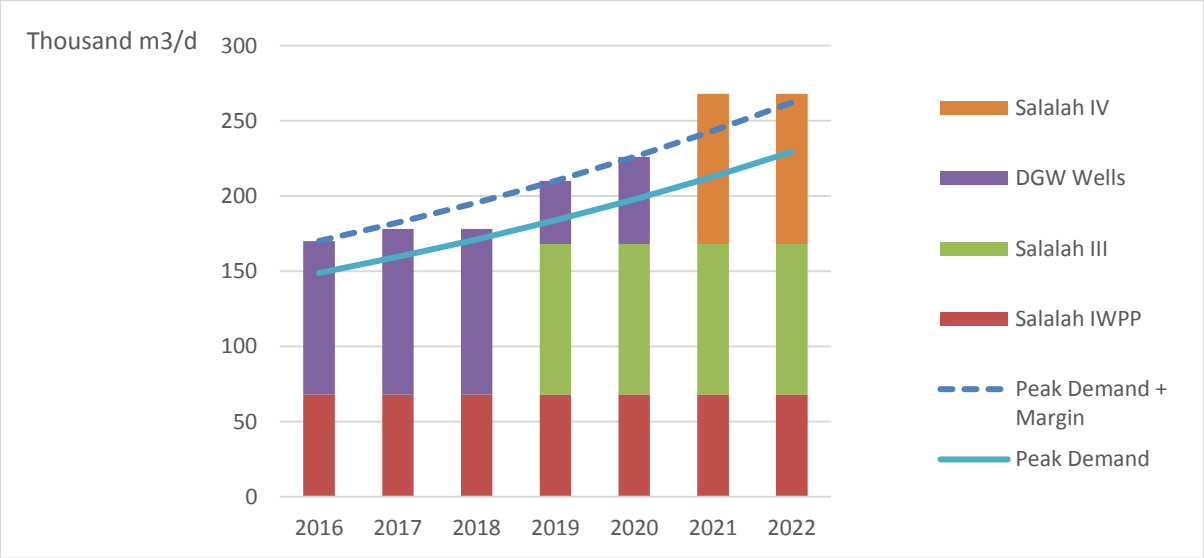
### *Dhofar Water Network - Desalination Capacity Requirement*

Figure 15 below provides a summary of the demand/supply balance in the Salalah/Taqa/Mirbat area during the 2016 - 2022 period. Current water demand exceeds desalination capacity, and the supply gap rises rapidly over the forecast horizon. DGW has requested OPWP to procure additional desalination capacity to bridge the supply gap as soon as possible.

DGW plans to save ground well supply capacity for contingency reserves, such as in case of outages in desalination units, and for the planning reserve margin over peak demand. Until additional water desalination capacity may be provided, in 2019, DGW will access groundwater resources to meet the supply gap. Thereafter, the intention is to maintain sufficient water desalination capacity to meet peak demand and to use ground well resources only for planning and contingency reserves.

Figure 15 shows both peak demand and a capacity target developed using the same reserve margin standard as the Interconnected Zone and Sharqiyah Zone in the northern regions of the Sultanate.

**Figure 15 Future Desalinated Water Capacity Requirement – Dhofar (Salalah/Taqa/Mirbat)**




| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|---|
| | | | | Thousand m³/d | | | |
| Peak Demand | 149 | 160 | 171 | 184 | 198 | 213 | 229 |
| Peak Demand + Margin | 170 | 182 | 196 | 210 | 226 | 243 | 262 |
| **Contracted Desalination Capacity** | | | | | | | |
| Salalah IWPP | 68 | 68 | 68 | 68 | 68 | 68 | 68 |
| **Reserve over Peak Demand + Margin(Shortfall)** | **-102** | **-114** | **-128** | **-142** | **-158** | **-175** | **-194** |
| **Prospective Contracted Capacity** | | | | | | | |
| New Salalah III IWP | | | | 100 | 100 | 100 | 100 |
| New Salalah IV IWP | | | | | | 100 | 100 |
| **All Water Desalination Resources** | **68** | **68** | **68** | **168** | **168** | **268** | **268** |
| **Reserve over Peak Demand (Shortfall)** | **-81** | **-92** | **-103** | **-16** | **-30** | **55** | **39** |
| DGW Well Supply[a] | 105 | 105 | 105 | 105 | 105 | 105 | 105 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Reserve over Peak Demand + Margin (Shortfall)** | 3 | 9 | 23 | 63 | 47 | 130 | 111 |

[a] Total well supply is shown as 105,000 $m^3$/d, considering an approximate capacity range of 100,000 to 110,000 $m^3$/d. In the chart, well supply is only shown to the extent it is required or available to meet peak demand.

In response to DGW's request for a new IWP with capacity of 100,000 $m^3$/d, OPWP conducted site evaluations and commenced procurement of the Salalah –III IWP. The bidder qualifications process was completed in 2015 and Request for Proposals issued in Q1 2016. The project will be operated under a WPA with OPWP and located at a site next to the existing Salalah IWPP. Commercial operation is scheduled to begin in January 2019.

From 2016 until the Salalah III IWP begins operation in 2019, the supply of desalinated water will not be sufficient to meet water demand, and DGW wells will make up the balance. Considering the current DGW forecast, total available wells supply is sufficient to meet demand in 2016, 2017, and 2018.

The capacity of the Salalah III IWP was determined to meet demand requirements assessed by DGW in 2014, and was approved by the Ministry of Finance accordingly. It was expected to provide sufficient desalinated water supply to meet DGW's water demand requirements through 2022. However, DGW's current forecast, considering the expanded scope of water supply needs, indicates that the addition of Salalah III IWP in 2019 will not provide sufficient desalinated water to meet all water demand needs in that year. Figure 15 indicates a supply deficit of 16,000 $m^3$/d against projected demand, which would be made up from DGW wells.

Additional desalination capacity would be required to meet DGW's objective to limit the role of well supply to contingency reserves. It is not feasible to increase the capacity of the Salalah IWP, which is under procurement, without delaying the project considerably. This is due to constraints on DGW infrastructure for evacuation of water from the plant site, which would require more time for pipeline and related capacity expansion. It is also advisable to select another site to provide source diversification, to mitigate risks of supply disruption.

OPWP and DGW have begun investigation of sites for a prospective Salalah IV IWP -. The project is nominally specified with a capacity of 100,000 $m^3$/d, subject to government approval. This capacity would meet DGW total demand requirements for several years beyond the forecast period, although the requirement will be studied further to assure that the timing aligns with commitments for network expansion. The commercial operation date is nominally specified as 2021; an earlier or later date may be accommodated subject to site selection and requirements for the DGW connection infrastructure.

## 2.5 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 Dhofar Power System, so as to benefit from economies of co-location and co-procurement. An assessment of these potential benefits led to the decision by OPWP to proceed with the Salalah IWPP – the first combined power and desalination plant to be developed in the Dhofar Power System.

OPWP considered the Salalah II IPP tender as a potential opportunity for combining power generation and water desalination at one site. However, DGW advised in 2013 that it was too soon to commit to additional desalination capacity, and therefore OPWP proceeded with the project on a power-only basis.

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

## 2.6 PROCUREMENT ACTIVITIES

### *Current Projects*

OPWP issued a request for qualifications in Q4 of 2015 for the Salalah III IWP with capacity of 100,000 $m^3$/d (22 MIGD). It will be located adjacent to the Salalah IWPP near Taqa. OPWP issued the Request for Proposal in Q1 2016, with bids due in Q2 2016 and award anticipated in Q4 2016. Scheduled COD is January 2019.

RAECO is developing a 50 MW wind farm at Harweel with MASDAR of Abu Dhabi, and procurement of the EPC contractor was initiated in 2015. The project will be operated by RAECO under a PPA with OPWP. The project is expected to reach commercial operation in 2017.

### *Future Procurement*

Two further potential procurement activities may be anticipated later in the forthcoming seven-year period:

- **Salalah IV IWP.** OPWP has initiated a study for the Salalah IV IWP, which may have capacity of 100,000 $m^3$/d, subject to government and regulatory approvals. The required commercial operation date may be around 2021, which would imply that initial procurement stages would begin in 2016.

- **Salalah V IPP.** The Salalah II IPP is expected to provide sufficient capacity to meet the generation security standard until around 2023 or 2024, depending upon demand growth. Procurement activities to meet the next plant, nominally the Salalah V IPP (or potentially IWPP), may be expected to begin around 2018 or 2019. A 400 kV transmission line to the MIS is also under consideration, which, if completed within this time frame, could defer the requirement for new generation capacity by a year or more.

## 2.7 FUEL REQUIREMENTS

### *2015 Fuel Usage*

Both power generation plants in the Dhofar Power System use natural gas. Total gas consumption in 2015 was about 850 million $Sm^3$ (equivalent to 2.33 million $Sm^3$/d), about 9% greater than in 2014, whereas the growth in electricity production was 13%. The peak daily gas consumption was 3.0 million $Sm^3$ in 2015, compared to 3.1 million $Sm^3$ in 2014.

### *Projected Fuel Requirements*

OPWP has prepared projections for the fuel requirements of the Dhofar Power System over the 2016-2022 period in Figure 16 below for each of the three demand scenarios. The projections are based on the following key assumptions:

- Salalah 2 IPP is assumed to begin commercial operation on schedule in January 2018;

- a 50 MW wind farm at Harweel is expected to begin commercial operation in 2017, with an average daily yield factor of about 30%; and

- no “commercial” imports or exports over the PDO interconnection are assumed to occur.

The projections are shown in Figure 16.

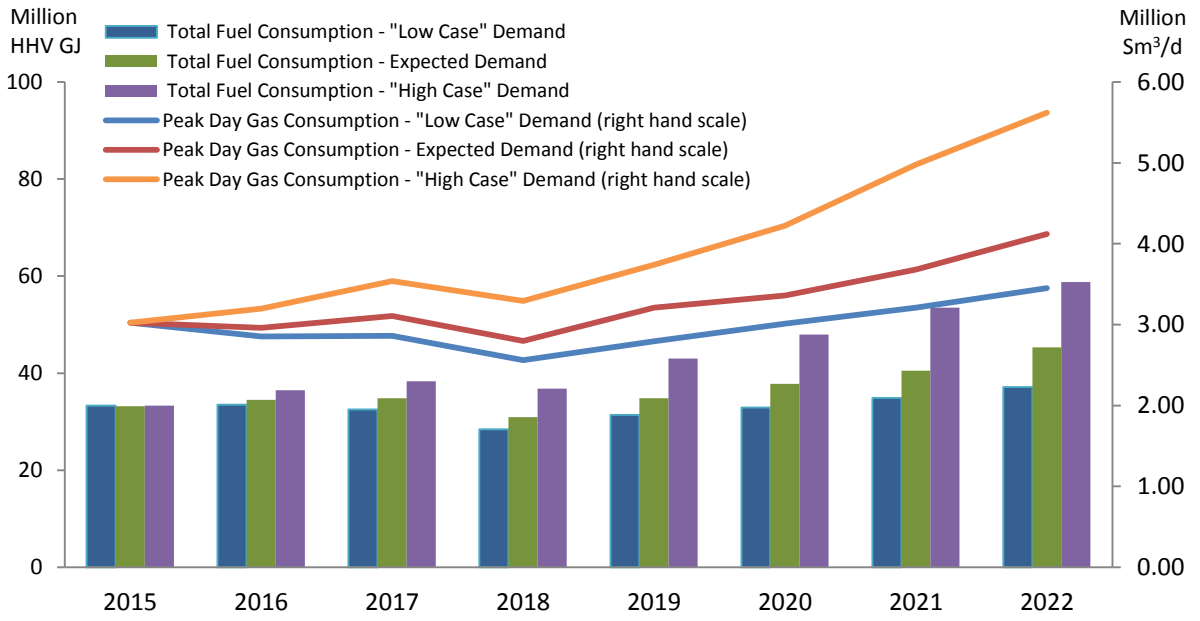
Overall fuel consumption is expected to increase at an average rate of about 5% per year in the Expected Demand scenario – substantially lower than the expected growth rate of electricity demand of about 9% per year. Under the Low Case demand scenario, fuel consumption increases at an average of 2% per year, whilst in the High Case demand scenario, it grows at an average rate of 9% per year – in both cases below the growth rate of electricity demand.

The lower growth rates in fuel consumption relative to electricity demand are mainly attributable to the addition of CCGT plants in the Dhofar Power System. The impact of the addition of the Salalah 2 IPP in 2018 is particularly evident in all scenarios.

### *Gas Availability*

OPWP consults with MOG on a regular basis, in order to confirm the future availability of gas for power generation (and associated water production) and to co-ordinate planning. In respect of the rapid growth rate in Salalah, and projected needs for the Salalah 2 IPP and later plants, it is particularly vital to secure future gas supply or identify a need for other fuel options.

**Figure 16 Projected Fuel Requirements – Dhofar Power System**




| | Actual | | | | | | | | Ave.% |
|---|---|---|---|---|---|---|---|---|---|
| | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | Growth |
| **Expected Demand** | | | | | | | | | |
| **Gas Consumption (million Sm³/d)** | | | | | | | | | |
| Annual Average | 2.3 | 2.4 | 2.4 | 2.2 | 2.4 | 2.6 | 2.8 | 3.2 | 5% |
| Peak Day | 3.0 | 3.0 | 3.1 | 2.8 | 3.2 | 3.4 | 3.7 | 4.1 | 5% |
| **Total Fuel Consumption (million HHV GJ)[a]** | **33** | **34** | **35** | **31** | **35** | **38** | **40** | **45** | **5%** |
| **Low Case Demand** | | | | | | | | | |
| **Gas Consumption (million Sm³/d)** | | | | | | | | | |
| Annual Average | 2.3 | 2.3 | 2.3 | 2.0 | 2.2 | 2.3 | 2.4 | 2.6 | 2% |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Peak Day | 3.0 | 2.9 | 2.9 | 2.6 | 2.8 | 3.0 | 3.2 | 3.5 | 2% |
| **Total Fuel Consumption (million HHV GJ)[a]** | **33** | **33** | **33** | **28** | **31** | **33** | **35** | **37** | **2%** |
| | | | | | | | | | |
| **High Case Demand** | | | | | | | | | |
| **Gas Consumption (million $Sm^3/d$)** | | | | | | | | | |
| Annual Average | 2.3 | 2.5 | 2.7 | 2.6 | 3.0 | 3.4 | 3.8 | 4.1 | 9% |
| Peak Day | 3.0 | 3.2 | 3.5 | 3.3 | 3.7 | 4.2 | 5.0 | 5.6 | 9% |
| **Total Fuel Consumption (million HHV GJ)[a]** | **33** | **36** | **38** | **37** | **43** | **48** | **54** | **59** | **8%** |

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

# SECTION 3 AD DUQM & MUSANDAM

***Ad Duqm:***

*Ad Duqm is located on the eastern coastline of the Al Wusta region, approximately halfway between the Main Interconnected System (MIS) and the Salalah System. Current population is estimated at 8,559[12], and is expected to grow rapidly due to the development of a new economic and industrial center.*

*The Ad Duqm region is currently served by a relatively small integrated generation and distribution system, owned and operated by Rural Areas Electricity Company (RAECO). RAECO owns and operates a 67 MW diesel-fuel fired power plant for supply to this grid area, and plans to add another 80 MW in 2018. RAECO is the sole licensed electricity supplier within the service area covered by the system, supplying existing and new electricity customers.*

*RAECO also provides for the potable water needs of Ad Duqm and the surrounding area with sources that include a small desalination plant and several wells.*

*OPWP's role in Ad Duqm came under government request to review options for development of an IPP or IWPP to accommodate plans for rapid development of electricity and water demand in the area.*

***Musandam:***

*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. Current population is estimated at around 39,813, which is expected to grow steadily over the coming years.*

*The relatively small integrated generation and distribution system currently in place in the Musandam Governorate is owned and operated by RAECO. Generation requirements are met by a number of small diesel generators located near load centers. OPWP is currently assisting RAECO with the procurement of a new 120 MW electricity generation plant.*

*There is no integrated water distribution network in Musandam, and the needs of communities are met by local wells or small desalination plants which are owned and operated by either PAEW or RAECO.*

[12] National Center for Statistics & Information – Population Statistics Bulletin (Issue 4 – 2014) Mid – Years Data

## 3.1 DEMAND FOR ELECTRICITY

### Historical Demand

Historically, all requirements to meet electricity demands in Ad Duqm, its surrounding areas, and Musandam have been within the jurisdiction of RAECO. Considering the relatively small energy requirements of these areas, they have been met most economically by utilizing diesel-fired generators, located close to the areas of consumption.

Demand in these two regions has been dominated by residential and small commercial consumers. This is changing rapidly due to the recent and continuing development of large commercial, tourism, and industrial projects.

### Demand Projections

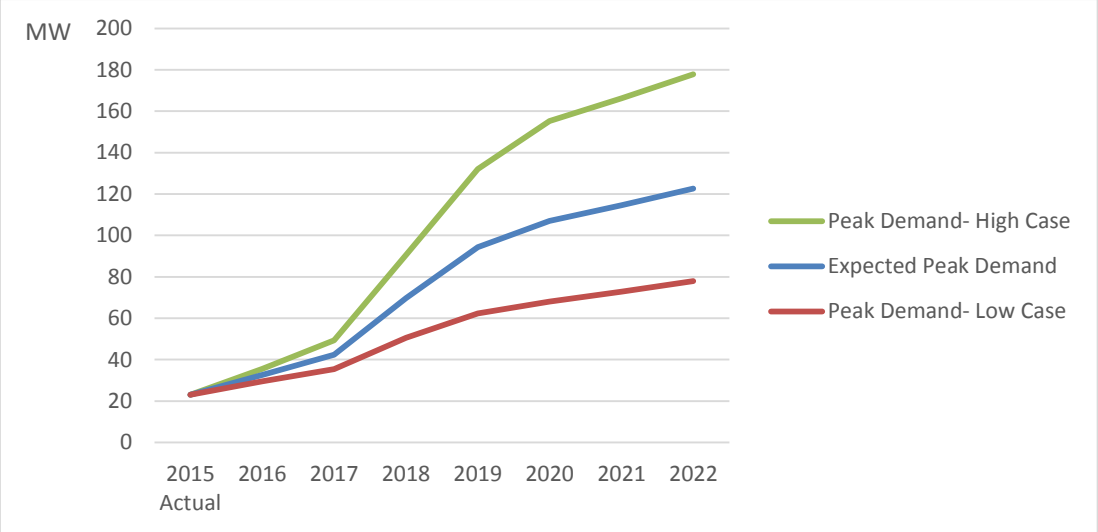
#### Ad Duqm

The developments being undertaken by the Special Economic Zone Authority of Duqm (SEZAD) will contribute substantial economic and population growth in Ad-Duqm. The demand for electricity in Ad Duqm is expected to grow significantly as SEZAD realizes its ambitious development plans. The first phase of the SEZAD Master Plan anticipates electricity demand of 650 MW by 2025. However, the pace of growth is highly uncertain and depends on many factors related to global markets, investment levels, and government incentives.

For the purposes of electricity demand projections, OPWP reports demand projections obtained from RAECO relating to domestic, and small industrial/commercial development. The demand is portrayed in three different scenarios, in Figure 17 below: an Expected Demand scenario corresponding to the RAECO forecast, and Low Case and High Case scenarios which OPWP has prepared on the basis of the central forecast.

The RAECO forecast shows a reduction in demand in 2016 and 2017 compared to its forecast reported in the previous 7 Year Statement. RAECO identifies the main drivers for this drop as a delay in construction of the Oman Oil refinery, a reduction in the number of construction workers for the refinery from 30,000 to 19,500 workers, a similar delay in commercial and light industry project construction, and delayed demand realization from the port of Duqm based on the number of investors committed to date.

**Figure 17 Electricity Demand Projections – Ad Duqm**




| Peak Electricity Demand | 2015 Actual | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | Ave. % Growth |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | *MW* | | | | |
| **RAECO: Expected Demand** | **23** | **33** | **42** | **70** | **94** | **107** | **115** | **123** | *27%* |
| *Change from 2015-2021 Statement (MW)* | *-12* | *-11* | *-8* | *16* | *37* | *46* | *50* | - | |
| **OPWP: Low Case** | **23** | **30** | **35** | **51** | **62** | **68** | **73** | **78** | *19%* |
| *Change from 2015-2021 Statement (MW)* | *-7* | *-9* | *-6* | *6* | *14* | *16* | *16* | - | |
| **OPWP: High Case** | **23** | **36** | **49** | **91** | **132** | **155** | **166** | **178** | *34%* |
| *Change from 2015-2021 Statement (MW)* | *-24* | *-18* | *-21* | *-6* | *13* | *25* | *24* | - | |

Under the Expected Demand scenario, peak demand is expected to grow at an average rate of 27% per year, from 23 MW in 2015 to 123 MW in 2022. The Expected Demand scenario is developed by RAECO from a expectations for general residential and commercial demand generated by population growth and development in the area.

The High Case scenario reflects (1) a higher than expected rate of growth associated with general and commercial demands, (2) higher materialization of customer applications relating to small-medium commercial and industrial applications, and (3) transmission connection to Haima in 2018, which adds demand associated with the Haima grid area. The Haima demand projection was prepared by RAECO. The other scenarios do not include grid connection to Haima within the forecast time period. The High Case scenario anticipates an average growth rate of 34% in peak demand, increasing from 23 MW in 2015 to 178 MW in 2022.

The Low Case scenario assumes a lower rate of growth associated with general residential and commercial demand, and assumes a lower materialization rate of small/medium industries of customer applications. This scenario has an average growth rate in peak demand of 19%, from 23 MW in 2015 to 78 MW in 2022. The peak demand forecast shows reduction in 2016 and 2017 relative to the previous 7-Year Statement in all scenarios.

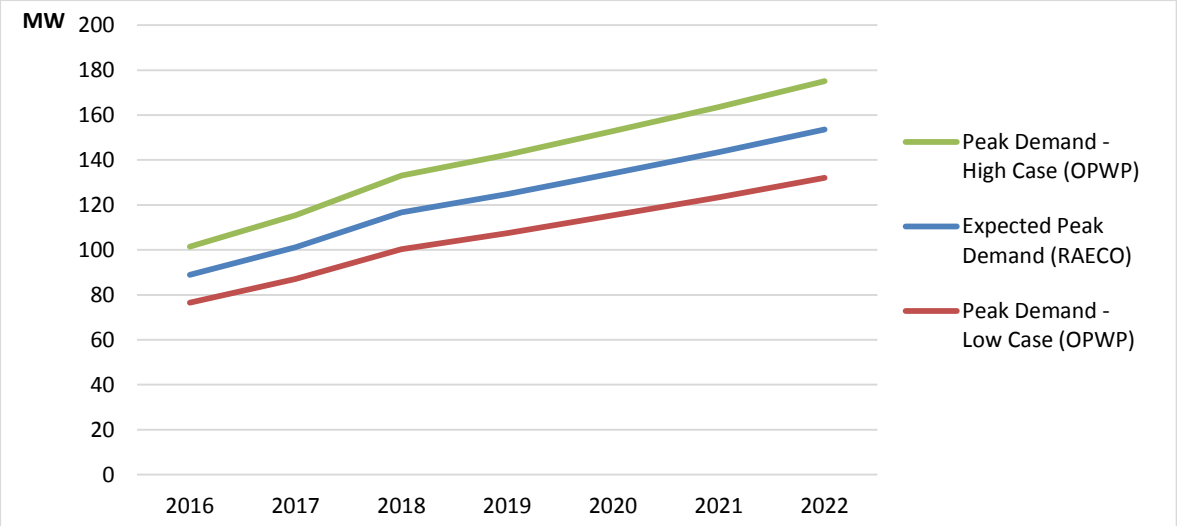
These projections do not include the large influx of industrial demand associated with SEZAD development plans. It is currently anticipated that the refinery and petrochemical complex being developed by Oman Oil Co. and others will include captive power generation to serve their own requirements. SEZAD plans large-scale industrial projects, diverse economic development and associated residential and commercial requirements over the next

30 years. The demand growth rate within the zone is expected to accelerate rapidly as key industries become established. OPWP will attend closely to the development pace and implications for electricity demand.

## Musandam

The Musandam Governorate expects future developments aimed to boost touristic, economic, and commercial activities. The Expected Demand scenario as shown below was developed by RAECO. OPWP prepared Low Case and High Case scenarios on the basis of alternate assumptions of annual growth rates for underlying demand, materialization of identified bulk consumers, and expectations for the coincidence of bulk consumers' peak demand with the peak demand on the Musandam power system. Observation of out-turns against these forecasts, and further details of specific projects, are expected to allow refinement of the forecast methodology in future OPWP Statements. The three demand scenarios are shown in figure 18 below.

**Figure 18 Electricity Demand Projections – Musandam Governorate**




| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | Ave. % Growth |
|---|---|---|---|---|---|---|---|---|
| | | | | *MW* | | | | |
| **RAECO Expected Case** | **89** | **101** | **117** | **125** | **134** | **144** | **154** | *10%* |
| *Change from 2015-2021 Statement (MW)* | *11* | *15* | *25* | *26* | *29* | *32* | | |
| **OPWP Low Case** | **76** | **87** | **100** | **107** | **115** | **123** | **132** | *8%* |
| *Change from 2015-2021 Statement (MW)* | *1* | *7* | *17* | *20* | *25* | *29* | | |
| **OPWP High Case** | **101** | **115** | **133** | **142** | **153** | **164** | **175** | *12%* |
| *Change from 2015-2021 Statement (MW)* | *27* | *31* | *39* | *41* | *44* | *47* | | |

Under the RAECO Expected Demand forecast, peak demand is expected to grow from 89 MW in 2015 to 154 MW in 2022, an average increase of 10% per year.

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 12% per year, from 89 MW in 2015 to 175 MW in 2022.

The Low Case scenario assumes a growth rate of 8% for peak demand, increasing only to 132 MW in 2022.

## 3.2 POWER GENERATION RESOURCES

### Sources of Power

#### Ad Duqm Zone

The RAECO system serving Ad Duqm and its surrounding areas is currently supplied by Ad Duqm power station, a 67 MW diesel-fired power plant which is also owned and operated by RAECO.

#### Musandam

RAECO owns and operates several power stations distributed near to load centers in the Musandam Governorate. They are all diesel-fired generators, with combined installed capacity of about 91 MW. The largest plant is located at Khasab City, and has installed capacity of about 57 MW.

The Musandam IPP is currently under construction, and will be operated by a consortium led by Oman Oil Company under a PPA with OPWP, for supply to RAECO. The IPP will provide a minimum net firm capacity of 120 MW, with expected COD by in February, 2017. The project will use reciprocating engines fueled primarily by natural gas.

### Prospective Contracts and Additional Requirements

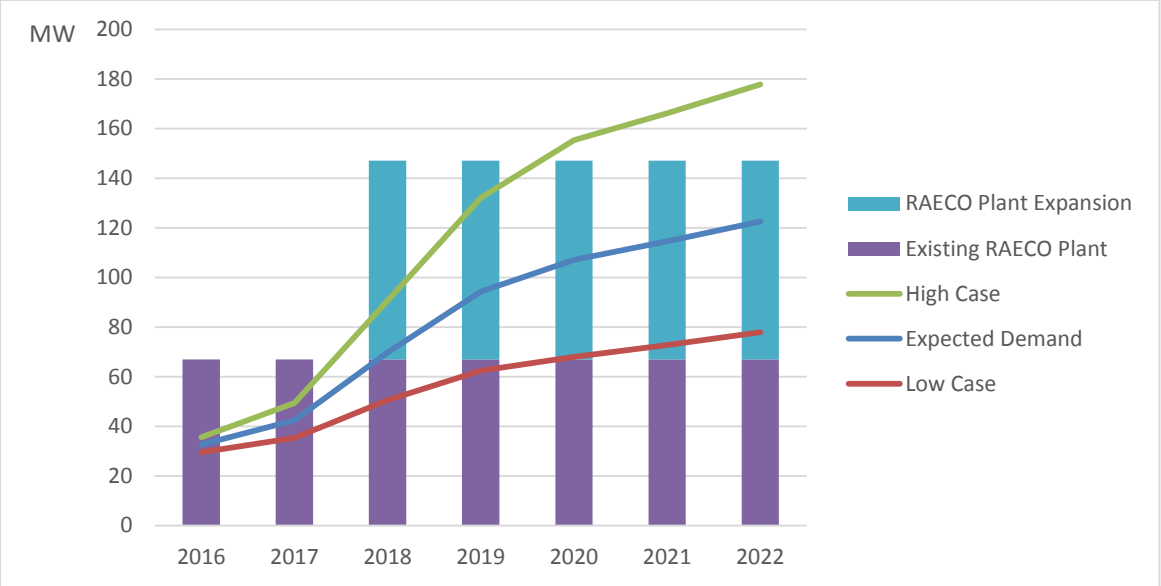
#### Ad Duqm Zone

RAECO plans to add around 80 MW of additional capacity to its existing plant at Ad Duqm by 2018. Figure 19 below demonstrates that the combined capacity of 147 MW, would be sufficient to meet Ad Duqm demand through 2022 under the Expected Demand and Low Case scenarios.

The Ad Duqm Zone may witness higher demand growth, which is represented in the High Case scenario. Figure 19 shows a supply deficit of 8 MW emerging in 2020 in this scenario, growing to 31 MW by 2022. The High Case scenario is currently considered unlikely to materialize, and no commitments are being made now to accommodate this potential incremental growth. If the outlook changes, this level of additional demand could be accommodated by temporary generation, such as rental diesel units, or possibly as a temporary capacity purchase from the refinery's captive power plant, subject to surplus capacity being available.

A transmission link to the MIS and PDO would also provide contingency options for supply to Ad Duqm. OPWP, OETC, and PDO have initiated a joint evaluation of a 400 kV transmission line linking the MIS with Duqm, the PDO system, and Dhofar. Subject to approval, this would provide Duqm with access to power generation resources in the MIS system. Once Ad Duqm develops as a major industrial and economic center, it will require this link to provide for grid stability and security.

**Figure 19 Future Power Generation Expansion Plan – Ad Duqm**

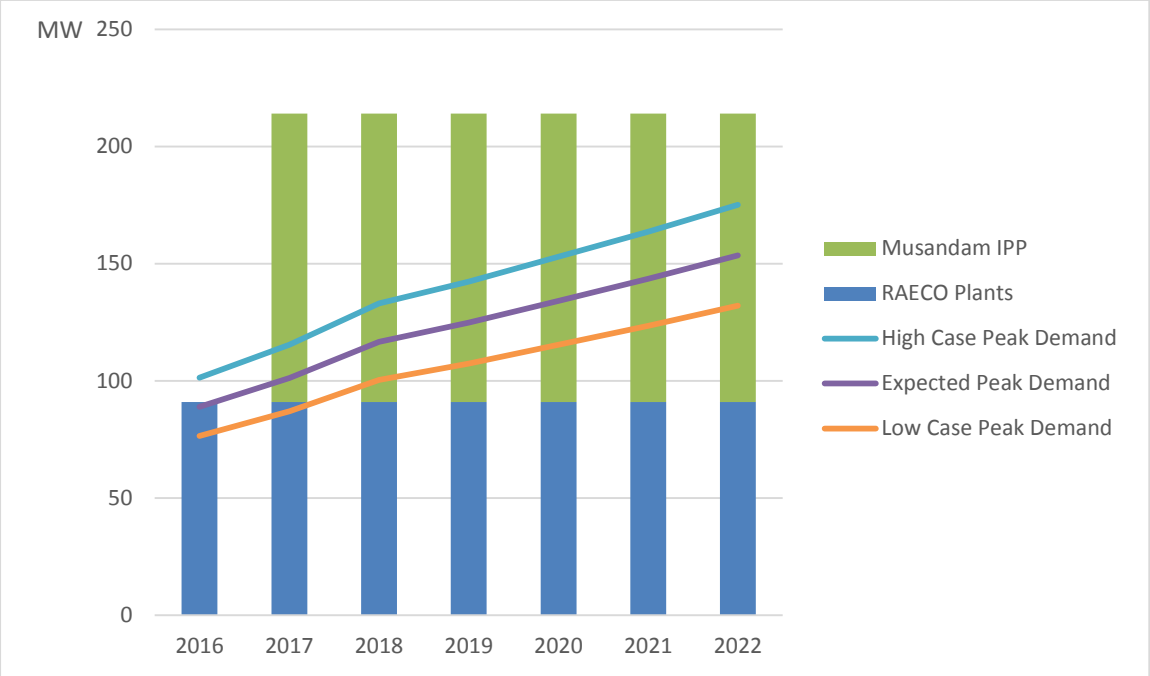



| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|---|
| **Contracted Capacity** | | | | MW | | | |
| Existing RAECO Plant | 67 | 67 | 67 | 67 | 67 | 67 | 67 |
| **Prospective Capacity** | | | | | | | |
| RAECO Plant Expansion | - | - | 80 | 80 | 80 | 80 | 80 |
| **Total Contracted Capacity + Prospective** | **67** | **67** | **147** | **147** | **147** | **147** | **147** |
| **Peak Demand** | | | | | | | |
| Expected | 33 | 42 | 70 | 94 | 107 | 115 | 123 |
| High Case | 36 | 49 | 91 | 132 | 155 | 166 | 178 |
| Low Case | 30 | 35 | 51 | 62 | 68 | 73 | 78 |

## Musandam Zone

Figure 20 below illustrates Musandam's supply/demand balance. The Musandam IPP contributes sufficient capacity to secure all three demand scenarios through 2022. It will enable RAECO to reduce its reliance on diesel generators, yielding a substantial savings in fuel costs.

## Figure 20 Future Power Generation Expansion Plans - Musandam Governorate




| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|---|
| **Contracted Capacity** | | | | MW | | | |
| RAECO Plants | 91 | 91 | 91 | 91 | 91 | 91 | 91 |
| **Prospective Capacity** | | | | | | | |
| Musandam IPP [a] | | 123 | 123 | 123 | 123 | 123 | 123 |
| **Total Contracted Capacity + Prospective** | **91** | **214** | **214** | **214** | **214** | **214** | **214** |
| **Peak Demand** | | | | | | | |
| Expected | 89 | 101 | 117 | 125 | 134 | 144 | 154 |
| High Case | 101 | 115 | 133 | 142 | 153 | 164 | 175 |
| Low Case | 76 | 87 | 100 | 107 | 115 | 123 | 132 |

The MW figures are at 45 deg. C

## 3.3 DESALINATED WATER REQUIREMENTS

### Demand for Water – Ad Duqm Zone

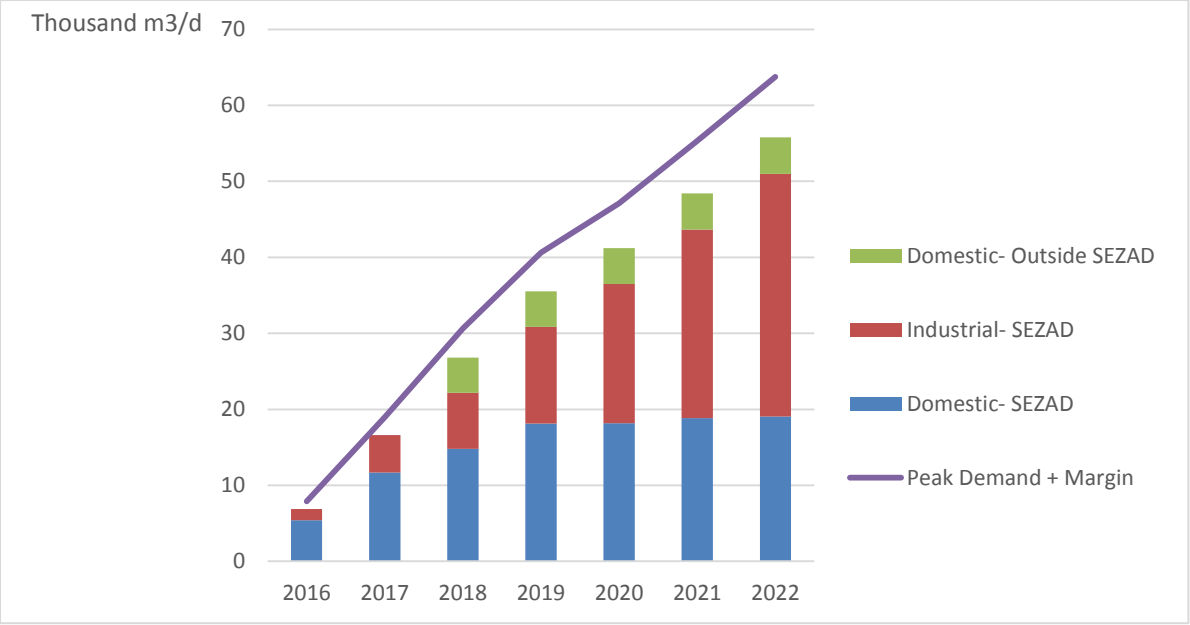
PAEW has provided OPWP with the water demand projections for the Ad Duqm Zone, based on estimates made by the Special Economic Zone Authority of Duqm (SEZAD) for industrial demand, domestic demand within the zone, and residential demand in the area surrounding the zone. The projections are shown in Figure 21 below. The SEZAD projections were prepared after discussions with PAEW toward aligning their forecast methodologies.

PAEW's responsibilities for water supply are considered to extend into the Special Economic Zone (SEZ), such that industrial water demand is included in the projection toward determining water supply requirements.[13] The SEZAD projection for domestic demand includes the town of Duqm; domestic demand outside of Duqm is the responsibility of PAEW.

A transmission pipeline is planned to connect Haima with the Duqm water supply. The projection for domestic demand outside of Duqm includes water demand from Haima and communities along the length of the pipeline, including Abu Madhabi and Al Ajaiz. This water demand must be addressed by water sources in Duqm when the transmission pipeline is commissioned, which is expected in 2018.

Figure 21 shows the water demand forecast for Ad Duqm Zone separated into the three demand sectors: domestic demand in the SEZ, industrial demand in the SEZAD, and domestic demand outside the SEZ. The industrial projects have the largest contribution to total water demand growth within the SEZ, although domestic demand is projected to grow most rapidly in the near term.

**Figure 21 Peak Water Demand and Capacity Requirement - Ad Duqm Zone**




[13] The boundaries of PAEW's reach into the SEZ remain undefined in the long term, in particular with respect to industrial demand. For the purposes of OPWP's Statement, the SEZAD water demand through 2022 is considered as part of the overall water demand to be addressed by PAEW supplies. The water demand of the oil refinery and related petrochemical projects are not included, as they are expected to develop their own water supply capacity.

| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|---|
| PAEW/SEZAD Forecast | Thousand m3/day | | | | | | |
| **Peak Water Demand** | **7** | **17** | **27** | **36** | **41** | **48** | **56** |
| Domestic- SEZAD | 5 | 12 | 15 | 18 | 18 | 19 | 19 |
| Industrial- SEZAD | 1.5 | 5 | 7 | 13 | 18 | 25 | 32 |
| Domestic- Outside SEZAD | | | 4.6 | 4.7 | 4.7 | 4.8 | 4.8 |
| **Peak Demand + Margin** | **8** | **19** | **31** | **41** | **47** | **55** | **64** |
| *Change from previous Statement (2015-2021)* | *-3* | *-2* | *-2* | *1* | *-2* | *-3* | - |

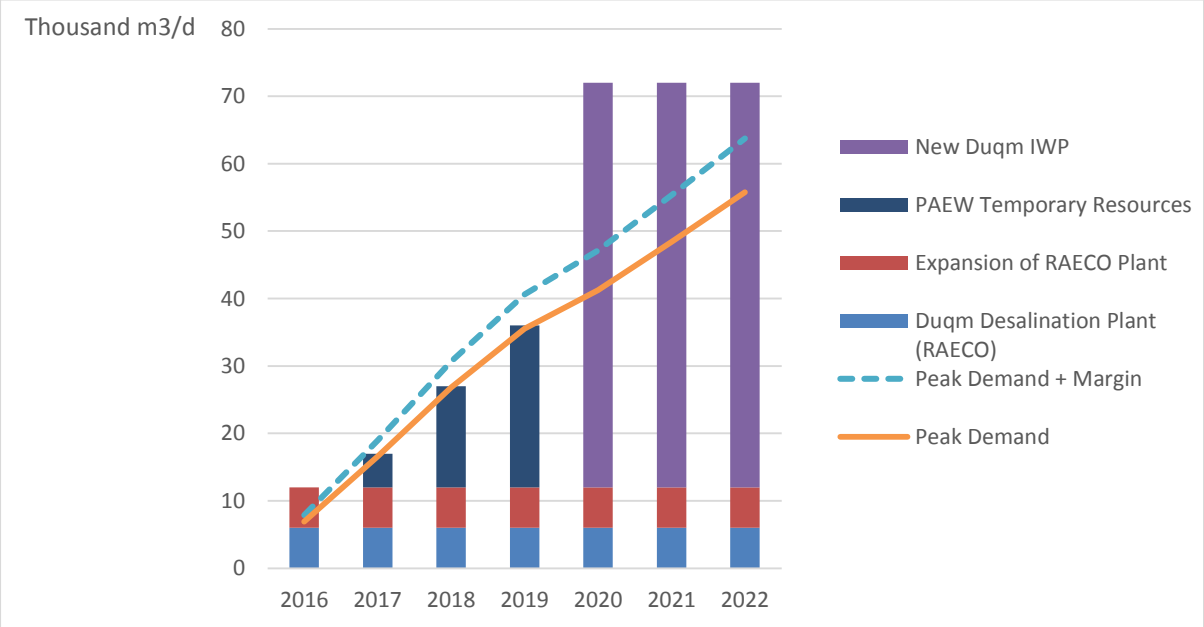
## Water Sources and Desalination Capacity Requirement – Ad Duqm Zone

The Ad Duqm Zone is currently served by a 6,000 $m^3$/d (1 MIGD) desalination plant owned by RAECO in Ad Duqm town, and a number of local water sources. RAECO expects to expand the plant to produce an additional 6,000 $m^3$/d (1 MIGD) in 2016.

Figure 22 compares the desalination capacity target with available water sources, demonstrating that the planned 2016 expansion of the RAECO plant will only meet the capacity target in 2016. A rapidly growing supply deficit emerges in 2017. The principal source of growth in this period is in domestic demand. Additional supplies may need to be made available if the anticipated demand growth is to be met.

OPWP expects to initiate procurement in 2016, in response to PAEW request, for a new Duqm IWP to be commissioned in 2020. The plant capacity is expected to be 60,000 $m^3$/d (13.2 MIGD), which would be sufficient to meet the capacity target through 2022. The capacity target is based on the RAECO demand projection and a 14% reserve margin. During the intervening years before the Duqm IWP is available, from 2017 to 2019, PAEW plans to provide for demand requirements in excess of the RAECO plants using wells and temporary water supply as needed.

**Figure 22 Water Supply and Demand Balance - Ad Duqm Zone**

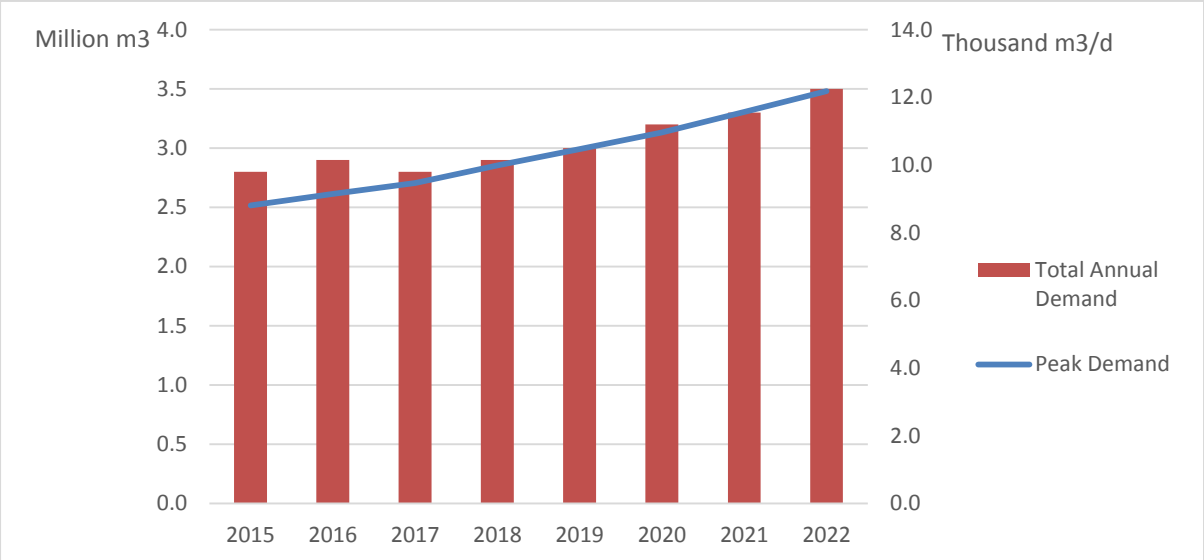


| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|---|
| **Duqm Zone** | | | | Thousand m3/day | | | |
| **Peak Water Demand** | **7** | **17** | **27** | **36** | **41** | **48** | **56** |
| **Peak Deamdn + Margin** | **8** | **19** | **31** | **41** | **47** | **55** | **64** |
| *Change from previous Statement (2015-2021)* | *-3* | *-2* | *-2* | *1* | *-2* | *-3* | |
| **Contracted Desalination Capacity** | | | | | | | |
| Duqm Desalination Plant (RAECo) | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| Expansion of RAECo Plant | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| **Prospective Capacity** | | | | | | | |
| PAEW Temporary Resources | - | 5 | 15 | 24 | - | - | - |
| New Duqm IWP | | | | | 60 | 60 | 60 |
| **All Resources** | **12** | **17** | **27** | **36** | **72** | **72** | **72** |
| Reserve over Peak Demand + Margin (shortfall) | 4 | 2 | 4 | 5 | 25 | 17 | 8 |

## Demand for Water – Musandam Zone

PAEW has provided OPWP with the water demand projections for the Musandam Zone, focusing on the Khasab City area. These projections are shown in Figure 23 below.

**Figure 23 Peak Water Demand Projections – Musandam**



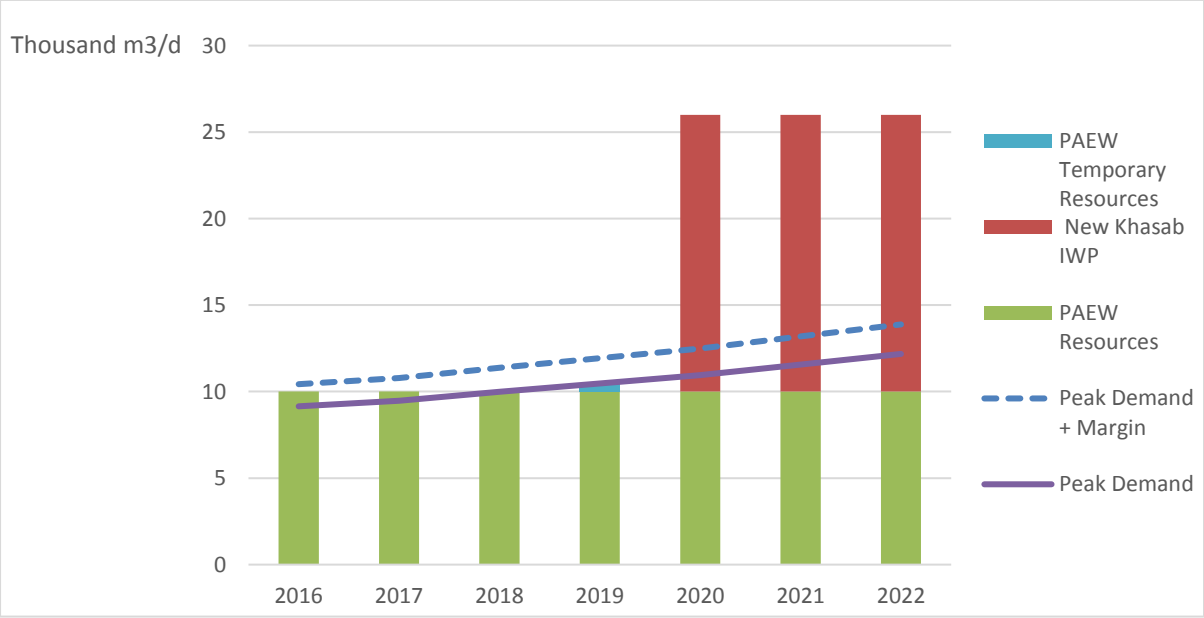
| | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | Ave.% Growth |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Thousand m3/d | | | | |
| **Peak Water Demand** | **8.8** | **9.1** | **9.5** | **10.0** | **10.5** | **11.0** | **11.6** | **12.2** | **5%** |
| | | | | | Million m3 | | | | |
| **Total Annual Demand** | **2.8** | **2.9** | **2.8** | **2.9** | **3.0** | **3.2** | **3.3** | **3.5** | **3%** |

### Desalination Capacity Requirement – Musandam

The Musandam Zone is currently served by small desalination plants: one in Kumzar (450 $m^3$/d) that is owned and operated by RAECO, three PAEW plants with combined capacity of about 3,500 $m^3$/d, and wells. PAEW has requested OPWP to initiate procurement for a new IWP to serve Khasab City, with capacity of about 16,000 $m^3$/d (3 MIGD). Procurement of the IWP is expected to begin in 2016 pending confirmation of the site location by PAEW, providing commercial operation potentially late in 2019. There may be incremental capacity needs for short periods before the new IWP is completed, to meet peak demand, which PAEW plans to assess and potentially meet via temporary capacity if required.

Figure 24 compares the desalination capacity target with the prospective water sources. The prospective IWP would have sufficient capacity to meet demand and reserve margin through 2022, allowing PAEW to reduce well production and allow aquifer recharge.

**Figure 24 Water Supply and Demand Balance – Musandam**




| Musandam Zone | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | Ave. % Growth |
|---|---|---|---|---|---|---|---|---|
| **Supply Requirement** | | | | Thousand m3/d | | | | |
| Peak Demand | 9.1 | 9.5 | 10.0 | 10.5 | 11.0 | 11.6 | 12.2 | 5% |
| **Peak Demand + Margin** | **10.4** | **10.8** | **11.4** | **11.9** | **12.5** | **13.2** | **13.9** | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Existing Capacity** | | | | | | | |
| PAEW Resources[a] | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| **Prospective Capacity** | | | | | | | |
| PAEW Resouces | - | - | - | 0.5 | - | - | - |
| Khasab City IWP | - | - | - | - | 16 | 16 | 16 |
| **Reserve over Peak Demand + Margin (Shortfall)** | 0.4 | 0.8 | 1.4 | 1.4 | 13.5 | 12.8 | 12.1 |

[a] Wells and small desalination plants are currently sufficient to meet capacity needs with no margin.

## 3.4 PROCUREMENT ACTIVITIES

OPWP expects to procure desalinated water facilities for operation in Ad Duqm and Musandam Governorate in 2016. These projects include the following:

- **Duqm IWP**, with capacity of 60,000 $m^3$/d (13.2 MIGD) using RO technology. The RFQ was released in December 2015, and the RFP is expected to be issued in 2016, pending final site approval by SEZAD. The project is expected to reach COD in the fourth quarter of 2019.
- **Khasab IWP**, with capacity of 16,000 $m^3$/d (3 MIGD) using RO technology, with anticipated COD in the fourth quarter of 2019. The procurement process is expected to begin in 2016, pending final site approvals.