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DHOFAR SERVICES

Capability Statement 2024-2026

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1 EXECUTIVE SUMMARY

This Capability Statement presents a holistic, picture of the **Nama Dhofar Services** (hereinafter referred to as **NDS**) operated electricity distribution network in the Dhofar Region (Earlier known as Dhofar integrated services Company or DISC); its current status, ongoing expansions and future development plans for the period 2024-2026. NDS, operating under the Distribution & Supply Licence, granted under the aegis of The Authority for Public Services Regulation (APSR) (previously known as Authority for Electricity Regulation Oman (AER)), is required to prepare a statement, with respect to each of the three successive financial years 2024-26, reflecting the circuit capacity, forecast of power flows, loading on each part of its Distribution System, and the associated fault levels. The statement is also required to provide information on the anticipated future requirements to manage and/or realize the circuit capacity, optimum connection points, constraints foreseen, progress of on-going investments, and any other information deemed important from the perspective of an existing or potential user of the system.

The Statement herewith presented, seeks to furnish an overview of NDS power distribution system, present & future, to a level of detail that is considered to be fit for purpose and suitably balanced. It includes information about the distribution network, its topology including all the components applied and used to develop the distribution system, such as overhead lines, underground cables or power transformers. The statement dedicates a chapter to provide the Design Philosophies and Practices observed by NDS, reflecting on the Design and Operational Criteria and Technical Standards. Also provided is an overview of the Distribution System in terms of Load Management, Load Profiles, System Losses and Interconnections. A comprehensive “power system study” has been executed using the DigSilent Power Factory software. The Capability Statement furnishes the results of this study, considering the system operation for the peak demand scenario, during every year of the three years under study.

The key messages intended to be conveyed through Capability Statement may be condensed as below:

- NDS network, in general, exhibits an appreciable level of compliance with the security standards. Latest update of the on-going and proposed projects at the 33 kV system level is presented in the Table 7.1-1 of Section 7 of this report. These projects primarily constitute Nama Dhofar Services infrastructural baseline towards ensuring a secure supply of electricity to its customers. The implementation of these projects will bring the necessary relief to existing 33/11 kV primary substations through the construction of new primary substations, provide additional capacity to meet the future electricity demand growth in those areas and opportunity for new customers to get power supply immediately.
- The region of Dhofar looks set to experience an average load growth of around 15.6% (excluding the RAECO transferred network area) for the next three years. Nama Dhofar Services, after restructuring is doing its best to minimize the number of occurrences of non-compliance with the security standards.

The main purpose of the Capability Statement is to enable the Users seeking the use of the NDS Distribution System, to identify and evaluate the opportunities available when connecting to and making use of such system. It also gives a forward view on the proposed Distribution infrastructure expansion plans to meet the forecast demand growth. However, we recommend prospective Users of the system and other stakeholders to contact NDS directly if they want to fully understand the opportunities available to them.

2 INTRODUCTION

As part of the restructuring process of the electricity, water and wastewater in the Dhofar Governorate, a new company "Nama Dhofar Services" (NDS) was formed on 1st June 2021 to serves the people of Dhofar governorate, covering electricity, water and wastewater with the aim to raise the quality of these services and make them more efficient, reliable and accessible.

Further, to eliminate/reduce the diesel generation plants in the Dhofar region (considering the high running/operation charges and high maintenance charges of Diesel generation plants), all the TANWEER owned distribution network assets in the Dhofar region have been transferred to NDS on 1st January 2022 in accordance with the license condition 34.

This Capability Statement is prepared according to Distribution and Supply Licence, Condition 32, which further describes the information to be included within the statement, as below:

- Information on the status of distribution capacity and estimated future requirements;
- Commentary from NDS explaining the parts of the system that are considered to be best suited to cater for new connections;
- Information of the potential system constraints to development;
- Progress report relating to on-going network developments;
- such further information as shall be reasonably necessary to enable any Person seeking to Connect to or use the Licensee's Distribution System to identify and evaluate the opportunities for so doing
- Assessment of NDS's system technical losses.
- such other matters as shall be specified in directions issued by the Authority from time to time for the purposes of this Condition.

The Distribution Planning Code in its clause (DPC 4.4) also refers to the obligations explained above.

This Statement focuses on the provision of information such as network capabilities and limits, planned network development/reinforcement initiatives, including potential customers that are interested in connecting to NDS network. It also contributes to fulfilling the objectives of Distribution Planning Code (DPC 2), with regards to exchange and supply of information.

2.1 Content of the Statement

The following summarises the content of the remainder of this report:

- **Design philosophies and practices** - General description of design philosophies, technical criteria, standards and interconnection requirements to both consumers and generators;
- **Overview of the distribution system** - General description of operating voltages, load profiles and expected evolution, as well as system losses;
- **Medium voltage distribution system** - Description of the 33kV and 11kV networks of NDS, including results of load flows and short-circuit calculation at 33kV and 11kV nodes (limited to PSS busbars), with comparisons to equipment ratings and analysis of DSSS compliance.

- **Low voltage distribution system** - Description of the low voltage distribution system of NDS, focusing on topology and main characteristics of the existing equipment;
- **Strategic development** - Description of the investments planned by NDS to ensure the adequate performance of its network with focus on ensuring security of supply.

2.2 NDS Distribution Network

The NDS distribution network of NDS region spread over in the Dhofar covers approximately an area of 11,550 sq.km, extending along the southern coast of Oman from Dhalkut (near Yeman border, located approximately 160km from Salalah in the western corner of Dhofar Governorate), to Shuwaymia area about 185km to the east of Salalah. The network also stretches into the Dhofar mountains and towards North of Salalah about 165km from Salalah to Saih al khairat area and also towards Al Mazyunah area (near Yeman border, located approximately 265km from Salalah). A large portion of the network covers a sparsely populated, rugged and occasionally mountainous terrain. However, in Salalah area and its proximity the network is characterized by higher load density and also by the presence of important industrial clients.

Geographical map showing the NDS authorized area i.e. Dhofar region is presented in the Figure 2.2-1 below.

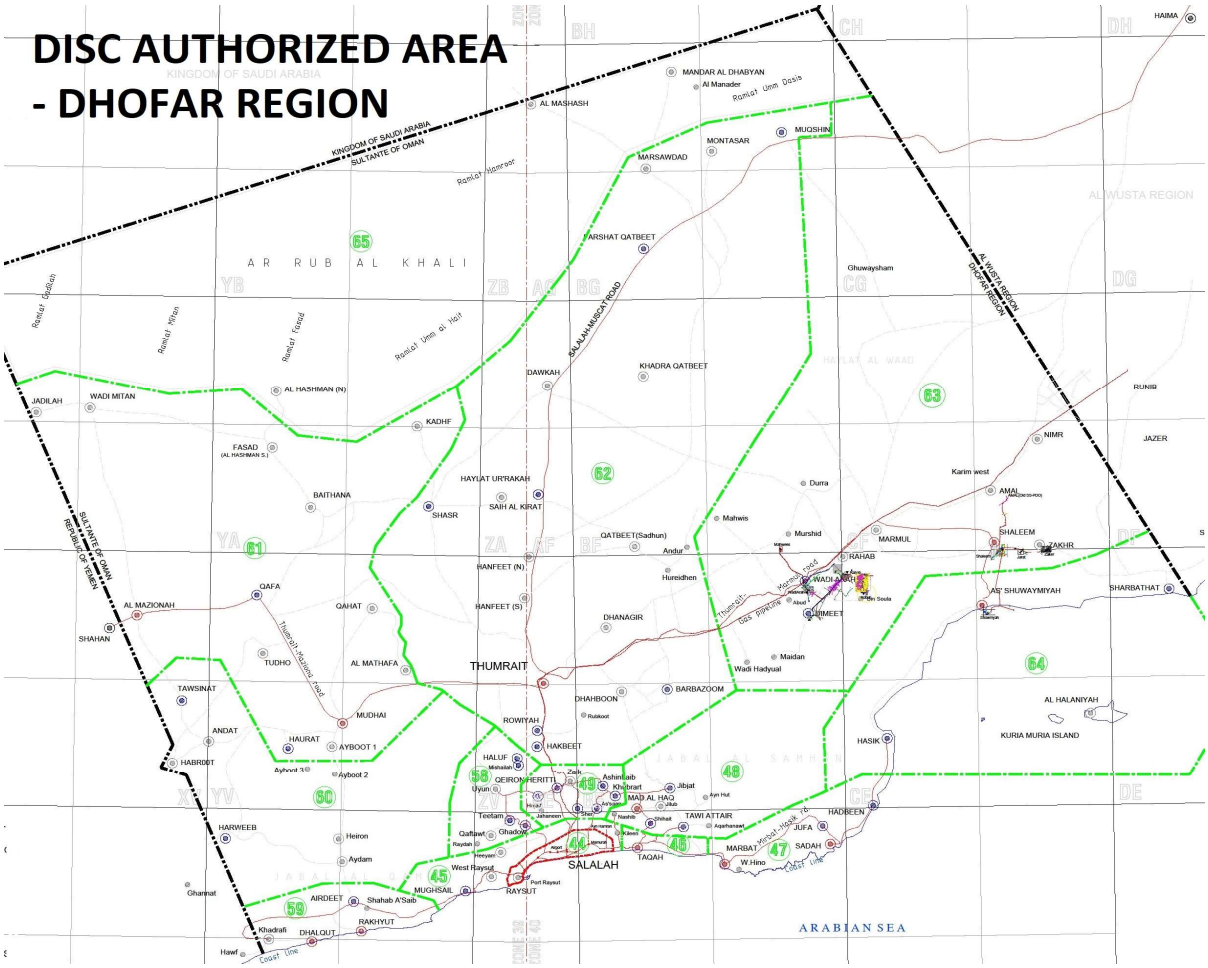


Figure 2.2-1 Geographical map showing NDS operational area in the Dhofar region

NDS asset information (network statistics) such as the total length of overhead lines and underground cables for each voltage level, number of power transformers and distribution transformers etc. is given in the below Table 2.2-1 (as on 30th Sep'23). The figures include all the distribution assets transferred from the TANWEER in the Dhofar region.

Table 2.2-1: NDS Asset Information (as on 30th Sep'23)

Asset	Type	Description	Grand Total
Network lines/cables circuit length	Overhead lines - circuit (in km)	LV lines	2004.9175
		11kV lines	2335.442
		33kV lines	1501.926
	Underground cables - circuit (in km)	LV cables	3109.864
		11kV cables	1681.817
		33kV cables	996.205
Number of Distribution Transformers	11kV/LV 3ph Pole Mounted Distribution Transformers (PMT)	50KVA	17
		100KVA	955
		200KVA	484
		315KVA	887
	11kV/LV 3ph Ground Mounted Distribution Transformers (GMT)	400KVA	0
		500KVA	525
		800KVA	9
		1000KVA	2426
		1250KVA	4
		1500KVA	1
		1600KVA	3
		2000KVA	2
Number of Power Transformers	33/11kV Power Transformers	0.315 MVA	1
		1 MVA	9
		3 MVA	10
		6 MVA	20
		10 MVA	13
		20 MVA	92

Customer Accounts and Energy: In accordance with the decision issued by the Council of Ministers, the new tariffs for the electricity and water sectors have been endorsed. The Authority issued its regulations. The new approved tariff for electricity and water includes the following categories: the Residential Tariff, which includes the citizen's account tariff, the resident's account tariff and additional accounts, while the Non-Residential Tariff includes Large Customers, the Non-Residential Category, and Agricultural and Fisheries Activities, for which the Cost-Reflective Tariff (CRT) is applied.

Cost Reflective Tariffs (CRT): The Council of Ministers approved the implementation of Cost Reflective Tariffs on electricity supplied to Government, Commercial and Industrial customers whose consumption exceeds 100 MWh per year, starting from 1 January 2021. Cost Reflective Tariffs consist of four components: - hourly Energy charges referenced to published PWP Bulk Supply Tariffs (BST); - a Transmission Use of System charge (T) applied to a customer's contribution to system peak demand; - a Distribution Use of System Charge (D)

applied to each kWh transported across a licensed Distribution System to a customer's premises; - a Supply charge (S) to recover the costs of administering a customer's account (including meter reading, billing and collection costs).

Detailed information/documents regarding the permitted tariffs are available on the APSR website and link for the same is given below.

Permitted Tariffs | Authority for Public Services Regulation (apsr.om)

Table 2.2-2 below shows the total number of customer account and the energy consumption up to September 2023 (excluding the recently transferred network area by TANWEER to NDS in the Dhofar region) for all customer categories based on the Tariff.

Table 2.2-2: Total number of Customer Account and Energy Consumption up to September 2023

Tariff Category	Total CA (in No's)	Total Units Supplied (in MWh)
Residential	**106,647**	**1,021,485**
Non-Residential	**30,452**	**290,179**
Agriculture & Fisheries (non-CRT)	**177**	**35,547**
Special Tariff Customer	**5**	**41,258**
CRT customers (Distribution and Transmission connected)	**1,508**	**1,264,590**
Total	**138,789**	**2,653,058**

The NDS network (excluding the RAECO transferred network area in the Dhofar region) is divided into the following three operation zones:

Zone 1 covers mainly the city of Salalah and nearby industrial sites such as Salalah Free Zone (SFZ) and Raysut Industrial Estate. It represents around 82.8% of non-bulk demand profile of NDS System and has historically presented very high bulk customer peak demand growth. Zone 1 has thirty-five (35) PSSs with total installed firm capacity (N-1 secure) of 770 MVA. Majority of bulk customers including Raysut Cement, Salalah Port, Octal and Dunes Oman etc. are in Zone-1.

Zone 2 covers an area to the north of Salalah (Al Sa'an, Qairoon Hairiti, Hakbeet, Thumrait and Dahboon), which represents around 5.6% of non-bulk demand profile of NDS System. Recently, Zone 2 has seen significant increase in residential customer's load. For the future, it is expected that the growth in Zone 2 will be contributed by small industrial customers (*e.g.* crusher plant), new street lightings, and developments by the Ministry of Defence. Zone 2 has six (6) PSS's with total installed firm capacity of 82 MVA. Thumrait RAFO is the major bulk customer in Zone-2.

Zone 3 covers the area to the East of Salalah (Taqa, Mirbat & Jufa/Sadah) which represents around 11.6% of non-bulk demand profile of NDS System. Zone 3 has seen some significant load growth over the last few years, mostly due to increase in non-bulk customers, since the presence of bulk customers is very limited. The nature of the load in Zone 3, being dispersed and with large presence of water pumps, represents an important challenge in terms of maintaining voltage quality. This is especially the case of the Juffa/ Sadah region which is radially fed from Mirbat and therefore not directly connected to a grid substation. Zone-3 has eight (8) PSS's with a total installed firm capacity of 136 MVA.

3 Design Philosophies and practices

NDS shall develop and maintain a Distribution System that allows operation within equipment design ratings for normal, planned outage and fault conditions and meet the requirement in the Distribution and Supply Licence with a design that complies with the Oman Electricity Standards (OES) and in line with Distribution Code. NDS shall provide a cost-effective solution in the development of the distribution network in Dhofar region.

3.1 Background

The Distribution System is designed in accordance with a number of national and international engineering recommendations. The key ones are referenced in the Distribution Code and are available from The Authority for Public Services Regulation (APSR), Oman.

NDS shall plan and develop its Distribution System in such a way that it complies with the system design requirements of Conditions 3, 4 and 31 of NDS's Distribution and Supply Licence:

- Condition 3: Compliance with the Grid Code;
- Condition 4: Implementation of and Compliance with the Distribution Code;
- Condition 31: Security standards and efficient and economic System - requires the system to be designed in accordance with Distribution System Security Standard (DSSS).

NDS distribution network consists of 33kV, 11kV and LV systems. The 33kV radial feeders emanating from twelve 132/33kV Grid substations transmit power to forty-nine (49) existing 33/11kV PSS's. The details of 33kV feeders emanating from each grid substation are given in section 8.2 of Annexure 8.

The 33kV radial feeders from grid substations are feeding 33/11kV primary substations which in turn supply the 11/0.433 kV distribution substations through 11kV feeders. The distribution substations are supplying electricity to customers through LV lines. Bulk customers are mostly connected at high voltage level i.e. 33kV, 11kV and some are also connected at low voltage.

The primary substations mainly comprise of 33kV switchgears and two 33/11kV transformers. The 33kV and 11kV bus are operated "normally open" with an auto-changeover scheme at 11kV to mitigate any unplanned interruptions on the 33kV feeders or on the power transformers. The 33kV distribution network is operated as a double circuit radial network. However, the new primary substations (which are under construction/planned) does not include 33kV switchgears and 33kV feeders from grid substation are directly connected to transformers.

Majority of the primary substations design is based on OES configuration of 2 x 20MVA transformers connected to busbar supplied through 33kV underground cables from grid substations in the urban areas. In rural areas, the 33kV connections is via a combination of overhead lines and underground cables depending on the route approved. The 33kV the overhead line and underground cable circuits are nominally rated at 20MVA to match the transformer rating.

There are a few exceptions to the standard 2 x 20MVA design outside the city, where the demand has previously been low. These are at Madinat Al Haq (2x10), Teetam (2x10 MVA), Hakbeet (2x10 MVA) and Dahaboon (2x6MVA).

Al Saan PSS and FOSHI (Hadbeen) primary substation is exceptional to the standard OES configuration, where it has 33/11kV, 1x6MVA capacity transformer fed by a single 33kV circuit to meet the demand in that area and also to mitigate the voltage issues in the NDS network in vicinity of Al Saan and FOSHI area.

NDS distribution system also have SQH-2 PSS, Dahariz PSS, Saada-2 and Jarziz PSS, which are commissioned recently with configuration of 3x20 MVA capacity. In this case, normally two transformers are operating in parallel and third transformer is fed radially.

NDS has incorporated the parallel operation philosophy in its recently constructed 2x20 MVA capacity PSS's at Ashoor A and Ashoor B also. Both these PSS's are designed and commissioned for parallel operation transformers and are currently operating in parallel. Further, NDS is planning to incorporate parallel operation of transformers in all its future primary substations.

NDS must adhere to the following planning criteria for the Distribution System, which influences the investment criteria:

- Network shall be designed to comply with security criterion such that following outage of any one feeder/ line or transformer, power supply shall be restored within the time frame specified in Distribution System Security Standard (DSSS) approved by APSR.
- The 11kV networks are operated radially with open ring with strategically located open points. The other end of the ring circuit is either fed from the same primary or from another primary, so that in the event of a fault on the either side of the open point, the faulted section can be isolated and the supplies restored from either end, maintaining the radial configuration whilst providing a level of security that is comparable with other utilities in the region.

3.2 Technical, Design and Operational Criteria

All users of the Distribution System who are connected to and use, or may use in future, shall meet the relevant requirements as set out in the Distribution Code. Each constituent part of the Distribution Code specifies which users it applies to.

The following sections attempt to provide an overview of technical, design and operational criteria of the Distribution Systems.

3.2.1 Design Fault Levels

The short circuit rating of customer equipment at the connection point for the 33kV and 11kV distribution systems should not be less than the design fault levels given in Table 3.2-1 below, which are in line with Section 1.4 of OES-24.

Table 3.2-1: NDS design short circuit levels

Nominal Voltage	Design Fault Level (MVA)
33 kV	1500
11 kV	350
0.415 kV	31

For 33kV the source neutral is typically connected to the substation earth mat via a neutral earthing resistor (NER), sized to limit earth fault current to no more than 1000A or 1500A. For study purpose, three phase symmetrical fault levels at 33kV network will be the most onerous condition as unbalanced short circuit current will be limited by the NERs. The neutral of 11kV network is solidly earthed.

3.2.2 Voltage Regulation

The voltage on the 33kV and 11kV sides of Distribution transformers at Connection Sites with Distribution System Users shall normally be controlled within the limits +/-6.0% of the nominal value.

The voltage at the Consumer's terminals shall not vary from the System nominal voltage by more than;

Consumers Connected at	Nominal voltage	Tolerance
HV	33/11kV	+6.0% to –6.0%
LV	415/240V	+6.0% to –6.0%

3.2.3 Frequency Deviations

The nominal System Frequency of NDS Distribution System will be 50.00Hz during normal operating condition and normally will be controlled by transmission operator, between 49.95Hz and 50.05Hz.

During exceptional steady state conditions, frequency deviations will not exceed 49.90Hz to 50.10Hz unless disturbed circumstances prevail.

Under disturbed conditions, the System frequency could rise transiently to 51.50Hz or fall to 48.00Hz. Significant dip in system frequency could also trigger under-frequency protection scheme of NDS.

3.2.4 Voltage Waveform Quality

Any non-linear equipment such as converters (rectifiers and inverters), arc furnaces and VFD's can draw current from, or inject current into, the Distribution System that will introduce a harmonic current component, which subsequently causes distortion to the voltage waveform. While these incidents cannot be eliminated completely, NDS aims to deliver improvement in supply quality to its customers.

As per Distribution Code DCC 4.3, all apparatus and Plant Connected to the Distribution System, and that part of the Distribution System at each Connection Point, should be capable of withstanding the following distortions of the voltage waveform in respect of harmonic content and phase unbalance.

- The maximum levels of Total Harmonic Distortion (THD) on the Distribution System at 33kV and 11kV, from all sources under both normal, planned outage and fault outage conditions, shall not exceed 2.0% with no individual harmonic greater than 1.5% unless abnormal conditions prevail.
- At LV the maximum levels of THD from all sources shall not exceed 2.5%.
- The maximum negative phase sequence component of the phase voltage on the Distribution System should remain below 1.0% unless abnormal conditions prevail.
- A maximum value of 2.0% is permitted for phase unbalance.

Bulk customers connecting to NDS network may be required to install measurement units at the customer premises to allow monitoring of customers' power quality performance.

3.2.5 Voltage Fluctuations

All customers connected to NDS network should be in conformity with Distribution Code DCC4.4 requirements on Voltage Fluctuations. Existing or new customer, for example with a large motor load may be operated intermittently which could cause voltage fluctuation: this fluctuation shall not be more than 1% of the nominal voltage of the customer supply.

Large voltage excursion may also be resulted from energization of a customer transformer, or sudden tripping of a large load due to a fault. While these events only occur occasionally, their impact on the system voltage shall be less than 3% of the nominal voltage, provided this does not have an adverse impact or risk to the Salalah Distribution System. Otherwise, NDS reserves the right to take a mitigation action, which as an example, may require the customer to install device that will limit customer's impact on network voltage profile.

3.2.6 Network Automation

The 33kV Network is operated as a double circuit radial network during normal operating condition. 33kV bus sections circuit breakers at grid substations were operated as normally open condition;

At PSS, 11kV bus sections circuit breakers were operated as normally open condition. As the current network configuration applies an auto-changeover scheme to automatically effect restoration following a single circuit fault, the current network operation complies with the requirements of the distribution system security standards (DSSS).

In 11kV network, auto-reclosers are installed on long 11kV overhead lines at strategic locations (with facility to send SMS indicating the location of operated auto-recloser) for fast identification of fault and restoration of power supply at the earliest, which in turn reduce the interruption time to customers.

3.2.7 Protection

NDS operate a number of standard protection schemes across its network, which are capable of detecting system faults, and through the operation of the appropriate circuit breaker, clear the faulty equipment from the system.

Protection principles are based on ensuring quick isolation of faulty plant and equipment in order that electrical faults are promptly disconnected from the network, and that the effects of faults on the network do not impose unreasonable risks to the healthy sections. This also ensures that the possibility of system disturbance and disruption of supply is reduced, together with ensuring the risk to third parties and personnel is controlled.

This is achieved through:

- Discrimination – The protection must isolate the faulty section of plant or equipment while ensuring that healthy parts of the network remain in service;
- Stability – The protection must remain inoperative when fault current, up to the design maximum or as per protection settings, flows to an external protection zone;
- Sensitivity – The protection must be sensitive enough to detect and operate at low levels of fault current;
- Reliability – When called upon to operate, the protection must not fail and conversely it must not operate inappropriately.

To ensure satisfactory operation of the Distribution System, protection systems' operating times, discrimination, and sensitivity at the ownership boundary shall be agreed between NDS and the Distribution System User during the process of application for connection and may be reviewed from time to time by NDS with the agreement of the user. Back-up protection by operation of other switchgear must normally be provided, to safeguard the system against intended switchgear failing to operate correctly to interrupt fault current on the 11kV or 33kV system.

Unit/differential and distance protection schemes are typically implemented on 33kV network; with overcurrent (OC) and earth fault (EF) as back-up protection while 11kV network is mainly protected by OC/EF based protection schemes. The power transformers are protected by current differential with backup OC/EF. Restricted earth fault (REF) is provided on the 11kV side of the transformer and a standby earth fault (SBEF) protection is applied at the transformer neutral to earth connection.

3.3 Distribution System Security Standard

NDS is obliged under its distribution licence to plan and develop its Distribution System in accordance with the approved Distribution System Security Standards (License Condition 31: 4a); operate and maintain a safe, efficient and economic Distribution System in accordance with the Security Standards (Licence Condition 31: 4b).

The Distribution System Security Standard (DSSS) in Table 3.3-1 is proposed for DSOs in Oman, and is based on an industry-wide approach that aims to ensure that supply interruptions, when they occur, are restored in a time that is inversely proportional to the amount of demand that has been interrupted. The effect of this is to reduce, as far as practical, the amount of Energy Not Served (ENS) to customers during any interruption. To achieve this, customers' demand is grouped into bands (security classes) of increasing size, and for each band a maximum time is specified by which part or all the supply shall be restored.

Table 3.3-1: NDS Distribution System Security Standard

Security Class	Demand Group	First outage (forced outage)	Second outage (planned outage and forced outage) *
A	< 2 MW	Repair time	No requirement
B	2 to 6 MW	3 hours	No requirement
C	6 to 20 MW	Within 15 min	Restoration time of planned outage
D	20 to 100 MW	Immediately***	Restoration time of planned outage
E	>100 MW	Immediately***	Immediately, 2/3rds of demand**

*Assumed to occur in non-summer periods with reduced demand and enhanced equipment rating.

**Maintenance period demand is defined as the maximum demand that is expected to occur during period when planned maintenance is completed. In absence of better data, for MIS assumption of 2/3rds of peak demand is used.

*** Definition of "immediately" means Momentary Interruption of power is allowed, however the restoration of power intended to be performed by automatic equipment and maximum allowed time for restoration of power supply is three (3) minutes as informed by the APSR during audit expectation meeting on 23rd Feb'21.

The first outage is assumed to be a forced outage: the unplanned outage of a circuit or transformer due either to automatic action (*e.g.* following a fault) or to operator intervention (*e.g.* if an item of equipment is being over-stressed). The second outage is assumed to be a forced outage, coincident with a planned (or pre-arranged) outage, which has a cumulative effect on the security of supply of that part of the system.

To encourage and ensure licensees are compliant with the DSSS and in line with its statutory duties[1], the Authority introduced a security of supply incentive for NDS for PCR-3 period 2018-21, whereby the NDS will be penalised annually if the level of unsecured peak demand is greater than 5% of the substation firm capacity.

3.4 Health, Safety and Environment

Nama Dhofar Services (NDS) is committed to Health, Safety and Environment regulations of Sultanate of Oman and is having an HSE Management System that is for the benefit of all employees and other stake holders including customers as a step in implementing HSE within organization in line with International Safety standards.

3.5 Technical Standards

The Salalah Distribution System User apparatus and Plant shall comply with the following rules and standards (in order of preference as envisaged by the Distribution Code):

- HSE Policy & Safety Rules;
- Oman Electric Standards (OES);
- International Standard Organization (ISO) and International Electro-technical Commission (IEC) Standards;
- Grid Code;
- Distribution Code.

In addition to the above, NDS shall operate under the aegis and technical boundaries defined under the following:

- Distribution and Supply License;
- Distribution System Security Standards (DSSS);
- Good Utility Practices;
- The Laws of the Sultanate of Oman;
- Law for the Regulation and Privatization of the Electricity and Related Water Sector (Sector Law);
- Ministry of Energy and Minerals;
- Other National standards and codes, where applicable.

3.5.1 Conductors

33kV 3-core 300mm2 copper XLPE insulated cable are typically used only in the urban areas. In the rural areas, the 33kV connection is usually via a two 33kV single circuit wood-pole overhead lines strung with a single conductor per phase, using 200mm2 ACSR conductors. In semi-rural areas, a combination of overhead

[1] Article (4) of Royal Decree No. 78/2004 promulgating the Law for the Regulation and Privatisation of the Electricity and Related Water Sectors

line and underground cable is used depending on the route. The overhead line and underground cable circuits are generally rated at around 20MVA (per circuit) to match the transformer rating.

The existing 11kV overhead line conductors commonly utilised in the distribution network are 100mm^2, 150mm^2 and 200mm^2 ACSR conductors. The cables normally used in 11kV network are 185mm^2 and 240mm^2 3-core XLPE copper conductors

The typical 11kV and 33kV conductors utilised within the Distribution System are provided in Table 3.5-1 below:

Table 3.5-1: Conductors in NDS Distribution System

Nominal Voltage (kV)	Conductor/Cable Type	Conductor Size (mm^2)
33	XLPE Copper	300
33	ACSR	200
11	XLPE Copper	240
11	XLPE Copper	185
11	ACSR	200
11	ACSR	150
11	ACSR	100

3.5.2 33/11kV Transformers

The 33/11kV supply arrangements in the Distribution System are generally based upon the use of transformer pairs, rated individually at 6MVA (ONAN), 10MVA (ONAN) and 20MVA (ONAF), with the 10MVA and 20MVA transformers being provided with on-load tap changers.

There are a few exceptions to the standard 2 x 20MVA design outside the city, where the demand has previously been low. These are at Madinat Al Haq (2x10), Teetam (2x10 MVA), Hakbeet (2x10 MVA), Dahaboon (2x6MVA), AlSaan (1x6MVA) and FOSHI (1x6MVA). Further, in some load centres like SQH, Jarziz, Saada and Dhariz areas, NDS is adopting new design of 3x20 MVA capacity PSS.

3.5.3 Capacitor Bank

33/11kV substations are typically designed with 11kV, 5MVAr capacitor bank connected for each 20MVA transformer or 3MVAr capacitor bank for each 6MVA or 10MVA transformer. These capacitor banks are configured in such a way that one capacitor bank is connected to each 11kV bus section.

33kV Capacitors banks of 20 MVAR capacity are also installed in each 33kV Buses of Ittin GSS, Shah'Aaon GSS and Saada (A&B) grid substations and recently 10 MVAR capacity banks are installed as part of the newly constructed grid substation in Mirbat (Mirbat GSS).

3.5.4 Switchgears

The requirements for continuous current rating of 11kV and 33kV switchgear are specified in OES-14 and OES-15, which are summarised in the Table 3.5-2 below:

Table 3.5-2: Standard Switchgear Continuous Ratings

Nominal Voltage (kV)	Application	Continuous Rating (Amps)
33	Bus Section	1200
33	Feeder	600
11	Bus Section	1200
11	Transformer	1200
11	Feeder	400

The fault breaking capability of both 11kV and 33kV switchgear should be at least equal to the design fault levels stated in Section 3.2.1.

3.5.5 Embedded Generator

At present, the following embedded generators are connected to the 33kV NDS Distribution Network and located in generating plant at NPS, which are owned and operated by Dhofar Generation Company, namely:

- Frame-6 GT: 30 MW.
- LM2500 GT: 17 MW.

The Distribution Code: DCC.8 is applicable to all existing or prospective embedded generators, including Customers with own generation, having Generator Sets (Gensets) operating or capable of operating in parallel with NDS Distribution System. Depending on the MW size, ability to be centrally dispatched and nominal voltage at connection point, the embedded Gensets can be characterised into the following three classes:

- Centrally Dispatched (CD) Embedded Gensets (all Gensets with a Registered Capacity of 5MW or greater will be centrally dispatched);
- Embedded Gensets “connected” at or below 20kV and with an output not in excess of 5MW;
- Embedded Gensets which are to be “connected” at Low Voltage and less than 300 kVA in capacity.

For each of the generation classes above, different sets of information may be required from the prospective embedded generators, following system modelling purpose, and to decide what method of “connection” will need to be employed and the voltage level at which the “connection” should be made. If NDS concludes that the nature of the proposed “connection” or changes to an existing “connection” requires more detailed consideration, then further information may be requested.

Prospective embedded generators which are to be connected at Low Voltage and are less than 50kVA in capacity, or “connected” at other than Low Voltage and less than 300kVA in capacity are required to provide information to NDS as specified in Distribution Code DCC.8.3.1.

4 Overview of the distribution system

As of 1st January 2014, the transmission part of Salalah Power System, until then owned and operated by NDS, has been transferred to the Oman Electricity Transmission Company (OETC). As a result of the restructuring, NDS own and operate the Distribution Network in Dhofar area.

The distribution system covers the NDS distribution network downstream from the 33 kV busbars at the grid substations. This includes the 33 kV outgoing feeders circuit breakers, the 33 kV grid substation busbars, the 33 kV circuits, all 33/11 kV primary substation equipment, the 11 kV circuits, the 11/0.415 kV distribution substations and the low voltage (415/240 V) networks to customer's metered connection point.

Typical arrangement in NDS network is for a pair of 33/11kV transformers at a primary substation to be operated radially, i.e. both the 33kV and 11kV bus-section breakers are normally open. On-site auto-changeover scheme is employed, by closing the 11kV bus-section breaker when one of the circuits is in outage. However, NDS is carrying out a study for parallel operation of transformers in its all primary substations and initial study indicates that most of the PSS can be operated in parallel with minor modifications in the system.

It is stipulated in the Distribution Code DCC.4.1 that the voltage on the 33kV and 11kV sides of Distribution transformers at Connection Sites with Distribution System Users shall normally be controlled within the limits +/-6% of the nominal value.

4.1 Load Management

The need for load management may arise in situations of insufficient Generation Capacity and where severe operating difficulties pose a threat to the stability of the Main Interconnected System (MIS) including the security of the Distribution System.

As per Distribution code DOC3.4, Demand Control in NDS network is implemented in following ways;

- Emergency Manual Demand shedding;
- Planned Rota Demand Shedding; and
- De-energisation of Demand by automatic under-frequency Demand Shedding.

Currently, NDS has Under Frequency Protection Scheme in place to provide grid support in preventing system instability of Dhofar power network. This protection scheme involves tripping a set of predetermined 33kV outgoing feeder circuits at grid substations, performed in up to 4 stages, depending on the level of under frequency on the system as per the requirements of the transmission system operator (OETC).

4.2 Load Profiles

SCADA facilities at the Distribution Control Centre (DCC) are being used to record the hourly demands of all the grid substations, primary substations and their associated outgoing feeders.

Table 4.2-1 and Figure 4.2-1 below shows the historical peak demand of NDS System. It can be observed that the peak demand has been increasing monotonously every year since 2003. However, from 2018 onwards Dhofar region is witnessing sudden weather changes (heavy rains or cool weather during summer periods).

This is mainly due tropical depression or cyclone effects in the Arabian sea during May or June, which is generally peak demand period.

Table 4.2-1: Historical Peak Demand Data for Salalah Power System

Year	Peak Date	Peak Demand
2001	23-May	157
2002	8-May	158
2003	31-May	178.3
2004	25-May	180.8
2005	13-Jun	199.3
2006	30-May	232.3
2007	20-May	253
2008	8-Jun	260.4
2009	26-May	283.8
2010	16-May	337
2011	31-May	348
2012	4-Jun	389.3
2013	28-May	420.3
2014	16-Jun	439
2015	27-May	495.4
2016	26-May	523.2
2017	1-Jun	552
2018	15-May	539.5
2019	14-Jun	548.9
2020	16-Jun	532
2021	17-Jun	536.2
2022	12-Jun	605.4
2023	1-Jun	626.4

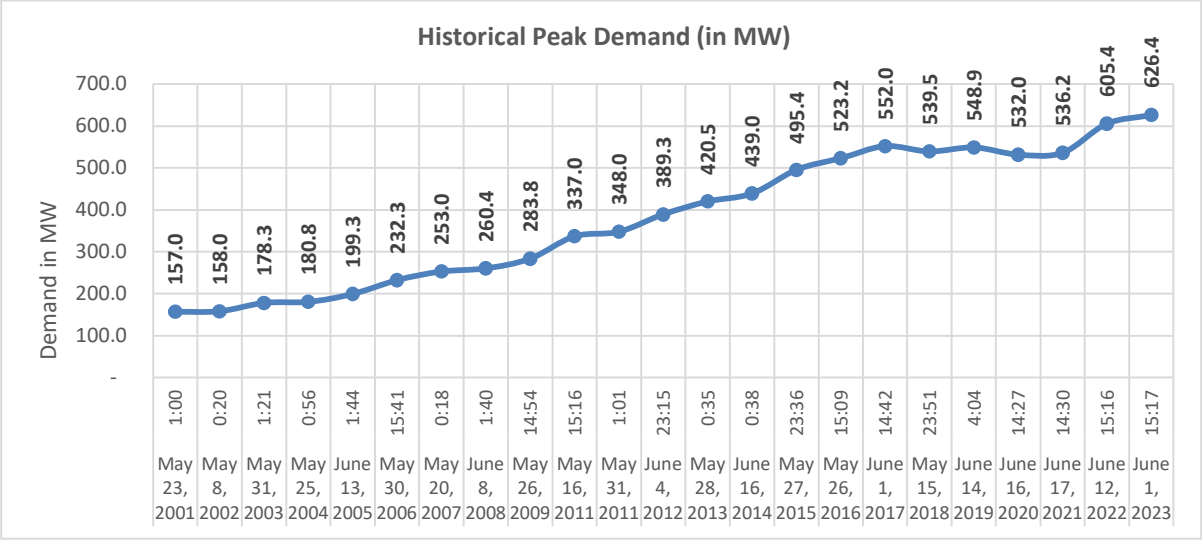


Figure 4.2-1 Historical System Peak Demand Profile for the period 2001 to 2023

From the above historical data, it can be observed that Dhofar System Peak Demand generally occurs between Mid of May to Mid of June.

The annual system demand profile is fairly consistent from year to year, with the maximum demands normally occurring in May or June. As per LDC (OETC), the maximum recorded system peak on the Dhofar Power System in 2023 was 626.4 MW (on 1st June'23 at 15:17Hrs) including the transmission customers demand and transmission losses.

Figure 4.2-2 shows the monthly maximum and minimum distribution system demand for the year 2023 (up to September 2023 as per Distribution Control Center (DCC) reports excluding the transmission customers demand and transmission losses).The minimum demand occurs on (5th June 2023@17:34Hrs) during Dhofar system partial blackout.

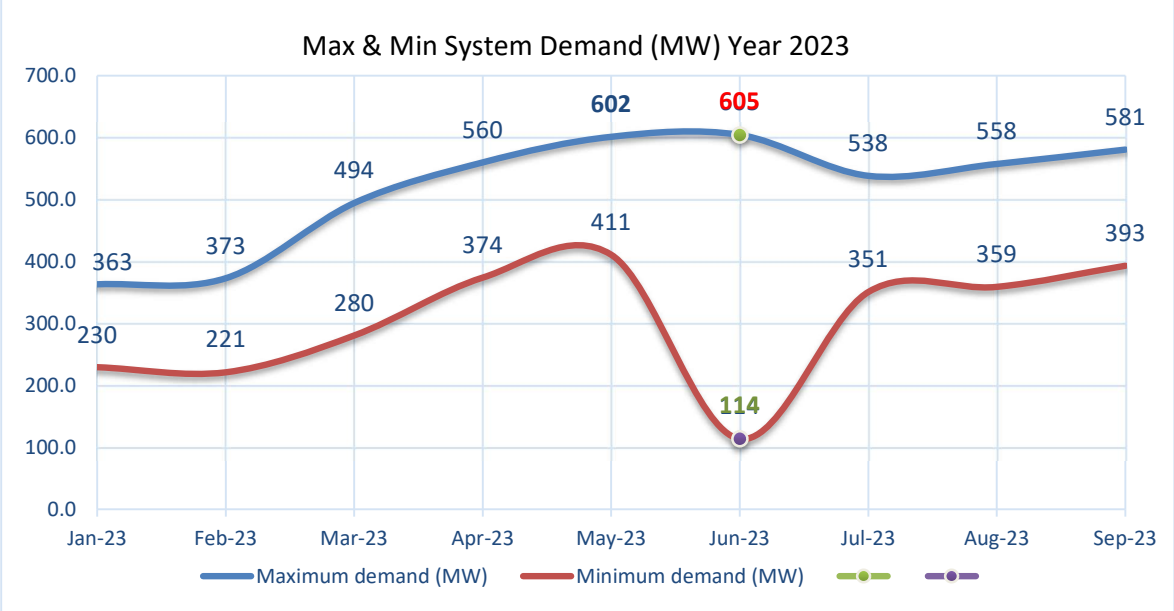


Figure 4.2-2 Monthly Maximum and Minimum Distribution System Demand Profile for 2023

Peak demand for all the primary substations (in MW, MVAR & MVA) for the year 2023 is provided in the Table 4.2-2.

Table 4.2-2: Peak Demand Data for all primary substations for the Y2023

Sl No	Primary Substation	Installed Capacity in MVA	Firm Capacity in MVA	2023		
				(in MW)	(in MVAr)	(in MVA)
1	Al Qoaf	2x20	20.0	13.40	4.40	14.1
2	Al Wadi	2x20	20.0	10.89	3.58	11.5
3	Al-Husn	2x20	20.0	11.73	3.85	12.3
4	Al-Husn 2	2x20	20.0	9.39	3.09	9.9
5	Commercial Area	2x20	20.0	13.00	4.27	13.7
6	Governorate Centre	2x20	20.0	11.76	3.87	12.4
7	New Salalah	2x20	20.0	10.96	3.60	11.5
8	Salalah A	2x20	20.0	12.11	3.98	12.7
9	Salalah B	2x20	20.0	11.60	3.81	12.2
10	Salalah C	2x20	20.0	13.90	4.57	14.6

Sl No	Primary Substation	Installed Capacity in MVA	Firm Capacity in MVA	2023		
				(in MW)	(in MVAr)	(in MVA)
11	SQH-2	3x20	40.0	11.30	3.71	11.9
12	Sultan Qaboos Hospital	2x20	20.0	8.68	2.85	9.1
13	Town Centre	2x20	20.0	12.89	4.24	13.6
14	Al Saada	2x20	20.0	19.44	6.39	20.5
15	Al Sa'an	1x6	3.2	3.01	0.99	3.2
16	Jarziz	3x20	40.0	17.47	5.74	18.4
17	Madinat Al-Saada	2x20	20.0	15.99	5.25	16.8
18	Mamurah	2x20	20.0	14.39	4.73	15.1
19	Saada 2	3x20	40.0	27.65	9.09	29.1
20	Sahalnoot	2x20	20.0	17.63	5.79	18.6
21	Sahalnoot 2	2x20	20.0	19.50	6.41	20.5
22	UAG	2x20	20.0	13.14	4.32	13.8
23	Dahariz	3x20	40.0	25.85	8.50	27.2
24	Adhan	2x20	20.0	10.70	3.52	11.3
25	Awqad	2x20	20.0	16.50	5.42	17.4
26	Industrial Area	2x20	20.0	17.25	5.67	18.2
27	Industrial Area 2	2x20	20.0	12.17	4.00	12.8
28	Khor Al Qurum	2x20	20.0	14.62	4.81	15.4
29	North Awqad	2x20	20.0	14.60	4.80	15.4
30	North Awqad 2	2x20	20.0	15.13	4.97	15.9
31	Raysut 'A'	2x20	20.0	11.15	3.66	11.7
32	Raysut Industrial Estate	2x20	20.0	15.00	4.93	15.8
33	Raysut Industrial Estate 2	2x20	20.0	15.15	4.98	15.9
34	Salalah Free Zone	2x20	20.0	16.91	5.56	17.8
35	Salalah Port GCT	2x20	20.0	5.24	1.72	5.5
36	Teetam	2x10	10.0	3.72	1.22	3.9
37	ASHOOR-A	2x20	20.0	9.41	3.09	9.9
38	ASHOOR-B	2x20	20.0	5.44	1.79	5.7
39	Jufa/Sadah	2x20	20.0	4.42	1.45	4.7
40	Madinat Al Haq	2x10	10.0	6.70	2.20	7.1
41	Mirbat	2x20	20.0	14.62	4.80	15.4
42	North Taqa	2x20	20.0	14.09	4.63	14.8
43	Taqa	2x20	20.0	15.17	4.99	16.0
44	Foshi	1x6	-	1.67	0.55	1.8
45	Hakbeet	2x10	10.0	2.70	0.89	2.8

Sl No	Primary Substation	Installed Capacity in MVA	Firm Capacity in MVA	2023		
				(in MW)	(in MVAr)	(in MVA)
46	Qairoon Hairiti	2x20	20.0	8.22	2.70	8.7
47	Thumrait ROP	2x20	20.0	0.00	0.00	0.0
48	Thumrait	2x20	20.0	17.12	5.63	18.0
49	Dhahboon	2x6	6.0	2.83	0.93	3.0

4.3 Voltage Magnitude

Table 4.3-1 shows the voltage magnitude for all the primary substations for the year 2023 (up to 30th September 2023).

Table 4.3-1: Voltage Magnitude for all the primary substations for the Y2023.

Sl No	Primary Substation	33kV Bus Voltage in kV		11kV Bus Voltage in kV	
		Maximum value (+6% = 34.98kV)	Minimum Value (-6%=31.02kV)	Maximum value (+6% = 11.66kV)	Minimum Value (-6%=10.34kV)
1	Adhan	33.75	32.41	11.11	10.68
2	AlHusn	34.67	31.86	11.54	10.64
3	AlHusn-2	33.54	32.33	11.20	10.80
4	AlQuof	33.21	31.88	11.16	10.67
5	AlSaan	33.02	31.10	11.52	11.01
6	AlWadi	33.30	32.36	11.26	10.77
7	Ashoor A	33.39	32.56	11.14	10.63
8	Ashoor B	33.41	32.55	11.26	10.77
9	Awqad	33.50	32.48	11.33	10.84
10	Commercial Area	33.29	32.25	11.11	10.75
11	Dahariz	33.50	32.47	11.26	10.79
12	Dahaboon	34.47	32.42	11.52	10.98
13	Foshi	33.50	31.17	11.58	10.58
14	Governorate Centre	34.22	31.58	11.44	10.80
15	Hakbeet	34.10	32.26	11.35	10.62
16	Industrial Area	33.22	32.30	11.11	10.68
17	Industrial Area-2	33.50	32.51	11.23	10.60
18	Jarziz	33.55	32.32	11.39	10.64
19	Jufa/Sadah	33.95	31.47	11.49	10.77
20	KHOR ALQURM	34.59	33.07	11.48	10.83
21	Madinat Al Haq	33.33	31.36	11.14	10.75

Sl No	Primary Substation	33kV Bus Voltage in kV		11kV Bus Voltage in kV	
		Maximum value (+6% = 34.98kV)	Minimum Value (-6%=31.02kV)	Maximum value (+6% = 11.66kV)	Minimum Value (-6%=10.34kV)
22	Madinat Al Saada	33.55	32.45	11.21	10.53
23	Mamurah	33.93	31.48	11.31	10.84
24	Mirbat	32.96	32.16	11.21	10.78
25	New Salalah	34.94	32.63	11.63	10.89
26	North Awqad	33.92	31.95	11.26	10.68
27	North Awqad-2	32.65	31.56	11.20	10.76
28	North Taqa	33.21	31.87	11.14	10.78
29	Qairoon Hairiti	33.55	31.84	11.36	10.54
30	Raysut	34.20	32.26	11.27	10.58
31	Raysut Industrial Estate	33.97	32.11	11.66	10.62
32	RIE-2	33.77	32.40	11.42	10.81
33	Saada	33.65	32.46	11.32	10.75
34	Saada-2	33.89	32.68	11.37	10.75
35	Sahalnoot	33.70	31.12	11.29	10.72
36	Sahalnoot-2	33.46	32.56	11.31	10.83
37	Salalah - A	34.56	31.82	11.00	10.99
38	Salalah - B	34.56	31.89	11.59	10.66
39	Salalah - C	34.67	32.27	11.45	10.78
40	Salalah Free Zone	33.65	32.77	11.27	10.75
41	SALALAH PORT (NEW)	33.59	32.79	11.14	10.86
42	SQH	33.36	32.31	11.23	10.81
43	SQH-2	34.29	32.82	11.34	10.90
44	Taqa	33.42	31.31	11.18	10.81
45	Teetam	33.37	32.38	11.39	10.94
46	Thumrait PSS	34.18	32.69	11.38	10.63
47	TownCenter	34.81	32.19	11.51	10.87
48	UAG	33.50	31.32	11.40	10.74
49	Thumrait ROP	33.94	32.60	11.24	10.81

4.4 System Losses

System losses are measured as the difference between the volume of electricity entering the distribution network and the volume of electricity metered as delivered to customers. These losses may be either technical or non-technical. Technical losses are a result of physically transporting electricity through the network, such as resistance in conductors. Non-technical losses are a result of metering errors or non-recorded consumption, such as theft. Losses increase the volume of electricity which must be generated to meet the level of demand, and therefore ultimately raise the cost of electricity for consumers (and for the government, which funds subsidies to the Licensees).

The Authority, as part of price control review process (PCR-4), has implemented a losses incentive mechanism (financial reward/penalties), whereby the performance of NDS is measured against a set of targets set by APSR. Accordingly, NDS has set one of its key performance indices as to reduce distribution losses in line with the targets set by APSR.

The Authority has set the long-term distribution losses target of 7.6% to NDS to be achieved by Y2029. Table 4.4-1 presents the annual losses reduction targets and the deadband determined by the APSR in its final proposal for NDS over the price control period 2022-2025.

Table 4.4-1: NDS Losses Targets for PCR-4 period (With and without the deadband)*

	2022	2023	2024	2025
Authority target	**9.5%**	**9.2%**	**9.0%**	**8.7%**
Deadband	0.5%	0.5%	0.4%	0.4%
Losses Deadband lower limit	9.0%	8.8%	8.5%	8.3%
Losses Deadband upper limit	10.0%	9.7%	9.4%	9.2%

*The losses incentive scheme will not apply to those networks transferring from RAEC (TANWEER) to NDS.

Total NDS system losses (including technical and non-technical) for year 2022 was calculated as 13.17%, which is slightly higher the last year. Further, as part of NDS efforts in managing losses reduction, and meeting regulatory obligations, measures such as Automatic Meter Reading (AMR) and Manual Meter Reading (MMR) are under implementation, which would attempt to reduce inefficiencies due to non-technical losses.

Total technical losses for the NDS Distribution network is estimated to be around 6.46% for the Y2023. NDS is continuously putting all its efforts to reduce the total system losses to meet the target set by APSR as per the above table.

Below chart shows the historical total distribution losses from 2014 onwards under regulatory regime.

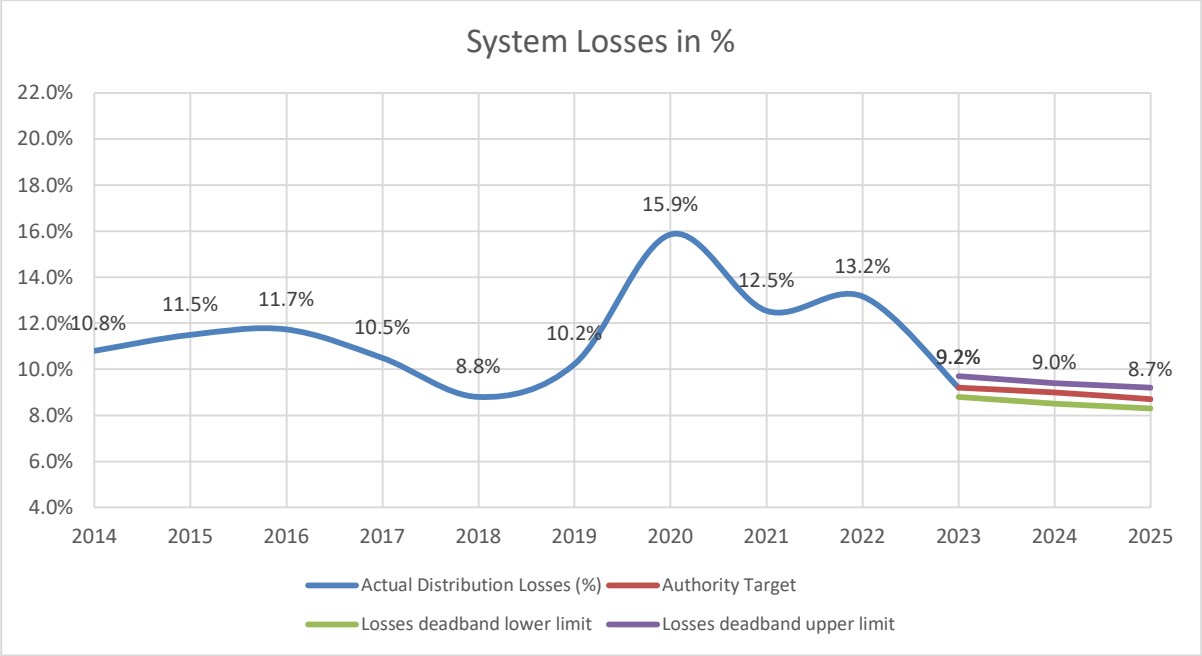


Figure 4.4-1 NDS Historical System Losses and APSR Target

4.5 Interconnections

There are currently no interconnections at distribution voltage level to other distribution networks owned and operated by other Distribution System Operators in Oman except some areas (mostly in Zone A operating area in recently transferred network area by TANWEER to NDS, which are connected to PDO network).

4.6 Renewable Energy – Solar Power Generation

The Renewable Energy Initiative aims to promote the use of clean solar energy to create a sustainable source for Oman and future generations. This initiative is based on the installation of solar panels in residential units to use the sun's rays to generate electricity, which will in turn reduce the level of dependence on traditional energy sources and create surplus energy that benefits the community.

Solar power is the conversion of sunlight into electricity directly using photovoltaics (PV) technology. Photovoltaics were initially solely used as a source of electricity for small and medium-sized applications. However, solar PV is rapidly becoming inexpensive, hence grid-connected solar PV systems and medium size utility-scale solar power stations can be built in to harness renewable energy from the Sun.

There has been a drive to promote renewable energy generation. Authority, working with other Government Agencies and Development Partners, established an initiative to accelerate renewable energy development solar and wind technologies.

In-order to deliver the Government's renewable energy target of electricity generation, Authority has introduced a Regulatory framework for Small Scale Grid Connected Solar PV Systems Standards in Oman. The Authority has officially launched this initiative on 24th May 2017 as **'Sahim Scheme to power homes by Solar Energy'**. This initiative enables any interested customers to install PV cells in their home and export the excess PV energy to local utility company. Accordingly, Customer who install PV plant shall enter into an

Agency Contract with NDS (Agent of PWP in Procurement of Output from Solar PV plants). Based on the Agency Contract, NDS shall remunerate eligible customers based on the relevant Bulk Supply Tariff (BST) for PV production exported to NDS Distribution Grid.

As of October 2023, five (5) customers have been successfully synchronized Solar PV System with NDS distribution system with an installed total capacity of 346 kW as shown in the below table and also a new customer application is approved to install a solar PV plant of capacity 7.5MW and now it is under design stage. We also received couple of customers enquires for installation of small Solar PV System.

Sl. No	Project	Tariff category	Designed capacity of Solar PV generation	Date of connection
1	Solar Customer - 1	Government	143 KWp	Connected from 1st Sep 2017
2	Solar Customer - 2	Commercial	30 KWp	Connected from 15th Dec 2018
3	Solar Customer - 3	Government	100 KWp	Connected from 21st Jan 2021
4	Solar Customer - 4	Government	10 KWp	Connected from 14th Nov 2021
5	Solar Customer - 5	Commercial	63 KWp	Connected from 4th July 2023

For Y2022, 250,186.15 KWH of solar PV energy exported from the existing solar PV producers (after their internal consumption) and Company remunerated the customer/s for the exported solar PV energy as per reverent Bulk Supply Tariff. In Y2023, 206661.96 KWH of solar PV energy exported from the aforesaid customers as on end of September 2023.

For technical standards, connection guidelines and safety standards and other related documents regarding the installation of roof-top Solar PV systems shall be obtained from The Authority for Public Services Regulation website (https://www.apsr.om/en/node/80).

4.7 Demand Forecast

It may be noted that from 1st Jan 2022, the TANWEER has transferred its network assets in the Dhofar region to NDS to provide the reliable and quality power supply and further to extend the transmission and distribution network in these areas to eliminate the Diesel generating power plants. Accordingly, Demand forecast for the Dhofar region is presented in two parts. First part covers the existing network of NDS and the second part consist of the TANWEER transferred distribution network areas in the Dhofar region and are presented in the section 4.7.1 .

4.7.1 Distribution Demand Forecast for Existing NDS Distribution Network

The electricity demand on the NDS distribution system comes from the following groups of customers:

- **Non-bulk customers**, comprising small residential, commercial, agricultural and industrial customers supplied at 11 kV and LV.
- **Bulk customers**, essentially large industrial, commercial, tourism and defence customers supplied at 33 kV and 11 kV.
- **SFZ customers**, essentially large, medium and small industrial and commercial customers that are or will be supplied at 132 kV, 33 kV, 11 kV and LV in the SFZ.

Based on historical data, continuous interaction with bulk customers, understanding of customer project and NDS experience with the above group of customers, NDS has developed a methodology for forecasting system peak for NDS system and was using it in its previous network development plans. However, NDS recognises the need of continues improvements on its demand forecast model and hence linked its demand forecast methodology to the Oman Gross Domestic Product (GDP) to take in account the effect of future economic prospects of Oman over system demand growth. The overall peak demand forecast for the next three years (2024-2026) is given in the Table 4.7.1-1 below.

Table 4.7.1-1: The Overall Peak Demand Forecast for the period 2024-2026

Demand (MW)	2023	2024	2025	2026
PSS Demand				
Non-bulk customers	470.1	513.3	534.4	558.0
11kV bulk & SFZ customers (coincident demand)	126.1	138.1	158.9	168.0
Aggregate PSS Demand	541.0	651.4	693.2	726.0
GSS Demand				
PSS Demand (coincident)	549.2	599.8	639.4	670.1
33kV bulk customers (coincident)	77.7	156.7	159.0	156.3
Aggregate GSS Demand	626.9	756.4	798.4	826.4
132kV bulk customers	26.9	27.0	27.0	177.1
System peak coincidence factor	95.8%	95.8%	95.8%	95.8%
System Peak Demand	**626.4**	**750.6**	**790.8**	**961.4**

System Peak Demand of NDS Distribution System is expected to grow from 626.4 MW in Y2023 to 961.4 MW by Y2026. Significant development of the distribution system will be taking place as the new PSS's and circuits are phased in (see Section 7) and also couple new bulk customers with demand requirement of more than 100 MW are also expected to implement their project during this period.

Demand forecast for all existing and future planned 33/11kV Primary Substations is given in the following section.

- **Primary Substation (PSS) Demand Forecast**

Table 4.7.1-2: Primary Substation load forecast for the period 2024-2026

Sl No	Primary Substation	Installed Capacity in MVA	Firm Capacity in MVA	2023 (in MVA)	2024	2025	2026
1	Awqad	2x20	20	17.37	19.32	17.11	18.02
2	Industrial Area	2x20	20	18.16	18.10	18.86	16.57
3	North Awqad	2x20	20	15.37	13.93	14.62	15.40
4	Raysut 'A'	2x20	20	11.74	11.77	12.13	12.54
5	Al Wadi	2x20	20	11.47	12.40	12.85	13.36
6	Commercial Area	2x20	20	13.68	14.80	15.34	15.94
7	Governorate Centre	2x20	20	12.38	14.99	15.44	15.95
8	New Salalah	2x20	20	11.54	12.01	12.34	12.71
9	Salalah A	2x20	20	12.75	13.79	14.29	14.85
10	Salalah B	2x20	20	12.21	13.21	13.69	14.23
11	Sultan Qaboos Hospital	2x20	20	9.14	11.35	11.62	11.92
12	Town Centre	2x20	20	13.57	14.96	15.44	15.97
13	Al Qoaf	2x20	20	14.10	15.11	16.54	17.08
14	Al-Husn	2x20	20	12.34	13.52	14.46	14.92
15	Al-Husn 2	2x20	20	9.88	9.45	9.55	9.66
16	UAG	2x20	20	13.83	14.97	15.53	16.15
17	Al Saada	2x20	20	20.46	18.43	19.07	17.68
18	Madinat Al-Saada	2x20	20	16.83	17.46	17.96	16.42
19	Mamurah	2x20	20	15.15	15.09	16.74	17.26
20	Sahalnoot	2x20	20	18.56	14.85	15.28	16.81

Sl No	Primary Substation	Installed Capacity in MVA	Firm Capacity in MVA	2023 (in MVA)	2024	2025	2026
21	Qairoon Hairiti	2x20	20	8.66	9.44	10.02	10.41
22	Thumrait	2x20	20	18.02	17.31	17.85	18.45
23	Jufa/Sadah	2x20	20	4.65	5.16	5.40	5.68
24	Mirbat	2x20	20	15.39	16.93	17.67	18.50
25	Taqa	2x20	20	15.97	14.20	16.91	17.68
26	North Taqa	2x20	20	14.83	16.38	17.14	17.99
27	Adhan	2x20	20	11.26	12.73	15.31	17.72
28	Salalah Free Zone	2x20	20	17.80	19.72	18.29	18.32
29	Raysut Industrial Estate	2x20	20	15.79	16.67	17.15	17.62
30	Madinat Al Haq	2x10	10	7.05	7.30	7.65	8.04
31	North Awqad 2	2x20	20	15.93	14.56	15.28	16.09
32	Hakbeet	2x10	10	2.84	3.07	3.19	3.32
33	Teetam	2x10	10	3.92	4.47	4.64	4.83
34	Al Sa'an	1x6	3.71	3.17	3.44	3.56	3.71
35	Saada 2	3x20	40	29.11	30.61	31.51	34.61
36	Salalah Port GCT	2x20	20	5.52	5.93	6.11	6.32
37	Raysut Industrial Estate 2	2x20	20	15.95	16.65	17.04	17.44
38	Khor Al Qurum	2x20	20	15.39	17.21	18.00	19.30
39	Sahalnoot 2	2x20	20	20.53	19.07	19.78	16.36
40	Jarziz	3x20	40	18.38	19.74	20.59	23.33
41	Salalah C	2x20	20	14.63	15.82	16.40	17.04
42	SQH-2	3x20	40	11.89	14.66	25.47	26.07
43	ASHOOR-A	2x20	20	9.91	10.01	9.96	9.91
44	ASHOOR-B	2x20	20	5.72	6.42	6.42	6.42
45	Dahariz	3x20	40	27.21	30.37	31.47	33.50
46	Dhahboon	2x6	6	2.98	3.22	3.34	3.47

Sl No	Primary Substation	Installed Capacity in MVA	Firm Capacity in MVA	2023 (in MVA)	2024	2025	2026
47	Industrial Area 2	2x20	20	12.81	14.24	14.95	15.74
48	Foshi	1x6	0	1.76	1.95	2.04	2.15
49	Thumrait ROP	2x20	20	0.00	3.16	3.95	3.95
50	ALMUROOJ	2x20	20	-	8.42	8.84	12.46
51	Sahalnoot3	2x20	20	-	12.63	13.10	16.78
52	Tawittir	2x10	10	-	4.74	4.96	5.22
53	SFZ-2	2x20	20	-	-	6.89	12.33

4.7.2 Distribution Demand Forecast for the TANWEER Transferred Distribution Network in the Dhofar Region

Currently, customers within Tanweer transferred areas in the Dhofar region are supplied with electricity either from Power Stations owned and operated by Tanweer or supplied through a Power Purchase Agreement (PPA) with Petroleum Development of Oman (PDO) in some remote areas. In addition to that, Tanweer has a PPA with Bahwan Astonfield at Al-Mazyounah to purchase renewable energy (Solar Plant).

Considering the wide area of network of TANWEER transferred assets in Dhofar region, distribution network in this areas are divided in to three zones for the ease of operation and maintenance purpose and the areas covered under each zone are given below.

ZONE-A Areas	ZONE-B Areas	ZONE-C Areas
Shaleem, Shuwaymia, Zakhar, Sharbathat, Shabeyia, Wadi Hakka village, Dimeet, Wadi Arah, Mahwees, Kaboot village, Wadi rahab village, Hasik, Juo Al Salam & Marmul and Al Halaniyat Island	Haila, Shaser, Saih Al Khirat, Hanfeet, Al Najid, Baithna, Hasman, Zenat Alsahrah, Dhaboon, Barbazoom, Rabkhoot, Fatkhait, Qatbet Sadhoon, Farshat Qatbeet, Marsawdad, Shigag , Al Mashash, Diwan Farm, Maqshan, Manadhar & Al Dhabyan	Shaihbasab, Rakhyut, Airdeet, Hafoof, Feroq, Jujool Maturah, Dalqut, Haymoot, Feroq, Khadrafi Areas, Sarfit MOD Areas, Harweeb, Mazyunah Area, Tousnat, New Shabiya, Mittan Village, Andhath, Habrout, Mitalath, Mudhai, Aiboot, Haurat, Mudhai Shabiya, Tadhooo, Qaffa & Al Mathafa

The demand profile for Tanweer transferred area in the Dhofar region is driven mainly by the residential (Domestic) customers. Also, the seasonal variation in the weather has a strong effect on the demand profile. In general, demand in some area has minimum peak in January and February, and then increases in summer (June & July) due to the climate and high temperature.

Accordingly, the demand forecast for the Tanweer transferred areas in the Dhofar region are also divided in to 3 zones as discussed in the following section and average demand growth rate 6% is considered for all the Tanweer transferred network area.

4.7.2.1 Zone-A Demand Forecast.

Zone-A distribution network covers the following areas like Shaleem, Shuwaymia, Zakhar, Sharbathat, Shabeyia, Wadi Hakka village, Dimeet, Wadi Arah, Mahwees, Kaboot village, Wadi rahab village, Hasik, Juo Al Salam & Marmul and most of these areas are linked with PDO network to feed the power to the NDS customers in that area. Considering the demand growth of 6% the demand forecast for the Zone-A area is calculated as given below Table 4.7.2.1-1: .

Table 4.7.2.1-1: Zone-A Demand Forecast

Sl No	Area	2023	2024	2025	2026
1	PDO Demand - Zone A	8.50	9.01	9.55	10.13
2	Sharbathat	1.35	1.43	1.52	1.61
3	Hasik	3.15	3.33	3.53	3.75
Total Demand in Zone-A (in MW)		**13.00**	**13.78**	**14.60**	**15.48**

33kV Interlinking projects to connect Sharbathat and Hasik are under planning stage. Currently existing Diesel Power Plants in Sharbathat and Hasik are feeding the nearby areas and details of the same are given in Table 4.7.2.1-2: . After commissioning of Sharbathat and Hasik PSS's these DG power plants shall be discontinued.

Table 4.7.2.1-2: Zone-A Generation Capacity

Installed Capacity (K.W) of the Units in the Power Stations of Zone-A Area									
SL No	Power Station Name	DG#01	DG#02	DG#03	DG#04	DG#05	DG#06	DG#07	Total in KW
1	Hasik	1000	1000	1000	1000	500	500	-	5,000
2	Sharbtat	180	255	292	1000	1000	1000	1000	4,727
								Grand Total in KW	**9,727**

4.7.2.2 Zone-B Demand Forecast.

Zone-B distribution network covers the following areas like Haila, Shaser, Saih Al Khirat, Hanfeet, Al Najid, Baithna, Hasman, Zenat Alsahrah, Dhaboon,Barbazoom, Rabkhoot, Fatkhait, Qatbet Sadhoon, Farshat Qatbeet, Marsawdad, Shigag , Al Mashash, Diwan Farm, Maqshan, Manadhar & Al Dhabyan and most of these areas were connected by Diesel power plants to feed the power to the NDS customers in that area. However, a new grid substation with 2x63 MVA capacity is constructed and commissioned recently in Saih Al Khairat and this will significantly reduce the diesel generation in Zone-B area. Considering the demand growth of 6% the demand forecast for the Zone-B area is calculated as given below Table 4.7.2.2-1.

Table 4.7.2.2-1: Zone-B Demand Forecast

Sl No	Area	2023	2024	2025	2026
1	PDO Demand - Zone B	0.27	0.28	0.30	0.43
2	Saih Al Khirat	40.50	42.93	45.51	46.56
3	Farshat Qatbeet	2.68	2.85	3.02	2.59
Total Demand in Zone-B (in MW)		**41.64**	**43.45**	**46.06**	**48.82**

Existing Diesel Power Plants in Saih Al Khairat and Farshat Qatbeet shall be discontinued after transfer of all the loads to new Saih Al Khairat GSS and details of the same are given in Table 4.7.2.1-2:

Table 4.7.2.2-2: Zone-B Generation Capacity

Installed Capacity (K.W) of the Units in the Power Staions of Zone-B Area								
SL No	Power Station Name	DG#01	DG#02	DG#03	DG#04	DG#05	DG#06	Total in KW
1	Saih Al Khairat	8003	8003	8003	8003	8003	8003	48,018
2	Farshat Qatbeet	1250	2500	2500	2500	2500	1250	12,500
							Grand Total in KW	60,518

4.7.2.3 Zone-C Demand Forecast.

Zone-C distribution network covers the following area like Shaihbasab, Rakhyut, Airdeet, Hafoof, Feroq, Jujool Maturah, Dalqut, Haymoot, Feroq, Khadrafi Areas, Sarfit MOD Areas, Harweeb, Mazyunah Area, Tousnat, New Shabiya, Mittan Village, Andhath, Habrout, Mitalath, Mudhai, Aiboot, Haurat, Mudhai Shabiya, Tadhooo, Qaffa & Al Mathafa and most of these areas are connected by Diesel power plants to feed the power to the NDS customers in that area. However, construction of three grid substations each one at Mudhai (2x30MVA), Mazyounah (2x63MVA) and Shahb Asaib (2x63MVA) is under tendering stage and are expected to be energized in the year 2026. Considering the demand growth of 6% the demand forecast for the Zone-C area is calculated as given below Table 4.7.2.3-1:

Table 4.7.2.3-1: Zone-C Demand Forecast

Sl No	Area	2023	2024	2025	2026
1	ShaabAssiab Area	15.37	16.29	17.27	18.31
2	Mazyouhna Area	14.25	15.11	16.01	16.97
3	Mudhai Area	2.79	2.96	3.13	3.32
Total Demand in Zone-C (in MW)		**32.41**	**34.35**	**36.42**	**38.60**

Details of the existing Diesel Power Plants in in Zone-C that will feed the nearby areas are given in Table 4.7.2.3-2

Table 4.7.2.3-2: Zone-C Generation Capacity

Installed Capacity (K.W) of the Units in the Power Staions of Zone-C Area												
SL No	Power Station Name	DG#01	DG#02	DG#03	DG#04	DG#05	DG#06	DG#07	DG#08	DG#09	DG#10	Total in KW
1	Al Mazyounah PS	2000	1000	1000	1000	2000	2000	1000				10,000
2	Shaabasaib Ps	1000	1000	-	1069	2000	2000	2000	2000	6000	6000	23,069
3	Mudhai PS	1000	1000	468	468	468	468	1000				4,872
4	Andat PS	256	200	500	500	500	500	1000				3,456
5	Mittan PS	292	250	345	1000	500	1000					3,387
6	Harweeb PS	175	200	400	500	500						1,775
										Grand Total in KW		46,559

4.7.2.4 Al Halaniyat Island area Demand Forecast.

Al Halaniyat is an Island located east of Salalah with very small population. Diesel power plant of around 1.5 MW installed capacity feed the power to the NDS customers in that area.

Table 4.7.2.4-1: Al Halaniyat Island Demand Forecast

Sl No	Area	2023	2024	2025	2026
1	Al Halaniyat Island	0.50	0.53	0.56	0.60
Total Demand in Al Halaniyat Island (in MW)		**0.50**	**0.53**	**0.56**	**0.60**

Table 4.7.2.4-2: Al Halaniyat Island Generation Capacity

Installed Capacity (K.W) of the Units in the Power Stations of Al Halaniyat Island Area						
SL No	**Power Station Name**	**DG#01**	**DG#02**	**DG#03**	**DG#04**	**Total in KW**
1	Al Halaniyat Island	320	320	320	560	1,520

4.7.2.5 Total Demand and Generation Capacity.

Total aggregated demand for the TANWEER Transferred Distribution Network in the Dhofar Region is given below in the Table 4.7.2.5-1 and most of these demand are fed by isolated diesel generation power plants of TANWEER and some areas are fed by through PDO interconnection lines and in some places mobile DG or rental DG's are hired, if required, by TANWEER to meet the demand.

Table 4.7.2.5-1: Demand Forecast for the TANWEER Transferred Distribution Network in the Dhofar Region

Area Name	Installed Capacity (in MW)	Demand			
		2023	2024	2025	2026
Zone-A	9.727	13.00	13.78	14.60	15.48
Zone-B	60.518	43.45	46.06	48.82	51.75
Zone-C	46.559	32.41	34.35	36.42	38.60
Al Halaniyat Island	1.52	0.5	0.53	0.56	0.6
Total Aggregated Demand (in MW)	**118.324**	**89.36**	**94.72**	**100.40**	**106.43**

4.7.2.6 Peak Demand Data for all primary substations in the TANWEER Transferred Distribution Network for the Y2023.

Peak demand for all the primary substations in the TANWEER Transferred Distribution Network (in MW, MVAR & MVA) for the year 2023 is provided in the Table 4.2-2.

Table 4.7.2.6-1: Peak Demand Data for all primary substations for the Y2023

Sl No	NAME OF PSS	Zone	Installed Capacity	MW	MVAR	MVA
1	SHALEEM PSS-1	Zone A	1 x 6 MVA	1.27	0.62	1.41
2	SHALEEM PSS-2	Zone A	1 x 3 MVA	0.00	0.00	0.00
3	SHUWAMIA PSS-1	Zone A	1 x 3 MVA	1.91	0.92	2.12
4	SHUWAMIA PSS-2	Zone A	1 x 3 MVA	0.00	0.00	0.00
5	ZAKHAR PSS-1	Zone A	1 x 1 MVA	0.08	0.04	0.09
6	ZAKHAR PSS-2	Zone A	1 x 0.315 MVA	0.00	0.00	0.00
7	KABOOT PSS-1	Zone A	1 x 1 MVA	0.05	0.02	0.05
8	MAHWEES PSS-1	Zone A	1x 1 MVA	0.17	0.08	0.19
9	MARMUL PSS-1	Zone A	1 x 6 MVA	0.32	0.16	0.36
10	HANFEET PSS	Zone B	3 x 10 MVA	9.30	4.50	10.33
11	AL NAJID PSS	Zone B	2 x 10 MVA	3.81	1.85	4.23
12	SHASER PSS	Zone B	2 x 10 MVA	5.49	2.66	6.10
13	SHASER 6 MVA PSS-1	Zone B	1 x 6 MVA	2.78	1.35	3.09
14	ZINAT AL SHARA PSS	Zone B	1 x 6 MVA	3.20	1.55	3.56
15	HASMAN PSS	Zone B	1 x 3 MVA	0.26	0.12	0.28
16	BAITHNA PSS	Zone B	1 x 3 MVA	0.36	0.18	0.40
17	FATKHIT PSS	Zone B	2 x 1 MVA	0.27	0.13	0.30
18	QUITBEET SHADHOON PSS	Zone B	1 x 1 MVA	0.10	0.05	0.11
19	RCA-QATBEET PSS	Zone B	1 x 3 MVA	0.27	0.13	0.30
20	MARSWADAD PSS	Zone B	1 x 3 MVA	0.65	0.31	0.72
21	MANADER PSS	Zone B	1 x 1 MVA	0.06	0.03	0.06
22	SHIGAG PSS	Zone B	1 x 1 MVA	0.05	0.03	0.06
23	MAQSHAN PSS-01	Zone B	2 x 6 MVA	0.79	0.38	0.88
24	GULF MUSHROOM PSS	Zone B	2 x 6 MVA	1.62	0.78	1.80
25	Al MAZYUNAH 2X20 MVA 11/33KV STEP UP INDOOR S/S	Zone C	2 x 20 MVA	4.07	1.97	4.52
26	33/11KV OUTDOOR PSS-1 HAFOOF	Zone C	2 x 6 MVA	2.14	1.04	2.38
27	33/11KV OUTDOOR PSS-2 FEROQ	Zone C	2 x 6 MVA	2.99	1.45	3.32
28	33/11KV OUTDOOR PRIMARY SUBSTATION-3 JUJOOL MATHURAH	Zone C	1 x 3 MVA	0.50	0.24	0.56
29	33/11KV INDOOR PSS AYDAM	Zone C	2 x 6 MVA	0.58	0.36	0.68
30	2X6 MVA 33/11KV OUTDOOR PSS-3 AL MAZYOUHNA SOCIAL HOUSE	Zone C	2 x 6 MVA	2.94	1.42	3.27
31	33/11KV OUTDOOR PRIMARY SUBSTATION-4 MAZYONAH ROP	Zone C	2 x 6 MVA	0.64	0.31	0.71
32	3MVA 33/11.5 KV PRIMARY SUBSTATION-02 TOUSINAT	Zone C	1 x 3 MVA	0.50	0.24	0.55
33	11/33KV STEP UP S/S MUDHAI	Zone C	1 x 3 MVA	0.33	0.16	0.37
34	33/11KV PSS-1 MATHAFAH	Zone C	1 x 1 MVA	0.25	0.12	0.28

4.7.2.7 Demand Forecast for all primary substations in the TANWEER Transferred Distribution Network for the period Y2024 to 2026.

Demand forecast for all Primary Substations is given in the following section.

Table 4.7.2.7-1: Primary Substation load forecast for the period 2024-2026

Sl NO	NAME OF PSS	Zone	Installed Capacity	2023 (MVA)	2024 (MVA)	2025 (MVA)	2026 (MVA)
1	SHALEEM PSS-1	Zone A	1 x 6 MVA	1.50	1.59	1.68	1.50
2	SHALEEM PSS-2	Zone A	1 x 3 MVA	0.00	0.00	0.00	0.00
3	SHUWAMIA PSS-1	Zone A	1 x 3 MVA	2.25	2.38	2.52	2.25
4	SHUWAMIA PSS-2	Zone A	1 x 3 MVA	0.00	0.00	0.00	0.00
5	ZAKHAR PSS-1	Zone A	1 x 1 MVA	0.09	0.10	0.10	0.09
6	ZAKHAR PSS-2	Zone A	1 x 0.315 MVA	0.00	0.00	0.00	0.00
7	KABOOT PSS-1	Zone A	1 x 1 MVA	0.05	0.06	0.06	0.05
8	MAHWEES PSS-1	Zone A	1x 1 MVA	0.20	0.21	0.23	0.20
9	MARMUL PSS-1	Zone A	1 x 6 MVA	0.38	0.40	0.43	0.38
10	HANFEET PSS	Zone B	3 x 10 MVA	10.95	11.61	12.31	10.95
11	AL NAJID PSS	Zone B	2 x 10 MVA	4.49	4.76	5.04	4.49
12	SHASER PSS	Zone B	2 x 10 MVA	6.47	6.85	7.27	6.47
13	SHASER 6 MVA PSS-1	Zone B	1 x 6 MVA	3.27	3.47	3.68	3.27
14	ZINAT AL SHARA PSS	Zone B	1 x 6 MVA	3.77	4.00	4.23	3.77
15	HASMAN PSS	Zone B	1 x 3 MVA	0.30	0.32	0.34	0.30
16	BAITHNA PSS	Zone B	1 x 3 MVA	0.43	0.45	0.48	0.43
17	FATKHIT PSS	Zone B	2 x 1 MVA	0.32	0.34	0.36	0.32
18	QUITBEET SHADHOON PSS	Zone B	1 x 1 MVA	0.11	0.12	0.13	0.11
19	RCA-QATBEET PSS	Zone B	1 x 3 MVA	0.32	0.34	0.36	0.32
20	MARSWADAD PSS	Zone B	1 x 3 MVA	0.77	0.81	0.86	0.77
21	MANADER PSS	Zone B	1 x 1 MVA	0.06	0.07	0.07	0.06
22	SHIGAG PSS	Zone B	1 x 1 MVA	0.06	0.07	0.07	0.06
23	MAQSHAN PSS-01	Zone B	2 x 6 MVA	0.93	0.99	1.05	0.93
24	GULF MUSHROOM PSS	Zone B	2 x 6 MVA	1.91	2.02	2.14	1.91
25	Al MAZYUNAH 2X20 MVA 11/33KV STEP UP INDOOR S/S	Zone C	2 x 20 MVA	4.79	5.08	5.38	4.79
26	33/11KV OUTDOOR PSS-1 HAFOOF	Zone C	2 x 6 MVA	2.52	2.67	2.83	2.52
27	33/11KV OUTDOOR PSS-2 FEROQ	Zone C	2 x 6 MVA	3.52	3.73	3.96	3.52
28	33/11KV OUTDOOR PRIMARY SUBSTATION-3 JUJOOL MATHURAH	Zone C	1 x 3 MVA	0.59	0.62	0.66	0.59
29	33/11KV INDOOR PSS AYDAM	Zone C	2 x 6 MVA	0.72	0.77	0.81	0.72
30	2X6 MVA 33/11KV OUTDOOR PSS-3 AL MAZYOUHNA SOCIAL HOUSE	Zone C	2 x 6 MVA	3.46	3.67	3.89	3.46
31	33/11KV OUTDOOR PRIMARY SUBSTATION-4 MAZYONAH ROP	Zone C	2 x 6 MVA	0.76	0.80	0.85	0.76
32	3MVA 33/11.5 KV PRIMARY SUBSTATION-02 TOUSINAT	Zone C	1 x 3 MVA	0.59	0.62	0.66	0.59
33	11/33KV STEP UP S/S MUDHAI	Zone C	1 x 3 MVA	0.39	0.42	0.44	0.39
34	33/11KV PSS-1 MATHAFAH	Zone C	1 x 1 MVA	0.29	0.31	0.33	0.29

4.7.3 Generation and Dhofar Transmission System

Oman Power and Water Procurement Company (OPWP) and Oman Electricity Transmission Company (OETC) are responsible for planning power generation and transmission system of Salalah Power System respectively.

- The Transmission Capability Statement, which is prepared by the OETC according to Transmission and Dispatch Licence Condition number 27 and the Grid Code / Planning Code is available for download on OETC website at www.omangrid.com. This Statement describes in detail the Dhofar transmission systems capability over the coming five years as per OETC forecast and provides up-to-date transmission system data in order to identify those parts of the system, which offer the opportunity for future development of existing and potential users of the system.
- OPWP prepares the 7-Year Statement annually in accordance with Condition 5 of its license, which provides a 7-year outlook for power and desalinated water supply in the Dhofar Power System and the same is available for download on the OPWP website at www.omanpwp.com. This statement describes the existing generation plant capacity and new planned power generation plants as per OPWP forecast. Overview of the same is given below. OPWP is required to ensure that sufficient power generation resources are available to meet NDS electricity demand.

4.7.3.1 Generation Capacity in Dhofar Region

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

➢ The gas-based power stations installed in Dhofar region are described briefly below:

- **NPS Power Plant @ Raysut**

The initial development of NPS Power Plant started in 2002. The power plant has eight gas turbines which six of them connected to 132kV system while the other two are connected to 33kV system. They are operating in open-cycle and the gross site rating of the units varies from 19.9 MW to 37 MW. The net generation capacity of the power station is approximately 273.4 MW.

- **Salalah-2 Independent Power Plant (IPP)**

Salalah-2 Independent Power Plant (IPP) commissioned in 2018 with the total capacity of 444 MW with six CCGT units (two blocks of 2 GTs and 1 ST each) working in a combined cycle. This is located next to NPS Power Plant at Raysut.

- **Salalah IWPP @ Ashoor**

Contracted capacity of 445 MW. The Salalah IWPP is a CCGT plant comprising of five gas turbines and two steam turbines. It is located in the Mirbat/Taqah region and achieved COD in 2012. The P(W)PA is scheduled to expire before the summer period in 2027.

➢ Renewable Energy Power Generation

As per OPWP's 7year statement, OPWP is committed to achieve ambitious goals to diversify the sources of electricity generation. Accordingly, electricity production by new solar and wind projects are expected to contribute significantly in the coming years. Some of the existing renewable energy power plants in dhofar region are discussed below.

- **Dhofar I Wind IPP (Wind Farm Plant near to Harweel)**

The first 50 MW wind farm project in the sultanate of Oman is commissioned in 2019. The wind farm located in Harweel has an installed capacity of 49.4 MW, comprising of 13 x 3.8 GE wind turbines. Following a similar methodology used for the Solar IPPs, OPWP has estimated a provisional capacity contribution value of 50% following the results of analyses that looked at both correlation between wind speed and demand profile, and the expected impact and contributions towards meeting LOLH requirements. This wind farm is located near Harweel area and is connected to the transmission system of Dhofar. OPWP has a PPA with the operator, RAECO.

- **Solar Energy Plant in Al-Mazyonah**

Solar Energy plant of 307 kWp generation capacity connected to Al-Mazyounah network. The plant consists of 432 (160 Wp modules) and 576 (150 Wp modules) solar panels with inverters, distribution and metering panel.

➢ Diesel Generation Plants

Distribution networks in the recently transferred areas from TANWEER to NDS are mostly isolated from the main network of NDS and hence customers in these areas are supplied by TANWEER's isolated diesel power plants supplying directly connecting feeders at 33kV or at 11kV levels. Most of the demand in these areas are fed by TANWEER owned Diesel Generation plants and in some places mobile DG or rental DG's are hired to meet the demand.

➢ Resource Development Plan by OPWP

As per the Nama Power and Water Procurement Co. (SAOC) 7 Year Statement 2023 – 2029, it has no plans to procure new gas-fired generation capacity for the Dhofar Power System (DPS) but plans additional Renewable Energy development. The Dhofar region has excellent potential for wind energy development, consequently, OPWP has plans to develop a second wind energy farm, currently estimated at 100 MW for COD in Q4 2026. Both wind resource and land are available for the power project, Dhofar II Wind IPP, which is expected to be developed adjacent to the existing Dhofar I Wind IPP. This project is anticipated to be competitively tendered. Final capacity of this project may vary slightly from the value mentioned here and is subject to wind farm layout optimization analyses. OPWP further notes that when the North-South Interconnect project is completed to Dhofar, PWP expects to develop more renewable energy projects in the DPS.

Furthermore, PWP assumed and based on the discussion with OETC that the North-South Interconnector all the way to Dhofar will be available by 2027. Accordingly, and as per OETC confirmation to PWP, the estimated capacity to be exported to Dhofar region via this link about 860 MW considering N-1 security standard. This value might be revised according to the project progress and demand development.

To utilise the existence of the interconnector and to secure DPS capacity requirements, PWP plan to procure another wind IPP at Sadah site. As per the wind data measured this site will have a good potential to develop up to 100 MW of wind IPP. The expected COD is 2028.

- **Interconnection with PDO**

Dhofar transmission system is interconnected with the transmission system of the Petroleum Development Oman (PDO). The interconnection is made at 132kV between Thumrait grid station on the Dhofar system and Harweel 132kV station on PDO 132kV network by 84.5 km single circuit overhead line. The interconnection essentially allows OETC and PDO to supply limited power to each other in emergency conditions on either system and provides important reliability benefits through the sharing of generation reserves. A proposed expansion of interconnection capacity is currently under consideration as part of the 400 kV North-South Interconnect project.

Recently transferred distribution network area by TANWEER to NDS also have some 33kV interconnection points to feed the customers in the following areas.

i. Shaleem, Shuwaymia & Zakhar
ii. Wadi Hakka village
iii. Dimeet, Wadi Arah & Mahwees
iv. Wadi rahab village
v. Kaboot village
vi. Juo Al Salam & Marmul
vii. Fatkhait & Qatbet Sadhoon

5 The Medium Voltage Distribution System.

5.1 System Configuration

The NDS MV distribution network is operated at 33 kV and 11 kV voltages, supplying non-bulk customers (mainly residential and small commercial loads) at low voltage levels of 415/240 V, whereas Bulk customers such as hotels, commercial malls or industrial users are normally fed from 11 kV substations' busbars of PSS's, though there are several larger consumers who are directly supplied from 33 kV busbars at GSS's.

NDS authorised area covers whole of Dhofar governorate as per Distribution and supply licence granted to NDS. The majority of the population and non-bulk load is concentrated near the shoreline, an area suitable for future network development.

NDS MV network is interconnected with 132 kV transmission system through twelve GSSs, namely: Thumrait, Shaa'aon, Ittin, Al Qurm, Ashoor, Raysut, NPS, Mirbat, Salalah IPP, Saada A , Saada B and Saih AL khairat. The grid substations are connected through parallel operated double circuit 132 kV overhead lines, running west from SFZ and NPS, where the industrial area and port are located, towards Ittin and Shaa'aon in central Salalah, and from there to East connecting to Al Qurm, Saada and Ashoor. The mountain region at the North is supplied through a link between Ittin and Thumrait. A geographic map shown below provides an overview of the topology of the 132 kV network for Y2023 (Source: OETC's 5year Annual Transmission Capability Statement 2023-2027).

Figure 5.1-1 132 kV grid substations forming the regional transmission network in the Dhofar Region

A new grid substation 132/33, 2x63 MVA capacity is commissioned at Saih Al Khairat in the Y2023 and is now feeding to distribution network of Tanweer transfer assets in the region. This grid will help in reducing the desial generation in the vicinity of Saih Al Khairat area. Further, NDS has submitted application to OETC for Construction of 3 Nos of Grid Substations at Mudhai (2x30MVA), Mazyounah (2x63MVA) and Shahb Asaib

(2x63MVA) and it is expected to be commissioned by June 2026 by OETC. Currently projects are under design stage and expected to be awarded for construction of the same at the earliest.

The MV distribution system comprises of 49 primary substations. Each installation normally comprises of two 33/11 kV power transformers to provide firm capacity. The transformers have rated powers of 6, 10 or 20 MVA. Out of total 49 PSS, 40 PSS have 2x20 MVA installed capacity. Madinat Al Haq, Hakbeet and Teetam PSSs which have a capacity of 2x10 each and PSS's SQH-2, Dhariz, Saada-2 & Jarziz have 3x20 MVA capacity. Couple of PSS's like Al Saan & Foshi have 1x6 MVA. Recently installed Dahaboon PSS have been constructed with installed capacity of 2x6MVA.

The power transformers are equipped with on-load tap changers (OLTC) for voltage regulation purposes and two banks of capacitors at the 11 kV bus intended for power factor correction (set at 0.95). For majority of the cases, the busbar arrangement is a sectionalized bus with Normally Open (NO) bus coupler circuit-breakers.

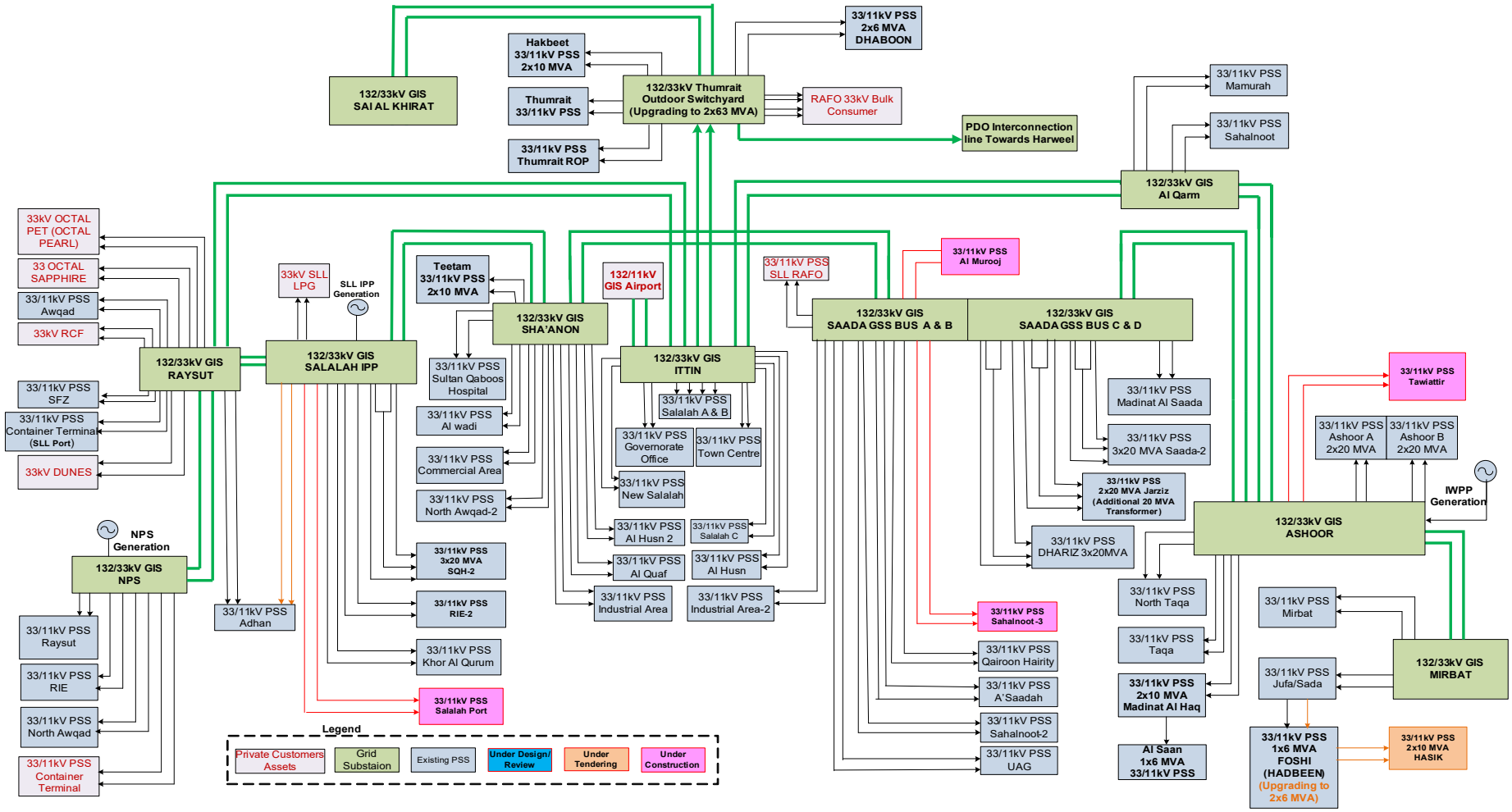
The network is being supervised by a SCADA system up to the point of 11 kV outgoing feeders at PSS's. A new Distribution Control Center (DCC) project has been successfully completed in Y2019 with a new SCADA system.

Figure 5.1-2 given below illustrates the single line diagram of NDS's 33 kV network for the year 2023 (excluding the distribution network recently transferred from the TANWEER in the Dhofar region).

OETC has constructed and commissioned a new grid substation of capacity 2x63MVA at Mirbat and this facilitate to feed reliable and quality power supply to Mirbat and Jufa/sadha areas. Both Mirbat PSS and Juffa/Sada PSS are now fed directly from new Mirbat grid substation.

Also, upgrading of the existing grid substation from 2x30MVA to 2x63MVA at Thumrait GSS is completed and energized.

Figure 5.1-2 Single line diagram showing NDS's 33 kV system for the Y2023 (As on Sept'23)



5.2 Modelling Approach

A software model of the distribution network, containing the 33 kV network and down to the 11kV busbars of PSS's has been developed in DIgSILENT® PowerFactory, reflecting the configuration of the NDS's Distribution Network. This model is subsequently used to simulate load growth and observe its impact on the network, thereby identifying reinforcement required to ensure that the network can be operated securely throughout the period 2024-2026. Based on the demand forecast study substation wise demand projection for next three years is furnished Table 4.7.1-2.

As a licensee distributor NDS is committed to drive its business in compliance with applicable legislation, codes and standards. NDS adopted DSSS as a guiding document to plan, operate and maintain its distribution network. In order to assess security compliance, it is required to analyse equipment overloading, voltages excursions and fault levels, studies that can be carried out through digital simulations encompassing:

- Load flow analysis;
- Short-circuit analysis.

It may be noted that modelling of the recently transferred network area by TANWEER to NDS in the Dhofar region needs to be developed in the Digsilent PowerFactory and hence the aforesaid study related parts are not are included in the report for these areas.

5.3 Primary Equipment Loading

Primary equipment loading is derived from area wise load projection of substation and details of the same are given in Table 4.7.1-2.

5.4 Voltage Non-Compliance

As regards voltages at 33 kV and 11 kV feeders in primary substations, simulation studies prove that no voltage violations were observed under steady state conditions in next three years.

5.5 Short Circuit Analysis

The designed short circuit rating for equipment on the NDS 33 kV network is 25 kA. Three phase symmetrical short circuit breaking current at 33kV and 11kV busbars is provided in Annexure, section 8.1. The results show that the maximum fault level is well within the short circuit rating of primary 33kV equipment.

The designed short circuit rating for equipment on the NDS 11 kV network is 18.5 kA (350 MVA). With radial operation of the network, the results show that the maximum fault level has been well within the short circuit rating of primary 11 kV equipment.

The study also shows that the change from radial to parallel operation of 11kV busbars at PSS level will significantly increase the prospective fault level, however it will remain within the short circuit rating of primary equipment. Further, NDS is evaluating the feasibility of the parallel operation of the 11kV busbars with the existing 2 x 20 MVA PSS configuration, considering overall design of the system and any other technical requirements (like CTs associated with unit protection schemes are adequately rated and suitable transformer tap change control schemes are in place and fully functional).

Considering the above points, NDS has conducted an inhouse study for the feasibility of parallel operation of power transformers in all PSS and the report is under final review and management approval process. On approval of the same by NDS Management, parallel operation scheme be implemented at the earliest. However, it may be noted that the current network configuration applies an auto-changeover scheme (load transfer from one 11kV busbar/transformer to other) to automatically effect restoration following a single circuit fault, the current network operation complies with the requirements of the distribution system security standards (DSSS) and hence parallel operation at 11kV side was not considered.

NDS protection team has done a detailed site visit of all the substations and initial findings indicates that in most of the PSS transformers can be operated in parallel with minimum changes in the protection schemes. However, some PSS require some investment to modify/upgrade the system for parallel operation. Till such time the current 11kV auto-changeover scheme will be in place and will be enabled at these PSS.

5.6 System Security Compliance

As is shown in Table 5.6-1, All the PSS's in the NDS are expected to be compliant with DSSS as long as the current/proposed network investments are executed as per the approved project plan.

Table 5.6-1: Security compliance of primary substations

Primary Substation Name	Actual transformer capacity (MVA)	Secure Capacity (MVA)	2024	2025	2026	Security Class			Security Compliant			33kV Voltages Compliant			11kV Voltages Compliant			Short Circuit Compliant		
			MW	MW	MW	2024	2025	2026	2024	2025	2026	2024	2025	2026	2024	2025	2026	2024	2025	2026
Awqad	2x20	20	18.35	16.26	17.12	C	C	C	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
Industrial Area	2x20	20	17.20	17.92	15.74	C	C	C	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
North Awqad	2x20	20	13.24	13.89	14.63	C	C	C	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
Raysut 'A'	2x20	20	11.18	11.52	11.91	C	C	C	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
Al Wadi	2x20	20	11.78	12.21	12.69	C	C	C	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
Commercial Area	2x20	20	14.06	14.57	15.14	C	C	C	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
Governorate Centre	2x20	20	14.24	14.67	15.15	C	C	C	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
New Salalah	2x20	20	11.41	11.73	12.08	C	C	C	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
Salalah A	2x20	20	13.10	13.57	14.11	C	C	C	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
Salalah B	2x20	20	12.55	13.00	13.51	C	C	C	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
Sultan Qaboos Hospital	2x20	20	10.78	11.04	11.32	C	C	C	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
Town Centre	2x20	20	14.22	14.67	15.17	C	C	C	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
Al Qoaf	2x20	20	14.35	15.71	16.23	C	C	C	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
Al-Husn	2x20	20	12.84	13.73	14.18	C	C	C	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
Al-Husn 2	2x20	20	8.98	9.07	9.18	C	C	C	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
UAG	2x20	20	14.23	14.75	15.35	C	C	C	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
Al Saada	2x20	20	17.51	18.12	16.80	C	C	C	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
Madinat Al-Saada	2x20	20	16.59	17.07	15.60	C	C	C	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
Mamurah	2x20	20	14.33	15.90	16.40	C	C	C	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
Sahalnoot	2x20	20	14.10	14.51	15.97	C	C	C	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
Qairoon Hairiti	2x20	20	8.97	9.52	9.89	C	C	C	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
Thumrait	2x20	20	16.44	16.96	17.53	C	C	C	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
Jufa/Sadah	2x20	20	4.90	5.13	5.40	B	B	B	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
Mirbat	2x20	20	16.08	16.78	17.58	C	C	C	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
Taqa	2x20	20	13.49	16.06	16.79	C	C	C	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
North Taqa	2x20	20	15.56	16.28	17.09	C	C	C	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
Adhan	2x20	20	12.09	14.55	16.84	C	C	C	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
Salalah Free Zone	2x20	20	18.73	17.37	17.40	C	C	C	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
Raysut Industrial Estate	2x20	20	15.84	16.29	16.74	C	C	C	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
Madinat Al Haq	2x10	10	6.93	7.26	7.64	C	C	C	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
North Awqad 2	2x20	20	13.83	14.51	15.28	C	C	C	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
Hakbeet	2x10	10	2.92	3.03	3.15	B	B	B	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
Teetam	2x10	10	4.25	4.41	4.59	B	B	B	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES

Primary Substation Name	Actual transformer capacity (MVA)	Secure Capacity (MVA)	2024	2025	2026	Security Class			Security Compliant			33kV Voltages Compliant			11kV Voltages Compliant			Short Circuit Compliant		
			MW	MW	MW	2024	2025	2026	2024	2025	2026	2024	2025	2026	2024	2025	2026	2024	2025	2026
Al Sa'an	1x6	3.52	3.26	3.39	3.52	B	B	B	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
Saada 2	3x20	40	29.08	29.93	32.88	D	D	D	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
Salalah Port GCT	2x20	20	5.63	5.80	6.00	B	B	B	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
Raysut Industrial Estate 2	2x20	20	15.82	16.19	16.57	C	C	C	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
Khor Al Qurum	2x20	20	16.35	17.10	18.33	C	C	C	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
Sahalnoot 2	2x20	20	18.12	18.79	15.55	C	C	C	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
Jarziz	3x20	40	18.75	19.56	22.16	C	C	D	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
Salalah C	2x20	20	15.03	15.58	16.19	C	C	C	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
SQH-2	3x20	40	13.92	24.19	24.77	C	D	D	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
ASHOOR-A	2x20	20	9.51	9.47	9.41	C	C	C	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
ASHOOR-B	2x20	20	6.10	6.10	6.10	C	C	C	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
Dahariz	3x20	40	28.85	29.89	31.83	D	D	D	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
Industrial Area 2	2x20	20	3.06	14.20	14.95	B	C	C	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
Dhahboon	2x6	6	13.53	3.17	3.30	C	B	B	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
Foshi	1x6	0	1.85	1.94	2.04	A	A	B	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
THUMRAIT ROP	2x20	20.0	3.00	3.75	3.75	B	B	B	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
Almurooj	2x20	20	8.00	8.39	11.84	C	C	C	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
Sahalnoot3	2x20	20	12.00	12.45	15.94	C	C	C	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
Tawittir	2x10	10	4.50	4.72	4.96	B	B	B	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES
SFZ-2	2x20	20	0.00	6.55	11.71	A	C	C	Y	Y	Y	YES	YES	YES	YES	YES	YES	YES	YES	YES

5.7 Noncompliance to DSSS:

NDS is committed to ensuring compliance with its License obligation to comply with the requirements of the DSSS. Authority allowed Capex allowances are efficiently utilised to support NDS network investment in the 33kV system and to achieve compliance with the DSSS.

Due to delay in commissioning of upgradation project of Jarziz PSS, existing Saada PSS and Sahalanoot-2 PSS loading crossed their firm capacity for short during the year 2023, however, no non-compliances are reported. The recent demand forecast indicates that all equipment loadings will be compliant to DSSS in the coming years.

Based on the recent Demand forecast, NDS has forecasted the requirements for network reinforcement and expansion in the NDS's Licensed Area. Expenditure plan is created to ensure NDS comply with its statutory obligations. Accordingly, construction of some primary substations was planned and allowance for the same was provided by the Authority in NDS's Price control 2022-25 submission. Following are the some of the major PSS projects, which are under progress and are expected to be completed in the PCR-4 period.

1. New PSS at Sahalnoot area (Sahalnoot-3) with capacity 2x20 MVA
2. New PSS at Almurooj with capacity 2x20 MVA
3. New PSS at Tawittir area (with capacity 2x10 MVA)

It may be noted that sudden addition of 10 MW in the Salalah Free Zone PSS by a new customer, there is no additional spare capacity left in the Salalah Free Zone PSS to connect new customers. Hence, a new primary substation named SFZ-2 is being planned for construction. To comply with the license obligations proposed SFZ-2 PSS is required before summer 2025. In case of any delay in the planned project, SFZ PSS may experience non-compliance to DSSS. This investment project is not part of the PCR-4 allowances.

Further, NDS is revising demand forecast annually based on the updated data received from the customers and accordingly reviews the requirement of new PSS every year during the preparation of its Electricity Distribution Network Development Plan (EDNDP). Commissioning of some new projects in the current year like Industrial Area-2 PSS, upgradation of Saada-2 & Jarziz PSS, Mirbat GSS and upgradation of Thumrait GSS will greatly help NDS to maintain all the PSS within DSSS compliance in the upcoming years.

It should be noted that the level of the security requirements on the distribution system would change in future if the demand on the system increases or decreases significantly due to unexpected bulk customers and unforeseen reasons. Due to this, it is possible that further non-compliances might arise in the future and might require to carryout additional network reinforcement works to mitigate the same.

5.8 Suitability for connections

Based on the outcome of simulation studies and assuming that the foreseen investments are realized, the large majority Salalah distribution system is generally well suited to receive new connections. Overall, it can be said that the prospective developments in the East area of Salalah (real estate, tourism), as well as West Area of the city (industry and commerce) and now these areas have sufficient spare capacity in PSS and GSS.

Further, a new grid substation at Mirbat with 2x63 MVA capacity and upgradation of Thumrait grid substation from 2x30MVA to 2x63 MVA will also have sufficient spare capacity for new connections.

5.9 TANWEER Interconnection

Considering the high running/operation charges and high maintenance charges of Diesel generation plants, our parent company i.e. Nama Holding Company desired to eliminate/reduce the diesel generation plants of TANWEER (RAECO) in the Dhofar region. Accordingly, on 1st January 2022, TANWEER transferred its distribution network in the remote and isolated areas of the Dhofar region and these areas will be connected to NDS network wherever possible immediately and/or necessary strengthening of transmission and Distribution network will be carried out to reduce the Diesel plants.

In view of the above, in association with TANWEER and OETC, NDS has carried out the feasibility study to connect TANWEER network to NDS network in Dhofar region for secured and reliable power supply to TANWEER customers through efficient investment plans. Accordingly, the projects for the investment proposals approved as part of PCR-4 submission to the Authority are presented in the Table 7.1-2.

6 The Low Voltage System

6.1 System Configuration

The main objective of the LV system is to distribute electricity in urban or rural areas and to supply it to customers connected at LV supply terminals in a safe, reliable and economic manner, whilst meeting statutory obligations.

An LV network extends from an existing 11/0.433kV Ground Mounted Substation or Pole Transformer. In a ground mounted substation, the LV system is typically fed from a feeder pillar that is connected to the LV side of an 11/0.433 kV transformer by single core cables as per OES 5. The transformer is normally protected by a fuse-switch combination of a RMU (Ring Main Unit), which is subsequently loop-connected into the 11kV network.

6.2 System Security

The security requirements specified in DSSS for LV connected customers are minimal, *i.e.* the load affected by a forced outage only needs to be restored within the time required to repair a failed component of the Distribution Network.

6.3 Application of LV Infrastructure

6.3.1 Distribution Substations

Distribution Substations (DSS) deliver energy to NDS low voltage networks and to industrial/commercial customer owned networks. Where customers take a supply at 11kV they own their 11kV/LV transformers and sometime operate their own internal 11kV circuits. The majority of customers take supply from the LV network supplied by 11kV/LV transformers owned by NDS.

Pole mounted transformers 50kVA will be the minimum size used for connection to domestic properties. Ground mounted transformers have local switchgear incorporating transformer protection fuses. At times, transformers are radial connected on tee-off circuits.

Typical 11/0.433 kV distribution transformers in Salalah network are of 50kVA, 100kVA, 200kVA, 315kVA, 500kVA and 1000kVA capacity (as per OES 5). The maximum transformer capacity for pole-mounted structure is 315kVA. The vector group of 11/0.433 kV transformers is Dyn11 and off-load tap changers are provided for voltage adjustment.

Recently, NDS is using package type distribution substations considering its compact dimensions, which is hugely beneficial, releasing valuable floor space. Package substations are Pre-assembled for quick installation, hence reduce the installation time compared to construction of traditional type 1000 KVA substations. Also, NDS is adopting the Dry type transformers for substations inside building, which is as per new OES#37 for “Indoor Distribution Transformers Not Containing Liquid Insulant” (Dry type transformers).

Recently, DCRP has approved the 11/0.433kV, 2000 kVA capacity transformers for some vendors and some customers are already planning to use this new capacity transformers which help in saving the cost as well as area of installation.

Eight-way feeder pillar are rated for 1,600A and is normally meant for a 1000kVA transformer, while 6-way feeder pillar are rated for 800A and is used in conjunction with a 500kVA transformer. Cut-out box serves the same purpose as feeder pillars and are typically used to connect LV customers to pole mounted transformer of up to 315kVA.

6.3.2 Switchgear

Majority of 11kV feeders are interlinked through Ring Main Unit (RMU), provides switching and earthing facilities for the connected 11kV ring network. The RMU has two oil operated switches (Oil Link Units) at its both ends and a t-off fuse (High Fuse Unit) that protect a distribution transformer. The two incomers of RMUs are on-load switch units, having 400A rating with 18.4kA short-circuit rating (3 sec). The 11kV High Fuse Unit is rated at 63 Amps for 1000kVA transformers and 31.5 Amp for 500kVA transformers.

6.3.3 Overhead Lines

Overhead lines are normally constructed in unplanned areas or whenever underground cable runs are not economical or impractical. This will normally be limited to rural areas and line routes are selected in such a way that minimise the impact on the environment and local amenity.

The Low-Tension overhead line (LT OHL) conductors commonly installed in Salalah network are 120mm^2 and 200mm^2 XLPE covered all aluminium conductors.

6.3.4 Underground Cables

LV underground cables are typically 4 core XLPE copper cables, with cross sectional area of 120mm^2, 185mm^2, or 240mm^2, which is in line with Oman Electric Standards (OES-21A & 21B)

6.3.5 Protection

The protection scheme is generally time-graded and is designed to minimise supply disruption during the occurrence of a system fault.

7 Strategic Development Statement

Strategic development of distribution networks plays an essential role in the asset management in electricity distribution companies. Owing to the capital-intensive nature of the field and long span operations of distribution companies, the significance of a strategy is highly emphasised. A well-devised strategy combines the best knowledge of the challenges posed by the operating environment and the future targets of the distribution company. Challenges originating from the operating environment are constantly evolving. The economic regulation, ageing infrastructure, scarcity of resources and tightening supply requirements, together with challenges created by the climate change, put evolving challenges on the energy sector. On the other hand, technology development for instance related to network automation and underground cabling together with an opportunity to outsource certain activities assists in answering these challenges. Some of these challenges are discussed below:

- **Efficiently meet future growth of electricity demand in the Dhofar region**:
  - NDS will develop programs to measure losses and improve customer metering;
  - Major driver of CAPEX & OPEX spending is the demand for energy, which is growing rapidly.
- **AMR Project and Prepaid Meters**:
  - To automate meter readings for high value customers AMR project being implemented;
  - To allow the customers to control credits and avoid high bills and also to avoid delayed payments installation of Prepaid meters started.
- **GIS for whole NDS Distribution Network**:
  - Phase-1 implementation of GIS for five primary substations is completed.
  - Implementation of GIS Phase-2 for remaining PSS is under progress.
- **Develop and retain the technical capability (attract, train, and retain competent technical staff):**
  - NDS will seek to provide professional development for its staff;
  - Provide technical training according to a need-based assessment.
- **Improve customer care and interaction** (meter reading, billing, and collection):
  - Report improvements based on “standard” KPI’s.
- **Ensure electric infrastructure is protected against cyber-attacks:**

  The existing standalone SCADA infrastructure system of NDS has its own communication network and is not connected to any other inside or outside communication network like IT, ICCP & CIS/CRM. Hence, existing Primary substation’s, SCADA equipment’s and associated devices are physically secured and isolated from the other Communication Networks thereby totally protected from any external cyber threats and attacks.

All of these challenges should ensure “best practices” including transparency, stability, and predictability. To meet the challenges NDS has already taken many strategic initiatives in line with the company’s as well as Nama group vision and mission.

7.1 33 kV Network Improvements

The purpose of this section is to provide a brief description of the 33kV development projects that are currently under construction. These improvement projects are required for NDS to operate the distribution network within the standards governed by NDS and APSR to ensure that existing and proposed assets meets new and existing standards and operates within its capabilities, for both demand and fault current, and delivers an adequate supply quality and safety to the end user. Table 7.1-1 and Table 7.1-2 presents a summary of the status of the projects presently on-going and/or proposed projects.

Table 7.1-1 : Summary of 33kV on-going and proposed projects in PCR-4

Project	Project Details	Reason for Investment	Status of the Project	Planned Year	Expected Completion Year
33kV ongoing Projects					
Industrial Area 2	New 2 x 20 MVA 33/11 kV Primary Substation	Based on load demand	completed	-	-
Foshi	New 1 x 6 MVA 33/11 kV Primary Substation at Hadbeen area	Based on load demand	completed	-	-
Jarziz	Additional 20 MVA transformer to upgrade the existing Jarziz 33/11 kV PSS to 3x20MVA	Based on load demand	completed	-	-
Adhan	Laying 33kV 3Cx300sqmm UG feeder to connect to SFZ-2 GSS (Shifting of Adhan PSS feed from Raysut GSS to Salalah IPPP GSS)	To maintain the security compliance	Under Retendering process	Feb-20	Apr-24
Saada-2	Additional 20 MVA transformer to upgrade the existing Saada-2 33/11 kV PSS to 3x20MVA	Based on load demand	completed	-	-
Tawiattir	New 2 x 10 MVA 33/11 kV Primary Substation	Based on load demand	Under construction	Feb-23	Dec-23
Sahlnoot-3	New 2 x 20 MVA 33/11 kV Primary Substation	Based on load demand	Under construction	Feb-23	Nov-23
AlMurooj	New 2 x 20 MVA 33/11 kV Primary Substation	Based on load demand	Under construction	Feb-23	Nov-23
Ongoing Grid Substations Projects					
Mirbat	New 2x63 MVA 132/33kV Grid Substation	To maintain the security compliance	Completed	-	-
Thumrait	Upgradation of existing Thumrait GSS to 2x63 MVA from 2x30 MVA	To maintain the security compliance	Completed	-	-

Table 7.1-2 : Summary of 33kV on-going and proposed projects in PCR-4 in the Distribution Network Area transferred to NDS in the Dhofar Region.

Project	Project Details	Reason for Investment	Status of the Project	Planned Year	Expected Completion Year
33kV ongoing Projects					
Shalem	Shifting of PDO tapping power source from existing PDO Amal GSS to Grater Saqar PDO GSS	Due to dismantling of Amal GSS by PDO	Completed	-	-
Aydam	Electricity Supply to Aydem Camp (RAO) at Dhofar Governorate.	Based on load demand	Completed	-	-
Hasik	33/11 kV, 2 x 10 MVA PSS designated as Hasik PSS and associated works to link isolated Tanweer Hasik PS in Dhofar with the utility grid network.	To eliminate the isolated Tanweer Hasik PS and to link with the NDS network	Under design	Mar-24	Mar-25
Shahb Asaib	33/11 kV, 2 x 20 MVA PSS designated as Shahb Asaib PSS to link isolated Tanweer Shahb Asaib PS in Dhofar with the utility grid network	To eliminate the isolated Tanweer Mudhai PS and to link with the Dhofar Transmission grid network	Under design*	Sep-26	Sep-26
Al Mazyounah	Capacity Upgradation to 3 x 20 MVA at Mazyounah PSS from existing 2 x 20 MVA, 33 /11 kV to link isolated Tanweer Mazyounah PS in Dhofar with the utility grid network	To eliminate the isolated Tanweer Mudhai PS and to link with the Dhofar Transmission grid network	Under design*	Sep-26	Sep-26
Mudhai	33/11 kV, 2 x 10 MVA PSS designated as Mudhai PSS	To eliminate the isolated Tanweer Mudhai PS and to link with the Dhofar Transmission grid network	Under design*	Sep-26	Sep-26
Mittan	33/11 kV, 2 x 6 MVA PSS designated as Mittan PSS to link isolated Tanweer Mittan PS in Dhofar with the utility grid network	To eliminate the isolated Tanweer Mittan PS and to link with the NDS network	Under design*	Sep-26	Sep-26
Farshat Qatbeet	Interlink Projects - To link isolated Tanweer Farshat Qatbeet PS in Dhofar with the utility grid network (33 KV lines+33kV Switchgear addition)	To eliminate the isolated Tanweer Farshat Qatbeet PS and to link with the NDS network	Under design	Dec-24	Dec-24

Project	Project Details	Reason for Investment	Status of the Project	Planned Year	Expected Completion Year
Shwmiya	Upgrade the existing 2x3MVA PSS to 2x 10MVA PSS at Shwmiya	To maintain the security compliance	Under design	April-25	Apr-25
Zakhar	Sharbathat interlink with Zakhar 33kV Line to enable grid connectivity and remove the Diesel generation by Extending 33kV line from Zakhar area	To eliminate the isolated Tanweer Sharbathat PS and to link with the NDS network	Under design	Jun-24	Jun-24
Ongoing Grid Substations Projects					
SAIH AL KHAIRAT GSS	SAIH AL KHAIRAT interlink project with existing power station 33kV switchgear	To maintain the security compliance	Completed	-	-
Mudhai GSS	New 2x30 MVA 132/33kV Grid Substation	To eliminate the isolated Tanweer Mudhai PS and to link with the Dhofar Transmission grid network	Under Design by OETC	Jun-26	Jun-26
Shahb Asaib GSS	New 2x63 MVA 132/33kV Grid Substation	To eliminate the isolated Tanweer Shahb Asaib PS and to link with the Dhofar Transmission grid network	Under Design by OETC	Jun-26	Jun-26
Al Mazyounah GSS	New 2x63 MVA 132/33kV Grid Substation	To eliminate the isolated Tanweer Al Mazyounah PS and to link with the Dhofar Transmission grid network	Under Design by OETC	Jun-26	Jun-26

8 Annexure

8.1 Short Circuit Analysis

Three phase symmetrical short circuit current at 33kV and 11kV busbars is provided in Table 8.1-1 and Table 8.1-2 respectively. It should be noted that the short circuit models do not include possible motor fault current contribution but note that equipment short circuit rating exceeds maximum fault current by an adequate margin.

Table 8.1-1 : 3-Phase Short Circuit (Ik'') [kA] levels at PSS 11 kV bus bars

Primary Substation	Short Circuit Rating of each 11kV Bus	2023	2024	2025	2026
Awqad	18.4 kA	5.71	5.72	5.73	5.74
Industrial Area	18.4 kA	6.21	6.22	6.23	6.25
North Awqad	18.4 kA	4.67	4.67	4.87	4.88
Raysut 'A'	18.4 kA	5.68	5.69	5.99	6.00
Al Wadi	18.4 kA	5.70	5.70	5.71	5.73
Commercial Area	18.4 kA	5.44	5.45	5.46	5.47
Governorate Centre	18.4 kA	5.47	5.48	5.48	5.49
New Salalah	18.4 kA	6.09	6.11	6.11	6.13
Salalah A	18.4 kA	5.50	5.51	5.52	5.53
Salalah B	18.4 kA	5.55	5.56	5.57	5.58
Sultan Qaboos Hospital	18.4 kA	6.07	6.08	6.08	6.10
Town Centre	20 kA	5.72	5.73	5.74	5.75
Al Qoaf	18.4 kA	5.30	5.31	5.31	5.33
Al-Husn	18.4 kA	5.40	5.40	5.41	5.42
Al-Husn 2	18.4 kA	5.38	5.38	5.39	5.40
UAG	18.4 kA	6.16	6.17	6.18	6.19
Al Saada	18.4 kA	6.87	6.89	6.89	6.91
Madinat Al-Saada	18.4 kA	6.75	6.76	6.77	6.78
Mamurah	18.4 kA	5.33	5.34	5.34	5.35
Sahalnoot	18.4 kA	5.27	5.28	5.28	5.29
Qairoon Hairiti	20 kA	4.03	4.04	4.04	4.04
Thumrait	18.4 kA	6.52	6.53	6.54	6.55
Jufa/Sadah	20 kA	2.07	2.07	2.07	2.07

Primary Substation	Short Circuit Rating of each 11kV Bus	2023	2024	2025	2026
Mirbat	18.4 kA	5.58	5.60	5.60	5.60
Taqa	18.4 kA	4.96	4.97	4.97	4.98
North Taqa	18.4 kA	5.38	5.40	5.40	5.41
Adhan	18.4 kA	6.21	6.22	6.22	6.24
Salalah Free Zone	18.4 kA	7.32	7.33	7.35	7.37
Raysut Industrial Estate	18.4 kA	6.02	6.03	6.36	6.38
Madinat Al Haq	26.3 kA	3.89	3.90	3.90	3.90
North Awqad 2	20 kA	6.00	6.00	6.00	6.00
Hakbeet	25 kA	3.39	3.39	3.39	3.39
Teetam	25 kA	3.00	3.00	3.00	3.01
Al Sa'an	25 kA	2.26	2.26	2.26	2.26
Saada 2	18.4 kA	12.27	12.32	12.34	12.38
Salalah Port GCT	18.4 kA	6.69	6.70	6.71	6.73
Raysut Industrial Estate 2	18.4 kA	6.46	6.47	6.48	6.50
Khor Al Qurum	25 kA	5.99	5.99	6.00	6.02
Sahalnoot 2	25 kA	6.87	6.89	6.89	6.91
Jarziz	25 kA	6.09	6.10	6.10	6.11
Salalah C	25 kA	5.62	5.63	5.64	5.65
SQH-2	25 kA	10.56	10.57	10.60	10.65
ASHOOR-A	25 kA	7.55	7.58	7.59	7.60
ASHOOR-B	25 kA	7.55	7.58	7.59	7.60
Dahariz	25 kA	10.68	10.72	10.73	10.77
Industrial Area 2	25 kA	5.80	5.81	5.82	5.83
Dhahboon	25 kA	2.03	2.03	2.03	2.03
Foshi	25 kA	1.39	1.39	1.39	1.39
Thumrait ROP	25 kA	2.03	2.03	2.03	2.03
ALMUROOJ	25 kA	-	5.99	6.00	6.02
Sahalnoot 3	25 kA	-	5.80	5.80	5.81
Tawittir	25 kA	-	5.75	5.75	5.76
SFZ 2	25 kA	-	-	6.94	6.96

Table 8.1-2 : 3-Phase Short Circuit (Ik'') [kA] levels at PSS 33 kV bus bars

Primary Substation	Short Circuit Rating of each 33kV Bus	2023	2024	2025	2026
Awqad	25 kA	5.74	5.76	5.77	5.82
Industrial Area	25 kA	7.55	7.59	7.62	7.69
North Awqad	25 kA	10.00	10.07	10.13	10.26
Raysut 'A'	25 kA	6.62	6.64	7.89	7.95
Al Wadi	25 kA	5.72	5.74	5.76	5.80
Commercial Area	25 kA	5.04	5.06	5.07	5.10
Governorate Centre	25 kA	5.09	5.11	5.12	5.14
New Salalah	25 kA	6.66	6.69	6.71	6.76
Salalah A	25 kA	5.52	5.54	5.55	5.58
Salalah B	25 kA	5.67	5.69	5.71	5.74
Sultan Qaboos Hospital	25 kA	6.96	6.99	7.02	7.08
Town Centre	25 kA	5.22	5.24	5.25	5.28
Al Qoaf	25 kA	4.70	4.72	4.73	4.76
Al-Husn	25 kA	4.88	4.89	4.91	4.94
Al-Husn 2	25 kA	4.93	4.95	4.96	4.98
UAG	25 kA	7.30	7.34	7.36	7.40
Al Saada	25 kA	9.59	9.67	9.70	9.78
Madinat Al-Saada	25 kA	8.94	9.00	9.03	9.10
Mamurah	25 kA	4.77	4.80	4.80	4.82
Sahalnoot	25 kA	4.69	4.71	4.72	4.74
Qairoon Hairiti	25 kA	2.95	2.95	2.96	2.96
Thumrait	25 kA	9.21	9.25	9.28	9.34
Jufa/Sadah	25 kA	0.96	0.97	0.97	0.97
Mirbat	25 kA	5.46	5.51	5.51	5.52
Taqa	25 kA	3.77	3.79	3.79	3.80
North Taqa	25 kA	4.55	4.58	4.58	4.59
Adhan	25 kA	7.49	7.51	7.54	7.62
Salalah Free Zone	25 kA	16.03	16.15	16.31	16.66
Raysut Industrial Estate	25 kA	6.24	6.26	7.35	7.41

Primary Substation	Short Circuit Rating of each 33kV Bus	2023	2024	2025	2026
Madinat Al Haq	25 kA	2.71	2.72	2.72	2.73
North Awqad 2	25 kA	7.95	7.95	7.95	7.95
Hakbeet	25 kA	2.30	2.30	2.31	2.31
Teetam	25 kA	1.84	1.84	1.85	1.85
Al Sa'an	25 kA	1.41	1.41	1.41	1.41
Saada 2	25 kA	12.59	12.72	12.78	12.91
Salalah Port GCT	25 kA	10.01	10.06	10.11	10.25
Raysut Industrial Estate 2	25 kA	7.61	7.63	7.67	7.74
Khor Al Qurum	25 kA	6.61	6.63	6.66	6.71
Sahalnoot 2	25 kA	9.59	9.67	9.70	9.78
Jarziz	25 kA	7.00	7.04	7.06	7.10
Salalah C	25 kA	5.52	5.54	5.56	5.59
SQH-2	25 kA	6.22	6.24	6.26	6.31
ASHOOR-A	25 kA	15.10	15.48	15.53	15.64
ASHOOR-B	25 kA	15.12	15.49	15.54	15.66
Dahariz	25 kA	6.57	6.61	6.62	6.66
Industrial Area 2	25 kA	6.02	6.04	6.06	6.09
Dhahboon	25 kA	1.17	1.17	1.17	1.17
Foshi	25 kA	0.67	0.67	0.67	0.67
Thumrait ROP	25 kA	1.17	1.17	1.17	1.17
ALMUROOJ	25 kA	-	6.63	6.66	6.71
Sahalnoot 3	25 kA	-	5.48	5.49	5.51
Tawittir	25 kA	-	5.37	5.37	5.39
SFZ 2	25 kA	-	-	11.82	12.01

8.2 33kV Feeder Load Forecast.

Table 8.2-1 : 33kV Feeders load forecast for the period 2024-2026

33 kV Feeder			Type of line	Feeder Rating	N-1 Secure Capacity of Connected PSS	2023	2024	2025	2026	Remark
From	To	FDR No/Name		MVA	MVA	MVA	MVA	MVA	MVA	
ITTIN GSS	GOVERNORATE CENTRE	35	Cable, 3CX300 mm2	21.9	20.0	5.5	6.6	6.8	7.1	
		36	Cable, 3CX300 mm2	21.9		6.9	8.4	8.6	8.9	
ITTIN GSS	AL HUSN	37A	Cable, 3CX300 mm2	21.9	20.0	5.4	5.9	6.3	6.5	
		38A	Cable, 3CX300 mm2	21.9		6.9	7.6	8.1	8.4	
ITTIN GSS	NEW SALALAH	52A	Cable, 3CX300 mm2	21.9	20.0	7.8	8.2	8.4	8.6	
		53A	Cable, 3CX300 mm2	21.9		3.7	3.8	4.0	4.1	
ITTIN GSS	TOWN CENTRE	54A	Cable, 3CX300 mm2	21.9	20.0	8.3	9.2	9.5	9.8	
		55A	Cable, 3CX300 mm2	21.9		6.3	5.8	5.9	6.1	
ITTIN GSS	SALALAH-A	48A	Cable, 3CX300 mm2	21.9	20.0	4.7	5.1	5.2	5.5	
		50A	Cable, 3CX300 mm2	21.9		8.1	8.7	9.0	9.4	
ITTIN GSS	SALALAH-B	49A	Cable, 3CX300 mm2	21.9	20.0	6.2	6.7	6.9	7.2	
		51A	Cable, 3CX300 mm2	21.9		6.0	6.5	6.8	7.0	
ITTIN GSS	SALALAH-C	FDR-1	Cable, 3CX300 mm2	21.9	20.0	5.0	5.4	5.6	5.8	
		FDR-2	Cable, 3CX300 mm2	21.9		9.7	10.4	10.8	11.2	
AL-QURUM GSS	SAHALNOOT	26	Cable, 3CX300 mm2	21.9	20.0	8.4	6.7	6.9	7.6	
		27	Cable, 3CX300 mm2	21.9		10.2	8.1	8.4	9.2	
AL-QURUM GSS	MAMURAH	60A	Cable, 3CX300 mm2	21.9	20.0	3.7	3.6	4.0	4.2	
		61A	Cable, 3CX300 mm2	21.9		11.5	11.4	12.7	13.1	
THUMRAIT GSS	Dhahboon	Dhahboon-1	Cable, 3CX300 mm2 and OHL 200 sqmm	21.9	20.0	0.5	0.6	0.6	0.6	
		Dhahboon-2	Cable, 3CX300 mm2 and OHL 200 sqmm	21.9		2.5	2.6	2.7	2.9	
THUMRAIT GSS	HAKBEET	HAKBEET-1	Cable, 3CX300 mm2 and OHL 200 sqmm	21.9	20.0	0.5	0.6	0.6	0.6	
		HAKBEET-2	Cable, 3CX300 mm2 and OHL 200 sqmm	21.9		2.3	2.5	2.6	2.7	
ASHOOR GSS	TAQA	TAQA-1	Cable, 3CX300 mm2	21.9	20.0	7.2	6.4	7.6	8.0	
		TAQA-2	Cable, 3CX300 mm2	21.9		8.8	7.8	9.3	9.7	

33 kV Feeder			Type of line	Feeder Rating	N-1 Secure Capacity of Connected PSS	2023	2024	2025	2026	Remark
From	To	FDR No/Name		MVA	MVA	MVA	MVA	MVA	MVA	
ASHOOR GSS	NORTH TAQA	N.TAQA-1	Cable, 3CX300 mm2	21.9	20.0	8.3	9.2	9.6	10.1	
		N.TAQA-2	Cable, 3CX300 mm2	21.9		6.5	7.2	7.6	7.9	
ASHOOR GSS	ASHOOR-A	ASHOOR-A-1	Cable, 3CX300 mm2	21.9	20.0	5.0	5.0	5.0	5.0	
		ASHOOR-A-2	Cable, 3CX300 mm2	21.9		5.0	5.0	5.0	5.0	
ASHOOR GSS	ASHOOR-B	ASHOOR-B-1	Cable, 3CX300 mm2	21.9	20.0	2.9	3.2	3.2	3.2	
		ASHOOR-B-2	Cable, 3CX300 mm2	21.9		2.9	3.2	3.2	3.2	
ASHOOR GSS	Tawittir	Tawittir-1	Cable, 3CX300 mm2	21.9	20.0	-	2.4	2.5	2.6	
		Tawittir-2	Cable, 3CX300 mm2	21.9		-	2.4	2.5	2.6	
Jufa/Sadah PSS	Foshi	Foshi-1	Cable, 3CX300 mm2 and OHL 200 sqmm	21.9	6.0	1.8	1.9	2.0	2.1	
ASHOOR GSS	MADINAT AL HAQ	MAHQ-1	Cable, 3CX300 mm2	21.9	20.0	6.9	7.6	7.9	8.3	
		MAHQ-2	Cable, 3CX300 mm2	21.9		2.9	3.2	3.3	3.5	
MADINAT AL HAQ PSS	AL SAAN	AL SAAN FD1	Cable, 3CX300 mm2 and OHL 200 sqmm	21.9	3.2	3.2	3.4	3.6	3.7	
Mirbat GSS	MIRBAT	MIRBAT-1	Cable, 3CX300 mm2	21.9	20.0	4.9	5.4	5.6	5.9	
		MIRBAT-2	Cable, 3CX300 mm2	21.9		10.5	11.5	12.0	12.6	
Mirbat GSS	JUFA/SADAH	64	Cable, 3CX300 mm2 and OHL 200 sqmm	21.9	20.0	2.6	2.8	3.0	3.1	
		65	Cable, 3CX300 mm2 and OHL 200 sqmm	21.9		2.1	2.3	2.4	2.6	
RAYSUT GSS	SFZ	78	Cable, 3CX300 mm2	21.9	20.0	7.1	7.8	7.3	7.3	
		79	Cable, 3CX300 mm2	21.9		10.7	11.9	11.0	11.0	
RAYSUT GSS	ADHAN	ADHAN-1	Cable, 3CX300 mm2	21.9	20.0	5.7	-	-	-	To be Shifted to SALALAH IPP GSS in 2024
		ADHAN-2	Cable, 3CX300 mm2	21.9		5.6	-	-	-	
RAYSUT GSS	AWQAD	AWQAD-1	Cable, 3CX300 mm2	21.9	20.0	9.6	10.7	9.5	10.0	
		AWQAD-2	Cable, 3CX300 mm2	21.9		7.7	8.6	7.6	8.0	
SALALAH IPP GSS	ADHAN	ADHAN-1	Cable, 3CX300 mm2	21.9	20.0	-	6.5	7.8	9.0	To be Shifted from RAYSUT GSS in 2024
		ADHAN-2	Cable, 3CX300 mm2	21.9		-	6.3	7.5	8.7	

33 kV Feeder			Type of line	Feeder Rating	N-1 Secure Capacity of Connected PSS	2023	2024	2025	2026	Remark
From	To	FDR No/Name		MVA	MVA	MVA	MVA	MVA	MVA	
SALALAH IPP GSS	RIE-2	FDR-1	Cable, 3CX300 mm2	21.9	20.0	8.0	8.3	8.5	8.7	
		FDR-2	Cable, 3CX300 mm2	21.9		8.0	8.3	8.5	8.7	
SALALAH IPP GSS	SQH-2	FDR-1	Cable, 3CX300 mm2	21.9	40.0	3.6	4.4	7.7	7.8	
		FDR-2	Cable, 3CX300 mm2	21.9		4.8	5.9	10.3	10.5	
		FDR-3	Cable, 3CX300 mm2	21.9		3.5	4.3	7.5	7.7	
SALALAH IPP GSS	KHOR AL QURUM	FDR-1	Cable, 3CX300 mm2	21.9	20.0	8.1	9.1	9.5	10.2	
		FDR-2	Cable, 3CX300 mm2	21.9		7.3	8.1	8.5	9.1	
SALALAH IPP GSS	SFZ-2	FDR-1	Cable, 3CX300 mm2	21.9	20.0	-	-	3.4	6.2	
		FDR-2	Cable, 3CX300 mm2	21.9		-	-	3.4	6.2	
NPS GSS	Raysut-A	68A	Cable, 3CX300 mm2	21.9	20.0	8.5	8.6	8.8	9.1	
		69A	Cable, 3CX300 mm2	21.9		3.2	3.2	3.3	3.4	
NPS GSS	NORTH AWQAD	31N	Cable, 3CX300 mm2 and OHL 200 sqmm	21.9	20.0	4.4	4.0	4.2	4.4	
		22N	Cable, 3CX300 mm2 and OHL 200 sqmm	21.9		10.9	9.9	10.4	11.0	
Shah'Aaon GSS	SULTAN QABOOS HOSPITAL	SQH-1	Cable, 3CX300 mm2	21.9	20.0	6.4	8.0	8.2	8.4	
		SQH-2	Cable, 3CX300 mm2	21.9		2.7	3.3	3.4	3.5	
Shah'Aaon GSS	AL WADI	AL WADI-1	Cable, 3CX300 mm2	21.9	20.0	6.9	7.4	7.7	8.0	
		AL WADI-2	Cable, 3CX300 mm2	21.9		4.6	5.0	5.1	5.3	
Shah'Aaon GSS	COMMERCIAL AREA	C.A-1	Cable, 3CX300 mm2	21.9	20.0	7.2	7.8	8.1	8.4	
		C.A-2	Cable, 3CX300 mm2	21.9		6.4	7.0	7.2	7.5	
Shah'Aaon GSS	INDUSTRIAL AREA	IND AREA-1	Cable, 3CX300 mm2	21.9	20.0	8.3	8.3	8.6	7.6	
		IND AREA-2	Cable, 3CX300 mm2	21.9		9.9	9.8	10.2	9.0	
Shah'Aaon GSS	AL QOOF	AL QOOF-1	Cable, 3CX300 mm2	21.9	20.0	9.1	9.8	10.7	11.0	
		AL QOOF-2	Cable, 3CX300 mm2	21.9		5.0	5.4	5.9	6.1	
Shah'Aaon GSS	AL HUSN 2	FDR-1	Cable, 3CX300 mm2	21.9	20.0	3.6	3.4	3.5	3.5	
		FDR-2	Cable, 3CX300 mm2	21.9		6.3	6.0	6.1	6.2	
Shah'Aaon GSS	TEETAM	TEETAM-1	Cable, 3CX300 mm2 and OHL 200 sqmm	21.9	20.0	1.5	2.2	2.3	2.4	
		TEETAM-2	Cable, 3CX300 mm2 and OHL 200 sqmm	21.9		2.4	2.2	2.3	2.4	

33 kV Feeder			Type of line	Feeder Rating	N-1 Secure Capacity of Connected PSS	2023	2024	2025	2026	Remark
From	To	FDR No/Name		MVA	MVA	MVA	MVA	MVA	MVA	
Shah'Aaon GSS	NORTH AWQAD 2	FDR-1	Cable, 3CX300 mm2	21.9	20.0	9.8	9.0	9.4	9.9	
		FDR-2	Cable, 3CX300 mm2	21.9		6.1	5.6	5.9	6.2	
SAADA GSS	INDUSTRIAL AREA 2	FDR-1	Cable, 3CX300 mm2	21.9	20.0	6.4	7.1	7.5	7.9	
		FDR-2	Cable, 3CX300 mm2	21.9		6.4	7.1	7.5	7.9	
SAADA GSS	QAIROON HAIRITI	FDR-1	Cable, 3CX300 mm2 and OHL 200 sqmm	21.9	20.0	6.2	6.7	7.2	7.4	
		FDR-2	Cable, 3CX300 mm2 and OHL 200 sqmm	21.9		2.5	2.7	2.9	3.0	
SAADA GSS	SAADA	FDR-1	Cable, 3CX300 mm2	21.9	20.0	7.9	7.1	7.3	6.8	
		FDR-2	Cable, 3CX300 mm2	21.9		12.6	11.3	11.7	10.9	
SAADA GSS	MADINAT A'SAADA	FDR-1	Cable, 3CX300 mm2	21.9	20.0	10.0	10.4	10.7	9.8	
		FDR-2	Cable, 3CX300 mm2	21.9		6.8	7.1	7.3	6.7	
SAADA GSS	UAG	FDR-1	Cable, 3CX300 mm2	21.9	20.0	8.2	8.9	9.2	9.6	
		FDR-2	Cable, 3CX300 mm2	21.9		5.6	6.1	6.3	6.6	
SAADA GSS	JARZEEZ	FDR-1	Cable, 3CX300 mm2	21.9	40.0	7.0	6.1	6.6	6.9	
		FDR-2	Cable, 3CX300 mm2	21.9		4.4	6.1	6.6	6.9	
		FDR-3	Cable, 3CX300 mm2	21.9		-	6.1	6.6	6.9	
SAADA GSS	SAHALNOOT 2	FDR-1	Cable, 3CX300 mm2	21.9	20.0	11.1	10.3	10.7	8.8	
		FDR-2	Cable, 3CX300 mm2	21.9		9.4	8.8	9.1	7.5	
SAADA GSS	DAHARIZ	FDR-1	Cable, 3CX300 mm2	21.9	40.0	10.5	10.1	10.5	8.7	
		FDR-2	Cable, 3CX300 mm2	21.9		6.2	10.1	10.5	8.7	
		FDR-3	Cable, 3CX300 mm2	21.9		10.5	10.1	10.5	8.7	
SAADA GSS	SAADA 2	FDR-1	Cable, 3CX300 mm2	21.9	20.0	10.4	11.0	11.3	12.4	
		FDR-2	Cable, 3CX300 mm2	21.9		17.3	18.2	18.8	20.6	
SAADA GSS	ALMUROOJ	FDR-1	Cable, 3CX300 mm2	21.9	20.0	-	4.2	4.4	6.2	
		FDR-2	Cable, 3CX300 mm2	21.9		-	4.2	4.4	6.2	
SAADA GSS	SAHALNOOT-3	FDR-1	Cable, 3CX300 mm2	21.9	20.0	-	6.3	6.6	8.4	
		FDR-2	Cable, 3CX300 mm2	21.9		-	6.3	6.6	8.4	

9 References

9.1 Glossary of terms

TERMS	DEFINITION
Distribution and Supply Licence	A licence granted to NDS to own, develop, maintain and operate the electricity distribution network, and to supply electricity, in the region of Dhofar in Oman.
Distribution Company	A company or a body holding a Licence from the Regulator, pursuant to the Law.
Circuit	A Circuit is the part of an electricity supply system between two or more circuit breakers, switches and/or fuses inclusive. It may include transformers, underground cables and overhead lines.
Circuit Capacity	Means the appropriate cyclic rating or emergency rating relevant to all circuit equipment.
Customer	Means any person, corporate body, or company who has an agreement with a Distribution Company for the supply of electricity.
Energy Not Served	Amount of energy not being served to consumers by the system during the period considered due to system capacity shortages or unexpected severe power outages.
First Outage	Signifies a fault or an arranged circuit outage.
Interruption	The total loss of electric power on at least one normally-energised conductor to one or more customers connected to the distribution portion of the system. It is the result of one or more component outages, depending on system configuration.
Outage	The loss of ability of a circuit element of the distribution network to deliver power. Note than the occurrence of an outage does not necessarily mean there will be an interruption: that will depend on the system configuration.
Regulator	Means the Authority for Electricity Regulation, Oman, established by Article (19) of the law for the regulation and privatization of the electricity and related water sector.
Second Outage	A forced outage coincident with an arranged (planned) circuit outage.
Security Class	Means a category of supply in section 3.4 of this document.
Repair Time	More accurate to call it restoration time, since it is the time required to re-establish power supply to the customers affected by the first or second outage. In situations where the network has been designed with a degree of redundancy and with reconfiguration capabilities, restoration can be less than the fault repair time.
Voltage Excursion	A deviation of system voltage beyond ±6% of nominal voltage.
User	A Person using the Distribution System of a Licensed Distributor, including all Power Producers having CDGensets, all Internally Interconnected Parties and International Interconnected Parties Connected to the Distribution System of a Licensed Distributor, Licensed Distributors and all Consumers Connected to the Distribution System of a Licensed Distributor

9.2 Abbreviations

TERMS	DEFINITION
APSR	The Authority for Public Services Regulation
AMR	Automatic Meter Reading
CD	Centrally Dispatched
DCC	Distribution Control Centre
DISCOs	Distribution Companies
DNDP	Distribution Network Development Plan
DPC	Dhofar Power Company S.A.O.C.
DISC	Dhofar Integrated Services Company S.A.O.C.
DSO	Distribution System Operator
NDS	Nama Dhofar Services
DSS	Distribution Substation
DSSS	Distribution System Security Standard
EF	Earth-fault
Genset	Generator Set
GSS	Grid Substation
HV	High Voltage
IDMT	Inverse Definite Minimum Time
IEEE	Institute of Electrical and Electronics Engineers
LV	Low Voltage
MIS	Main Interconnected System
MV	Medium Voltage
NPS	New Power Station
NER	Neutral Earthing Resistor
OC	Overcurrent
OETC	Oman Electricity Transmission Company
O/P	Normally Open Point
OES	Oman Electricity Standards
OHL	Overhead Line
OPWP	Oman Power and Water Procurement Company
PDO	Petroleum Development Oman
PSS	Primary Substation
REF	Restricted Earth Fault
RMU	Ring Main Unit
RTU	Remote Terminal Units
SBEF	Standby Earth Fault
SCADA	Supervisory Control and Data Acquisition
SMR	Self-Meter Reading
SFZ	Salalah Free Zone
TSSS	Transmission System Security Standard
UG	Underground
USERs	DISCOs, GENCOs, Non-embedded customers, interconnected utilities
CRT	Cost Reflective Tariff

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