

OPERATION & CONTROL OF OMAN GRID IN REGULATED ENVIRONMENT

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Abstract

Power System operation and control under regulated environment offers lot of challenges to the electric utility industry in Oman. With the advent of an open market environment, competition in the industry and restructuring of the electricity sector into separate generation, transmission and distribution entities, new issues in power system operation & control are inevitable. The main goal of this restructuring was to increase competition and provide the customer a quality product at competitive prices. One of the important characteristics of the quality of product may be reliable and uninterrupted service to the loads. On the other hand, economic forces have been driving the dramatic restructuring of the power industry throughout the world in the last decade or so. In Oman also electricity market evolution is slowly focusing on two aspects: Reliability as well as Economics. These two aspects have conflicting objectives. However, major consequences of this new electric utility environment are the greater emphasis on secure and reliable operation of the Grid. This has resulted in challenges for system operation engineers in the restructured electricity market and experiencing more and more uncertainties. The system uncertainty may come from various sources. The objective of this paper is to investigate power system characteristics with respect of system parameter uncertainties with analytical approaches.

Key words: Regulation, Reliability, Economy

1.0 Introduction

The regulation of electric utility industry has posed fundamental challenges to the reliability of the electric power system. The electricity market will encourage the development of efficient and economic generation sources. However the capacity, control and operation of the Oman grid system require strengthening to support a fully competitive market. Developing better ways to operate transmission & distribution system is the major technological challenge of restructuring. New and improved transmission, communication, control and

metering technologies and systems need to be developed for the new structure of the electrical system to succeed and similarly to operate the complex grids.

Oman Electricity Transmission Company SAOC (OETC) is incorporated as a closed joint stock company (SAOC) in accordance with the Commercial Companies Law No. 4/74 having its registered office in Muscat. The company was formed as part of the privatization of electricity and related water sector activities in the Sultanate of Oman. The company came into existence as a commercial entity following the promulgation of Sultani Decree No. 78/2004, the Law for the Regulation and Privatization of the Electricity and Related Water Sector, generally known in the electricity sector as the 'Sector Law'. The law provided for the unbundling of the electricity and water activities previously undertaken by the Ministry of Housing, Electricity and Water (MHEW).

The company started its commercial operation effective from May 01, 2005 after the Transmission and Dispatch License (the License which came into force on May 01, 2005) was granted to the company by the Authority for Electricity Regulation (AER) in Sultanate of Oman.

2. OETC activities

OETC operates the High Voltage transmission system at 220kv and 132 kV in the Northern Region of Oman. This grid interconnects the areas of Muscat Governorate and the regions of Dakhliyah, Batinah, Dhahirah, and Sharqiya. The Grid consists of about 570 kms of 220 kV circuits, 2653 kms of 132 kv circuits and 37 grid stations.

This network is supplied by seven gas based power stations viz. Ghubrah, Rusail, Waddi Jizzi, Manah, Al Kamil, Barka & Sohar.

Peak Demand in OETC grid in 2006 = 2638 MW (Gross)

OETC's business is to maintain, operate, reinforce and extend the transmission system assets as well as to manage the electricity supply and demand in the integrated network through real time load generation balance in the Northern Grid.

OETC is responsible for:

- a) Scheduling and Dispatch of electrical power generated by Power Stations.
- b) Ownership and operation of transmission system.
- c) Evacuate the generated power to load centre through distribution companies.

Hence, OETC's functions can be categorized under:

- a) Transmission function
- b) Load Dispatch function

OETC is responsible for development and also compliance with the provisions of stipulations of Grid Code. OETC is also responsible for operating the Grid in accordance with the conditions of the Transmission and Dispatch License.

3.0 Grid of Sultanate of Oman

Oman Electricity Transmission Company owns and operates the 220KV and 132KV interconnected transmission grid in the north of Oman.

The OETC network borders with and has network interconnection with Petroleum Development Oman (PDO), which has its own electricity transmission system for oil exploration and development in the central region of Oman. The network interconnection is provided by a single 132KV overhead line circuit from Nizwa Grid Station to the PDO transmission system at Nahda.

The southern part of Oman has a separate transmission and distribution network supplying Salalah town and the surrounding area. This network, which includes Raysut Power Station, is managed in a vertically integrated manner by Dhofar Power Company under a 20 year concession agreement.

The Oman Electricity Transmission Company serves the three distribution companies, viz., Muscat Electricity Distribution Company (MEDC), Mazoon Electricity company (MEC), and Majan Electricity Company (MEC) and is also directly connected to large generators.

The total supply area of the three distribution companies is approximately 126,000 km². Muscat EDC (around 3000km²) supplying in the areas of Rumais, Jahloot, Wadi Adai, Wadi Kabir, Bausher, Ghubrah, Madinat Sultan Qaboos, Barka, Mawelleh, Rusail and Seeb. Mazoon EC supplying in the areas of Nizwa, Bahla, Izki, Sumail, Mudhairb, Mudhaibi, JBB Ali, Sur, Muladah, Barka (shared with Muscat EDC) and Khabourah (shared with Majan EC). Majan EC supplying in the areas of Ibri, Al

hail, Dhank, Al wasit, Buraimi, Shinas, Sohar, Khabourah, Sohar Industrial Port.

There are seven major power stations connected to the OETC network, two in the Muscat EDC (Ghubrah and Rusail), three in the Mazoon EC (Barka, Manah, Al Kamil) and two in Majan EC (Waddi Jizzi, Sohar)

OETC is authorized to undertake all regulated activities of electricity transmission (132 kV and above).

The three distribution companies own the network assets operating at voltages below 132 KV down to the customer supply point.

A 220KV international interconnection with the United Arab Emirates (UAE) is also under construction and expected to be completed by end of 2006. This will connect into the Al Wasit Grid Station (Mahada) substation of Oman in the west of the present grid network to Al Oha Grid Station (Al Ain) of Abu Dhabi (UAE). This link is planned to be a part of Gulf Cooperation Council (GCC) interconnection.

4.0 **System Reliability & Quality of Power**

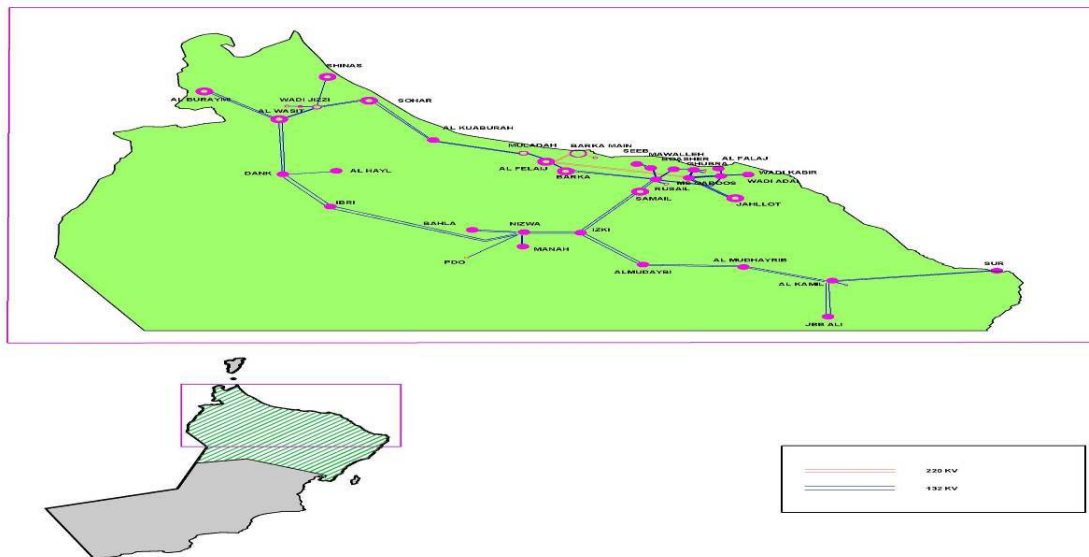
Reliability is the degree of performance of the elements of the bulk electric system that results in electricity being delivered to customers within accepted standards and in the amount desired at a reasonable price.

The operation of an electric system today requires the highest possible reliability of service to the customer consistent with economic justification of the cost of such service. The power system is a high order multivariable process whose dynamic response is influenced by a wide array of devices with different characteristics and response rates. Depending on the network topology, system operating condition and the form of disturbance, different sets of opposing forces may experience sustained imbalance affecting system reliability.

The quality of power is measured by several characteristics. In addition to, maintenance of basic grid parameters, uninterrupted service to the loads constitutes one of the important concerns. The ability of the integrated electric network to withstand sudden disturbance such as short circuits / generator outage / tripping of transmission system is an important issue.

OETC transmission network is quite reliable and OETC transmission system availability in the year 2005 was 97.7 % and in 2006, availability is expected to be better than 2005.

220 KV, 132 KV OMAN ELECTRICITY TRANSMISSION NETWORK



5.0 Grid operation and interconnection:

Presently, Operating the Oman electricity grid poses significant technical and managerial challenges. With the advent of 'Grid Code' in transmission and 'Distribution Grid Code' in distribution sector, competitive market operating in real time needs to exhibit sufficient flexibility to assure reliable operation at all time within the context of the market. The choice is between the creation of an engineering approach to reliability assurance that is capable of accommodating markets or a market approach that is sufficiently nimble to accommodate for reliability concerns. Interconnection of initially separate UAE grid with Oman grid in this year is for the primary purpose of sharing reserves – that is, for reliability purpose – and also for the additional purpose of optimality of operation.

Operation of a system with many controllable flows requires the development of new operational approaches. Traditional power system operation is based on the premise that no single event (such as the loss of a line or a generation) should lead to the cascading uncontrolled failure of a large portion of the system. Such criterion for running a system is often called the “n-1” criterion. Attaining reliable operation requires redundancy: redundancy in transmission and redundancy in generation. Generally, it has been considered that reliability is not an economic matter. Although, Operators of a system do not necessarily concern themselves with the economy of the system

6.0 Operation of International Interconnection:

A 220KV international interconnection with the United Arab Emirates (UAE) is also under construction and expected to be completed by end of 2006. This will connect into the Al Wasit Grid Station (Mahada) substation of Oman in the west of the present grid network to Al Oha Grid Station (Al Ain) of Abu Dhabi (UAE). This link is planned to be a part of Gulf Cooperation Council (GCC) interconnection.

Electric power systems were originally interconnected for two purposes: reliability and economy. Operation of the international interconnection of various grids facilitated maintenance of system frequency, monitoring of trades between countries, and the prevention of major power outages. Interconnection also led to a variety of problems: inter-area stability concerns and issues associated with management and coordination of a very large, diverse set of generators and loads.

7.0 Economic Dispatch

Economic Dispatch is that step in the solution of the generation control problem which allocates generation changes of an area among alternative area generating sources to achieve optimum area economy. The technology of energy conservation, characterized by increased sizes, pressures, and temperatures of steam units, have resulted in continued improvement of unit operating efficiencies, correspondingly, there has been

increasing disparity between the heat rates of the alternative generating sources. Such disparity, coupled with varying fuel costs and varying transmission loss factors, makes possible very significant difference.

8.0 Transmission Reliability

The new environment of competitions will place an increasing demand on transmission services. The availability of these services must be based strictly on the physical and electrical characteristics and capabilities of transmission system using appropriate system criteria & guides. The protection system will need to be provided to ensure the performance requirement set by entities responsible for ensuring reliability. There will be greater need to provide redundancy, analyze maloperation and develop maintenance & testing programmes. In such an environment special emphasis need to be given on 'special protection schemes' also.

In near future, with competitions and trading of electricity on the open market, in GCC countries, the change in grid condition will have a greater range of uncertainty. In short term open access scenario, when bids will be finalized, there will be need to guarantee that there is sufficient transmission capability to conduct this transaction without jeopardizing the reliability of the entire system.

9.0 Transmission Technologies:

In general, electric industry restructuring is based in part on the assumption of a transmission system that is flexible, reliable, and open to all exchanges no matter where the suppliers and consumers of energy are located. However, neither the existing transmission system nor its management infrastructure can fully support this open exchange. Some desirable market transactions are quite different from those envisioned when the transmission system was designed, and they may stress the limits of safe operation. The risk posed by such transactions may not be recognized in time to avert major system emergencies, which may be difficult to manage without loss of customer load. These problems can be remedied in part by direct technical reinforcements to the transmission system, in the form of improved hardware technology.

Development of new technology must be closely linked to its actual deployment for operational use. Together, both activities should reflect, serve, and keep pace with the evolving infrastructure needs of transmission organizations. This is not happening. Neither the details nor the needs of this infrastructure are well known, and all parties are understandably averse to investments that may not be promptly and directly beneficial to them.

To summarize, key issues include :(1) the capability and cost of new technologies to improve operation of the

transmission system; and (2) the requirements of and institutional options available to support timely development and deployment of these technologies through the current period of industry restructuring.

10.0 Oman Power Scenario:

10.1 Operational Performance

Oman Electricity Transmission Company operates and maintains the high voltage transmission system at 220kv and 132 kV in the Northern Region of Oman. This grid interconnects the areas of Muscat Governorate and the regions of Dakhliyah, Batinah, Dhahirah, and Sharquiya. The Grid consists of about 570 kms of 220 kV circuits, 2653 kms of 132 kv circuits and 37 grid stations.

10.2 System Demand

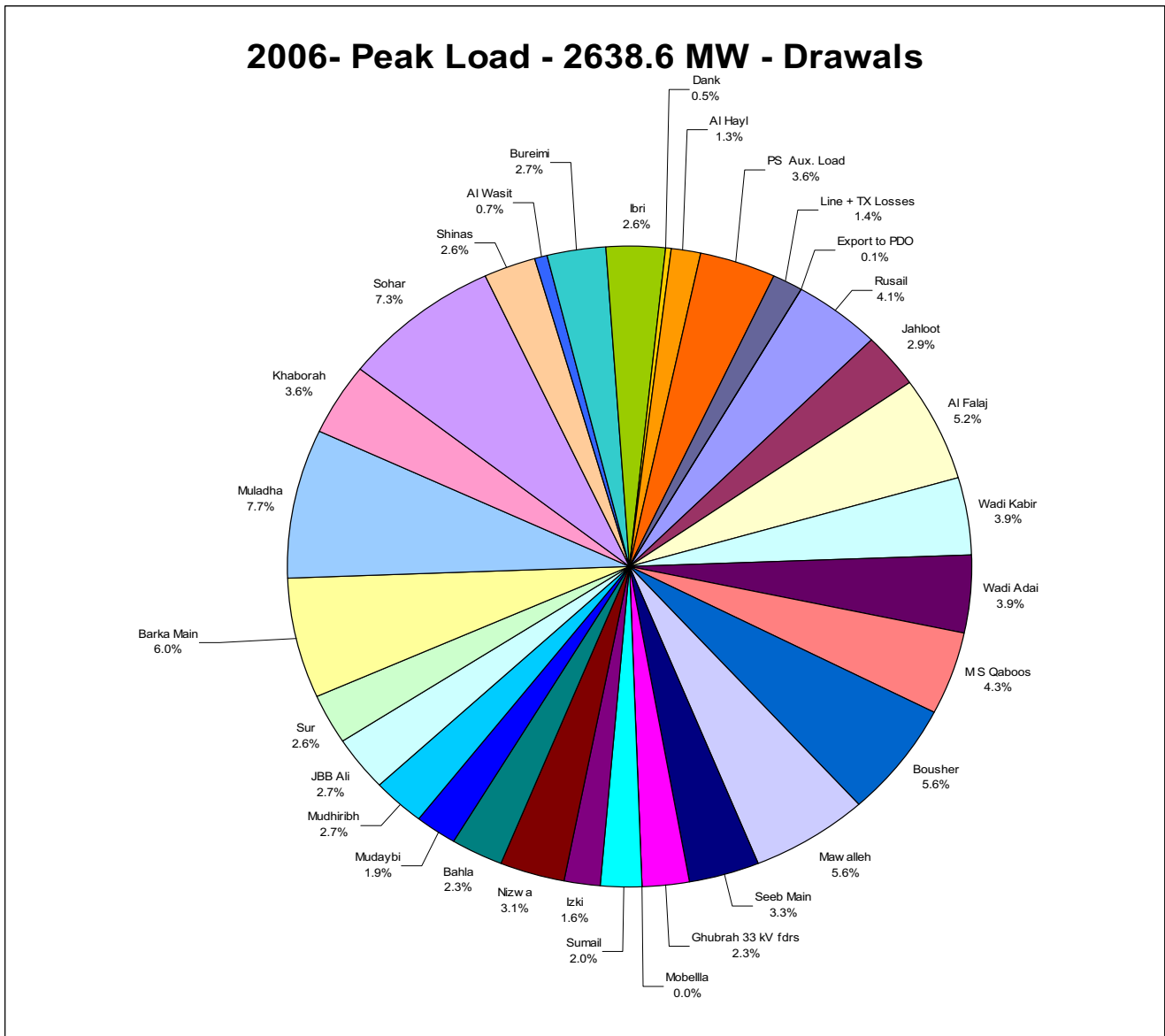
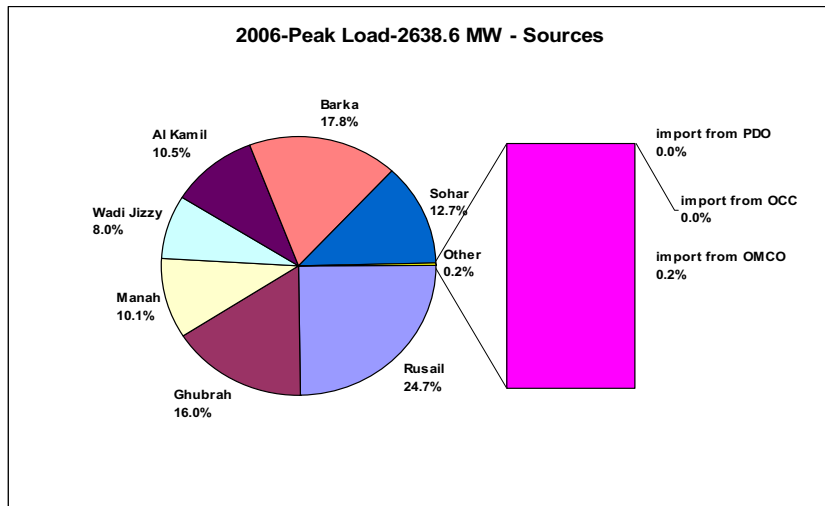
The actual summer peak demand of OETC's main interconnected transmission system in the year 2006 was 2638 MW on 16.07.2006(Centrally Dispatched). Load Growth of last six years:

2000-01	7.1%
2001-02	8.1%
2002-03	7.6%
2003-04	6.2%
2004-05	5.2%
2005-06	5.7%

10.3 Load in Distribution areas

At peak the load in the distribution areas are as follows;

Muscat Disco load	1146.4 MW (46% approx.)
Mazoon Disco load	831.7 MW (33% approx.)
Dakhliyah	238.8 MW
Sharquiya	259.0 MW
South Batinah	333.9 MW
Majan Disco load	527.2 MW (21% approx.)
North Batinah	322.8 MW
Dhahirah	204.4 MW



11.0 CONCLUSIONS:

The Oman power system is taking a big leap in the areas of generation, transmission & distribution of power. With the International interconnection in synchronous mode, in near future, the integrated system will be large. Successful operation & control of this integrated grid is a real challenge for grid operators and network managers.

The new environment of competition will place an increasing demand on transmission services. The availability of these services must be based strictly on the physical and electrical characteristics and capabilities of transmission system. The protection system will need to be provided to ensure the performance requirement set by entities responsible for ensuring reliability. Special emphasis need to be given on 'special protection schemes' also in near future.

With competition and trading of electricity with other countries on the open market, the change in grid condition will have a greater range of uncertainty. There will be need to guarantee that there is sufficient transmission capability to conduct these transactions without jeopardizing the reliability of the entire system.

However, in the end, the real winner will be the consumer,. With the improved grid performance viz. system availability and system voltages, it will be easier for the utilities to provide the consumer with more reliable supplies of power.

References:

- 1) OETC System Condition Report (summer)-2005 & 2006.
- 2) OETC Five Year Annual Transmission Capability Statement.