UNIT- V

POWER SYSTEM OPERATION IN COMPETITIVE ENVIRONMENT

1.1. INTRODUCTION

Throughout the world, electric power utilities are currently undergoing major restructuring process and are adopting the deregulated market operation. Competition has been introduced in power systems around the world based on the promise that it will increase the efficiency of the industrial sector and reduce the cost of electrical energy of all customers. Electrical energy could not be stored in large quantities. Continuity of supply is sought as more important than the cost of the electrical energy. To meet the growing power demand, electric power industry has to adopt the deregulated structure.

For integrated operation of deregulated system, regulating agencies such as pool operator or system operator have to be formulated. In the deregulated power market, the electricity is dispatched with the help of either by a separate power exchange or the system *1* pool operator.

The power system deregulation is expected to offer the benefit of lower electricity price, better consumer senice and improved system efficiency. However, it poses several technical challenges with respect to its conceptualization and integrated operation. Basic issues of ensuring economical, secured and stable operation of the power system, which can deliver the power at desired quality, has to be addressed carefully in a deregulated market. The complexity is more in such an arrangement.

Power systems, all over the world, have been forced to operate to their full capacities due to the environmental and I or economical constraints. This results in the need of new generation centers and bansmission lines. The amount of electric power that can be misaimed between two locations through a tmsmission network is also limited by security constraints. Power flows should not be allowed to increase to a level where a random event could cause the network to collapse due to overloading, angular instability, voltages instability or cascaded outages. This state of the system is called as congestion of the power system. Managing congestion to minimize the restrictions of the

transmission network becomes the central activity of power system operators in recent The deregulation of the electric utility industry allows many independent power producers (IPP) to be connected across the transmission system. This situation also calls for effective methods to ensure the transmission system reliability, while the power is msfemd through the network.

In a deregulated environment, there are many simultaneous bilateral and multilateral transactions in addition to power pooling. Therefore, it is very much important that sellers and buyers of electricity need to fmd the cost allocation to their wheeling transactions. Independent System Operator (ISO), a supreme entity for the control of transmission system, also needs to know such costs in order to make correct economic and engineering decisions on up&ng the hmsmission facilities. So wheeling is currently a high priority problem in both regulated and deregulated power industries. Transmission Open Access (TOA) is an important step for the translation of conventional power systems to a deregulated power system. It consists of the regulatory structure, which includes transmission righf obligations, operational procedures and economic conditions of the system and enables two or more parties to use the transmission network for electricity power transfer of another party. This concept is gaining deep attention which desire to introduce competition into traditional regulated utilities without giving up their existing regulatory structure. Such a deregulated system study is carried out in the present thesis work. Before entRing into the details of the work, important terms used have bccn explained in the following section.

BASIC CONCEPTS

Wheeling

Wheeling is the transmission of power from a seller to a buya through a third party network. It may be defined as," the use of transmission or distribution facilities of a system to transmit power of and for another entity or entities" . It may also be defined as:' Wheeling is the use of some party's

(or parties') transmission system(s) for the benefit of the other parties".

Bilatera1 Wheeling Transaction It is a bilateral exchange of power between a buying and selling entity. The exchange may be a proposed, scheduled or actual one.

Multilateral Wheeling Transactions

Multilateral transactions are an extension of bilateral transactions. In a multilateral transaction, power is injected at different buses and taken out at some other different buses simultanmusly, such that the sum of all generations is equal to all loads in the transaction, excluding losses. Transmission losses may be either supplied by the generators of the transactions or by the pool *1* utility as per predefined contract. This trade is arranged by energy brokers and involves more than two parties.

Transmission Open Access (TOA)

Because of transmission open access, entities that did not own bansmission lines were granted the right to use the transmission system. The aim of TOA is to introduce competition into the traditional regulated utilities without giving up the existing regulating structure.

Resfructuring

Restmcturing of regulated power se~toris to separate the functions of power generation, transmission, distribution and electricity supply to consumers.

Deregulation

It is changing the existing monopoly franchise rule or other regulations of regulated industry, that affect how electric companies do business, and how customers may buy electric power and services .

Awilable Transfer Capability (ATC)

The ATC is a measure of the transfer capability remaining in the physical transmission network for further commercial activity over and above already committed uses.

Toul Tnrnsfer Capability (TTC)

It is defined as the amount of electric power that can be transferred over the interconnected tnmmission network or particular path or interface in a reliable manner, while meeting all of a well defined pre- and postcontingency system conditions from a specified set.

Transmission Relhbili@ Margin (TRM)

It is defined as that amount of transmission transfer capability necessary to ensure that the interconnected transmission network is secured under a reasonable range of uncertainties in the system.

Capaciry Bencft Mcvgr'n (CBM)

It is defrned as that amount of transmission transfer capability reserved for load serving entities on the host transmission system to ensure access to generation from interconnected systems to meet generation reliability requirements.

Short Run Marginal Cod (SRMC)

Short run marginal cost of wheeling transactions for a unit megawatt in deregulated environment is calculated by taking into account the difference between bus incremental costs of the buses for producing an additional mega watt at each bus.

Embedded Cost

Embedded cost is defined as the revenue requirements needed to pay for all existing transmission facilities plus any new facilities added to the transmission network during the life of the contract for transmission service.

Transmission System Congestion

In a competitive electricity market, congestion refers to the overloading of lines or traasfonnas due to market settlement. The chances of congestion in the deregulated market are quite high as compared to the monopolistic market, as the customen would like to purchase electricity from the cheapest available sources. The congestion is undesirable in the system and should be alleviated for the secure operation of the system.

DEREGULATION IN POWER INDUSTRY

The driving force behiid the development of power systems is the growing demand for electrical energy in developing countries. The energy demand will be the greatest in the near future. As energy demand continues to grow, higher voltage levels are needed. In the beginning, A.C. transmission has to transfer power over long distances. In such transmission, technical problems such as voltage control and dynamic stability will arise. This involves in heavy pricing over the customer. The deregulated power system is to give opportunity to the customer to buy energy at a more favorable price.

The electric supply industry in every country for about the last one hundred years has been a natural monopoly and as a monopoly attracted regulation by government. Without exception, the industry has been operated as a vertically integrated monopoly organization that owned the generation, transmission and distribution facilities. It was also a local monopoly, in the sense that in any area one company or government agency sold electric power and services to all customers. The major difference between conventional monopolistic electricity market and the emerging deregulated market is that electricity in the forma case is considered as merely energy supply sector, whmas in the latter case it is treated as a service sector and is to be marketed like any other common commodity. In a monopolistic market, the same agency is respmible for power generation, transportation, distribution as well as conkol, whereas in the new market structure these tasks are segregated and have to be separately paid by the transacting parties. In the conventional market, the single utility is responsible for maintaining physical flow of electricity, satisfying consumer's demands at proper voltage and6equmcy level, security, cconomy and reliability of the system. In the newmated electricity market, of these tasks arc treated as separate services, in addition to the primary *task* of the system operator and wire companies to ensure meetin the powa transactions all the time. The additid *suvices* include afianging powa for the loss makeup or load following, maintaining the *system* kquacy, providing enough voltage I VAR support, arranging for start-up power, spinning reserve in the system dc.

These arc called ancillary senices in the deregulated environment and have to bearrang ed and paid sepsratcly. Some of these ancillary services can directly be arranged by the seller I buyas of electricity. In addition, the transmission of electricity itself will be treated as a separate mice and has to be changed from the transacting parties and paid to the wire companies.

Motivations for Deregulated Power Industry

Since the 1980's the electricity supply indusby has been undergoing rapid andim nsible changes wingth e indushy that is markably stable and served the public well. A significant feature of these changes is that it allows for competition amo ng genwn and create marlra conditions in the industry, which are *seen* as *mccssary* toreduce costs of energy production and diseibution, eliminate certain inefficiencies, shed manpower and increase customer choice. This transition towards a deregulated powa mukt is commonly reid to as electricity supply industry restruchuing or duegldation. South American countria such as Argentina and Chile, wac the first few to

introduce daqulrral marlrd of electricity in the mideighties followed by U.K., Sdviniw countries and the USA in the 1990s, whac it is now fully operational. Some of the Asian countries, including India, have already taken initial *steps* in this direction.

In India, a limited level of competition is already introduced *a!* generation level by allowing participation of Mepardeat Power Producers (IPPs). In addition, sepatation of threc organs of power system i.e. gentration, bansmission and distribution has already been hein a few *states.*

Shortly most of the pwa utilities in the country will be adopting the daegulated *structure* in some *scnsc*. Further, the ngulaiory bodies have been formed at central level and also at some of the states. Their primary function, at present, is to fix tariff for power sales. Many factors such as technology advances, changes in political and ideological attitudes, regulatory failures, high tariffs, managerial inadequacy, global financial drives, the rise of environmentalism, and the shortage of public resources for investment in developing countries, contributed to the worldwide bud towards deregulation.

Elements of Rabuetutcd Syrtcms

The structural components representing various segments of the deregulated electricity markd are Generation companies (Gencos). Distribution companies (Discos), Scheduling Chudhon (SCs), Transmission Ownas (TOs), an Independent System Operator (ISO). and a Power Exchange (PX). Ccncos *Garos art* rsponsible for operating and maintaining generating plant in the generation sector and in most of the cays are the owners of the plant Where he transmission network was state-owned before restructuring, obviously This integrity will be retained and a distinction between owner and operator is redundant.

lndependent System Operator *(ISO)*

To achieve these objectives, the IS0 perfonus one or more of the following functions.

I. Power system operations function

This fundamental hraction includes the operation-planning fuoctim and realtime control.

a. Opaation-planning function includes

i. Perfonn power system scheduling.

ii. Coodnation with energy markets.

iii. Perform power system dispatch.

iv. Dctmnine Available Transfer Capabilities (ATCs).

v. Determine real-time ATCs.

vi. Pncalculate short-nm costs aod prices.

vii. Calculate hourly prices for transmission-related services.

b. Real-time control includes

i. Monitor power system operation *status*.

ii. Monitor sysdcm security.

iii. Conduct physical network operations and network switching.

iv. Deal with outages and emergencies.

v. Coordinalc real-time systan operation.

vi. Run a power pool where @a can bid to buy and sell magy.

vii. Submit the supply and load scbcdule to the IS0 according to pn-specified protocols.

11. Ancillary rcrvica provision function

i. Own certain ancillary services for satisfactory grid operation.

ii. Rvchase ancillary services transactions from *market* participants according to prc-specified protocols.

iii. Provide ancillary services to transmission users.

iv. Allocate *costs* of ancillary services among all usm.

UI. Tnnsmiuioa facilities provision funetion

i. Maintain the transmission network.

ii. Provide transmission facilities for all supplies and loads.

iii. Plan transmission, reactive powcr and FAmS expansion.

iv. Plan and commissionowned ancillary snvices.