

Power System Restructuring & Competitive Wholesale Electricity Markets in Deregulated Environment

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Abstract— The analysis and the formation of the electric energy industry implements by forming a platform for the three components covering the generation, transmission, and distribution. Once the electric power is formed, it is further passed through the transmission lines having high voltage and large capacity to the regions in which the electricity will be consumed. Then it is converted to a voltage that is low and is passed to the users. The energy/electricity restructured process has been performed in different parts economically to generate units that are small along with the separation of the utilities thereby increasing the market structure. But a number of defining factors makes electricity a difficult task to be dealt causing unstable conditions thereby leading to raise the cost of the electricity. A shortfall or surplus of electricity means not only few of the end users are not able to have the deficit/excess power, rather it focuses on the fact which endangers the whole power grid thereby causing it to be on the verge of instability further leading to extinction in the market structure. The bulk power market structure, which includes the exchange between utilities, sales to large commercial and contract based sales to distributors and industrial customers, is now characterized by-Sharp Price Competition. The objective of this paper is to evaluate the scope of the generation to be distributed based on Competitive Wholesale Market and study the impact of it on the deregulated power market [1].

Keywords—Deregulated Power Market, Competitive Wholesale Market, Power System Restructuring, Market Design, and Locational Marginal Price.

I. INTRODUCTION

A. Overview of Restructuring

The change towards the restructured or deregulated power industry is ever changing and it has been considered since the past to present scenario of the power system. The wholesale competition market and also the retail market including the transmission network perform processes to profit the end consumers. Thus, this competition leads to, too many new challenges and issues to the functioning of restructured/deregulated power system. Many reasons led to deregulation of power sector in India. Some of the reasons for going into deregulated power market are firstly, these provide a risk free finance to build up the infrastructure as it is a proved technology, the risk that is involved in investing the money is out [2]

and secondly, monopoly utilities have an obligation to serve all customers but they do not promote the active attention to the consumer needs, whereas a competitive energy service company predicts the consumer needs and provides response in advance: competition brings single occurrence, efficiency and lowers the cost [3].

B. Energy Markets: Competitive Environment, Computational Tools

The market power structures includes different world regions, it is true that the transmission and generation processes services will be unbundled. The generation market is fully competitive in nature, operation of a transmission system remains in a regulated monopoly and it allows open access to all suppliers and the consumers and the function is implemented by the Independent System Operator (ISO) [4]. The ISO helps in maintaining the reliability in area assuring open, nondiscriminatory access to transmission network. The new computational tools and software for the generating units and for the market competitors the objectives such as new emerging competition, planning of the system financial requirements and scheduling of the system. The generating units require new systems of bidding so as to form the new strategy and plans, to achieve the varying prices. The Energy Management System consists of following elements (a) Supervisory Control and Data Acquisition Systems-Including the data acquisition, alarming control, online processor topology. (b) Automatic generation control covering generation scheduling and control applications. (c) Network analysis application functions as topology processor, state estimator, power flow control and contingency analysis. (d) Dispatch Training Simulator includes all the above three components having a separate environment off-line structure. The new systems may include market long term planning processes providing settlement and billing, thereby determining the payments of the holding services, market administrative roles of the ISO, scheduling and the system balancing of the power system and congestion management process.

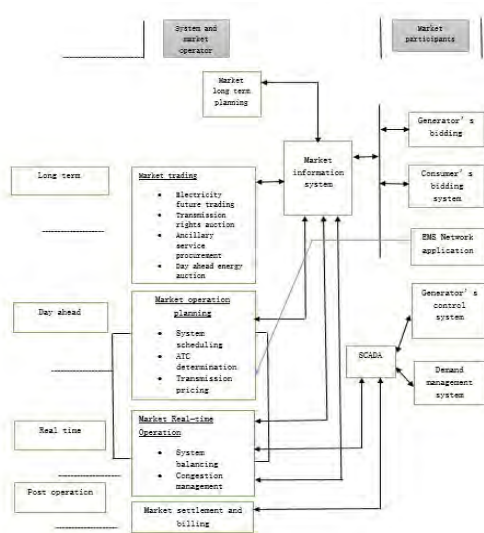


Fig.1. Software used in competitive market

II. COMPETITIVE WHOLESALE ENERGY MARKET

Electricity energy markets are under-going different major changes, these changes are varying in nature but defining the trend towards a competitive and open environment which further results in power being traded as commodity and in creation of competitive markets to facilitate trading process. The generating units bids their power at the marketplace in order to maximize their profits. Thus, a restructured, completely competitive electrical energy market is behaving like a sandwich comprising of race/competition above and below the power supply systems. So we can divide restructuring market into two levels which are (i) wholesale and (ii) retail levels. The main point to note is that the delivery of power, it means, transmission and distribution remains a monopoly. This is shown in the Fig.2.

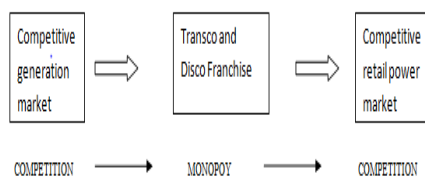


Fig.2. Competitive Wholesale Market

In European countries, these are known as transmission system operators, in India, these are called as load dispatch center and in US they are called as the regional transmission organizations or independent system operators. The Wholesale market refers to the exchange of energy, ancillary services,

capacity of heavy power system and the inter-connection to systems. The retail power market refers to the exchange of energy which lowers the voltage distribution services.

A. Energy in the Market structure

The competitive wholesale electric/energy markets usually forms powerful platform. The energy/electricity market varies on a large scale. The market prevent the outages during normal operations but it is very less effective during emergency conditions [5]. The market models attempts to meet the demand satisfying the constraints of the security. In US, the RTOs/ISOs runs the energy markets consisting of two markets- settling markets, where the energy/electricity are based on day-ahead (forward) market usually followed by a real-time (practical) market maintaining the stability of market structure. Secondly, the energy in the market structure involves-The Locational Marginal Price (LMP) covering price paid to generators and marginal/profitable cost serving load in a particular region, higher-priced electricity/energy is dispatched which further includes (a) *Resolution Dispatch*- It is the 5-minute short dispatch interval which improves the system flexibility, matching-changes in variable generation and reduces the required levels of regulations.(b) *Frequent Power Markets-Step market*- It is a two way system causing errors to be resolved in the real time, balanced system. Alternative effective solution- enables the participation from the power units with fast instantaneous starting up times (c) *Negative Pricing Impact* includes the process of negative pricing usually helps to encourage the storage process and in order to absorb the large quantity and the amount of storage the operator must follow the following strategies:-

Survival quantity: The low prices are required to cover the variable costs.

Profit Maximization: Choose the price producing techniques for the maximum Profit.

Share Leadership: High prices to cover higher performance quality, setting up high prices to shape the market, low possible prices, and product quality, overcoming the negative effect and monitoring the prices. In an obvious manner, government organizations will still manage the process by taking the right decisions but the retailers will decide which supplies are needed and which structure is economical in its nature [6].

B. Ancillary Services

The Ancillary services are defined as the activities that are needed to provide support to the transmission system via maintaining the operations of the system and it also provides the needed amount of safety. In a deregulated system, transmission system networks have an access to the third party members to have benefits of power wheeling and cash markets

for energy/electricity. These are now treated as unbundled and are priced separately with the process of system operators to purchase the ancillary services from providers. The figure above generally represents some examples of ancillary services which are procured and managed by an ISO [7].

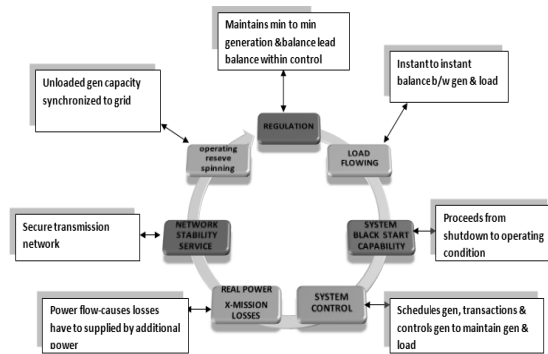


Fig.3. Ancillary services management

III. MARKET DESIGN FEATURES

A. Encouraging Investment

Energy markets with complex designing might be critical for the desired outputs of the power system. These designs are not able to attract the participants of the market. The objectives that are to be met by the presence of such investments must cover the flexibility of the system so that the system can boost up the presence of market and can uplift undesired and instable structure of the system. Flexible systems have various encouraging system investment including- ability to start a system, absorption of the excessive power and cyclic variation while on and off. The flexibility can be provided by encouraging the energy product mix structure and also the generation and transmission each with a difference in the capabilities of the market system.

B. Minimizing Complexity

The complexity in the designing of the market structure leads to the market revision process and it may lead to the conflicts in between the markets. So before planning or taking any significant action the factor of minimizing the complexity of the system should be kept in mind. The following are the stages of overcoming the complexity-



Fig.4. Stages of the complexity

C. Harmonizing (implementation)

Reliability and the security of the energy systems needs a sensitive time implementation to lead a multiple time based production. Energy markets provide short-term price signals from seconds to days, which are effective at the available capacity. Few of the power markets provide long term price visibility and are ineffective at the optimal amount of long-term installed capacity to meet reliability. A challenge in market design is how to provide long-term market signals to encourage or implement the investments in new generation. The changing role of Marketing Organisation involves the following initiation process for implementation-simple department, integrated marketing department, separate marketing department, marketing organisation, objective and goals of the firm and areas of operation.

D. Market Depth

Power markets maintains a good buyer and seller relationship through the internal and external contracts or the contracts that are bilateral in nature indicating the fading of long term market dispatch criteria, generally decreases the market involvement. So, for maintaining a standard depth of the market we need to keep the above mentioned points in mind.

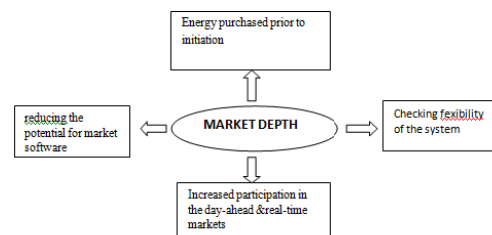


Fig.5. Criteria for market depth

IV. MARKET-DESIGN ANALYSIS

A. Collaboration

The Market-design strategic analysis forms a good platform collaboration of the international structure and merging of the system. The unanswered questions in a particular part of a system, performs the calculation theory of consumer choices required before the initiation of the function. It is particularly a need of the every country specially the developing one to have the choice to form the market and whole efficient power system to work efficiently improving the supply/demand curve in the world. Some of the activities towards the development are-

(a) *Experimental economics studies*: These are done

very carefully to reflect more precisely different decisions along with the strategy of behavior affecting the market. Such studies can reveal the unexpected consequences in the markets. (b)*Consultative processes*: Done directly and transparently collects key stakeholder requirements and provides a platform for ongoing feedback and refinement of the market designs.

B. Short-term Operational Timescale

Short-term Operational Timescale involves the planning over a time horizon based upon the capacity of the system operation in the market model. The capacity determines the amount of fixed cost and also qualifies the criteria based on the system demand that must be satisfied in its nature. Combining the short term generation scheduling along with long term generation scheduling one can easily evaluate the distribution system power flow and congestion free environment. Based on the Fig.6. , the process of utilization and efficiency can also be calculated as- Utilization is the percent of the designed capacity achieved in the market system.

$Utilization = Actual Output / Design Capacity$

Efficiency is the percent of effective capacity achieved in the market model design.

$Efficiency = Actual Output / Effective Capacity$

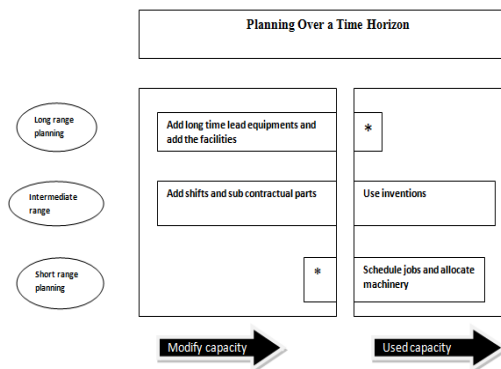


Fig.6. Planning Over a Time Horizon

C. Long-term Planning Timescale

Long term planning is a long term contract based commitment to deliver different types of the goods/services to retailers. A study should be done on the characteristics of planning based on time scaling techniques to deal with market structure for the development of the future and presently working market models. Some of the methods of designing the market structure generally covers-(a) *Functional Organisation* (i.e. periodic definition, old long term planning, dating process and data set), (b) *Product Management Organisation* (i.e. application description, error reports and plan back up processes), (c) *Market Centred Organisation* (i.e.

work load and work station description). The contribution based on both long and short term planning of Wholesale Activities is shown in TABLE I.

TABLE I SECTOR GDP OF WHOLESALE SERVICES IN INDIA

Year	Sector-Vise GDP
1996	20
1997	21
1998	20
1999	21
2000	22
2001	22
2002	23
2003	26
2004	31
2005	35

From the year 2006 up to present 2012, the gross domestic product (GDP) has been increased very sharply up to 40-45%.

V. STEP TOWARDS: A CHALLENGING MARKET

21st step towards the Power System: The involvement and the investment requirements in the energy system are exceeding \$15 trillion over next twenty five years and demand of the energy doubles in nature. This reference to our power system will open a fast emerging access to electricity industry. The energy demand has been shown in Fig.7. , which describes the consumption of the energy on the basis of present and the future scenario.

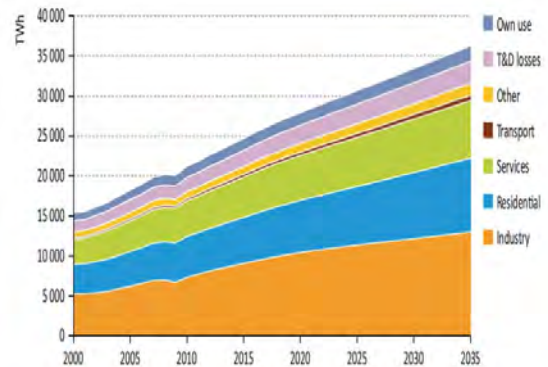


Fig.7. Electricity demand (2010–2035)

The main objective of achieving the target in a competitive market are-(a) creating clear and effective incentives for investment. (b) Promoting efficient operation of power systems. (c) Improving the reliability of the energy/electricity service process. These main objectives have been driven for the power market to be designed. The other new objectives consists of-(d) Decreasing the

environmental impacts of energy/electricity service. (e) Fast expansion to have a large amount of energy mix and to provide open area for un-served consumers. The examples of these challenges includes:-

Increased demand response participation-

Demand response increases the elasticity as well as the structure of the wholesale market. The market design focuses upon the following:

Regulation: An authoritative rule of the system, state of being controlled or governed and the act of controlling according to rule. There are two types of barriers defined as (a) *Barriers: Customer-related:* A barrier incorporating the demand response is willingness of the consumers and having the ability to participate providing the benefits of the system. Mostly, it is automatically dispatching of the unit either by operator or the third person who participates in the competitive market structure. (b) *Market Rules:* Marketing is the place which perform all the business activities that provides a direction to the flow of goods and services from sellers to buyers or users.

Integrating the generation: It provides a great impact on the operation of the wholesale market. In country like Denmark, the combined generation is required for the wholesale markets. The generation facility produces the energy at the lowest price to serve consumers dealing with operational generation and transmission facility.

*Clarifying the storage-*Storage is an operation serving as the generator, load, or it is an alternative way to power system transmission operations providing flexibility for the heavy loaded power system. Storage provides benefits to the main components of power system. The solutions like open access to the owner of any storage unit in order to divide or separate each part by selling it to the third party for transformation in market model storage option [8].

VI. CONCLUSION

The electricity market is indicating that electricity is becoming more and more costly in its nature. The criteria to maintain the market design is very tough. Many of the competitive objectives must be needed to perform the tasks of energy management systems including the short-term price methods to see the long-term investing process, minimizing/decreasing the power of market and providing the incentives/profit margin for distributors for the services that do not require energy to balance the structure of the grid. The wholesale markets in so many areas are related with the pricing structure in the retail process. It means that the participants in the wholesale markets have the ability to predict, plan and implement the process. Firstly, the power systems may require a transactional model to form a system on a strict separation between

wholesale and the markets of retail else generation and distribution processes, and secondly to one that can integrate present working of the markets in order to have the flexibility and reliability of the market model structure. There is major need for international collaboration on wholesale market design environment. Thus a build up for collaborative/evaluated analysis and modeling will help to describe the ways towards the 21st century of the power systems. Re-designing of the rules of electricity market can only change the on time supply-demand but not the practical reality of the whole system. The markets that are hybrid in nature includes both the deregulation and regulated shifts that should be dealt carefully and must be tested to understand/investigate both the technical and financial outputs of the system and should also be focused on the issues correlated with the market design along with the policy of public's objective deriving market design.

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