COMPARATIVE ANALYSIS OF DIFFERENT WHEELING CHARGE METHODOLOGY

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Abstract-In the restructured power system need to develop the transmission cost scheme that can provide the useful economic information to power markets, such as generation, transmission companies and customers. In this paper proposes an analytical approach for allocating the wheeling charge based on MW-MILE method. Wheeling cost is the most important parameter for recovering the invested cost. The MW-mile method allocates the charges based on transmission capacity and wheeling distance. The approach based on applying MW-MILE method on IEEE-14 bus system.

Keywords: Restructured power system, wheeling charge ,MW-MILE method.

I. INTRODUCTION

Electrical energy playing a fundamental part in our life. In today's modern society, electrical energy can be found everywhere .For providing energy in household appliances such as lighting, air-conditioners, televisions sets to office equipment such as computers, fax machines and also providing energy for the industrial. Machineries, electrical energy has become sheer necessity in our life. That's why electric power industry is probably the largest and the most complex industry in the world. Generation, transmission and distribution of Electricity must be accomplished at minimum cost but at maximum efficiency. For many years in the past, the electric power industries in the world are operating in regulated, monopolistic market. Large power companies often dominate the overall authority over all activities in generation, transmission and distribution. These companies often have owned the assets and operations of these three activities and are referred as vertically integrated utilities. Now, these vertically integrated utilities are owned and run by governments in many parts of the world.

II. DERUGULATION

In deregulation environment, generation, transmission and distribution are independent activities; there is a competition among generators for customers. Main benefits from the deregulation are, cheaper electricity, efficient capacity expansion planning, cost minimization, more choice and better service. Since the electrical power supply industry around the word has experienced a period of rapid and irreversible change. The need for more efficiency in power production and delivery has led to a restructuring of the power sectors in several countries traditionally under control of federal and state governments.

III. OPEN ACCESS TRANSMISSION SYSTEM

The Open Access Same-Time Information System (OASIS) is an Internet-based system for obtaining services related to electric power transmission in North America. It is the primary means by which high-voltage transmission lines are reserved for moving wholesale quantities of electricity. OASIS permits posting, viewing, uploading, and downloading of transmission transfer capability in standardized Protocols. The data posted on OASIS should clearly identify what service is available, which requests were accepted, denied, interrupted or Curtailed, permitting business decisions to be made solely from the OASIS-derived in formation. The SaskPower Open Access Transmission Tariff (OATT) provides open and equitable access for wholesale power suppliers to the SaskPower power grid.

IV. WHEELING

The term "wheeling" has a number of definitions. Wheeling is the use of transmission or distribution facilities of a system to transmit power of and for another entity. The fig.1, shows the general wheeling diagram.

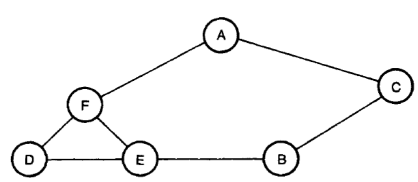

Fig.1. General wheeling diagram.

Wheeling occurs on an AC interconnection that contains more than two utilities whenever transaction takes place.

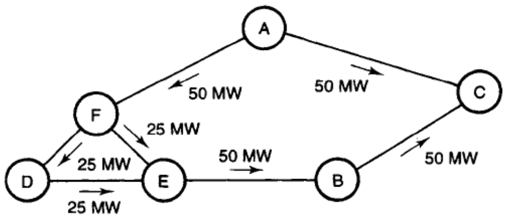

Fig 2. Six interconnected wheeling diagram

Consider the six interconnected control areas shown in Figure2.Considerthe six interconnected control areas. Areas A and C negotiate the sale of 100 MW by A to C. A to F transferring some amount of power and F area power is transfer to C area through the areas D & E. remaining power is transferring areas A to C.

V. BILATERAL TRANSACTIONS

A bilateral transaction involves a trade negotiated between two participants, with price, quantity and other trade data known only by the parties involved..In the power market one buyer and seller are involved in the bilateral transactions. Since bilateral transactions do not occur on regulated exchanges, such transactions are referred to as "off exchange" or "over the counter" (OTC) transactions. Over-the-counter or off-exchange trading is done directly between two parties, without any supervision of an exchange. It is contrasted with exchange trading, which occurs via these facilities. An exchange has the benefit of facilitating liquitiy, mitigates all credit risk concerning the default of one party in the transaction, provides transparency, and maintains the current market price. In an OTC trade, the price is not necessarily made public information.

VI. MULTILATERAL TRANSACTIONS

Multilateral means that multiple parties can input their selling and buying intentions into the system and a transaction is established between these parties when intentions match. The multi lateral transactions based on bilateral transactions among market participants.

VII. WHEELING CHARGE CALCULATION

a) MW-MILE METHOD

The MW-Mile method is also known as Line-by line method. The change in the magnitude of power flow on the system caused by wheeling transaction is taken into consideration in order to assist in the allocation of the wheeling costs of each of the wheeling transaction. One distinct feature is the length of the transmission lines used in the transaction is also taken into consideration when determining the wheeling costs. This attempts to solve the flaws in the rolled-in-embedded method where the distance between the point of supply and the point of the recipient has no effect in determining the usage of the transmission system by the wheeling transaction. MW-mile method attempts to allocate the wheeling costs based on the actual system usage as close as possible. Therefore, Two power flow executions are needed with one having native loads only and the only with the wheeling transaction comes into play. The power flow-mile on each transmission line of the system due to a particular wheeling transaction is calculated by obtaining the product of the transmission line length and the change in the magnitude of the power flow caused by the transaction. The power flow-miles of each transmission line are totaled up to represent the amount of the transmission resources used by the corresponding transaction. The total system capacity is obtained by totaling up the product of each transmission line length and some measures of the contribution made by the transmission facility towards the capacity of the system. This contribution can be measures by several alternatives such as measuring the temperature based rating, surge impedance loading, actual power flows.

In the original MW-Mile methodology DC power flow formulation was used to estimate the usage of firm transmission services by wheeling transactions, and the procedure for multi-transaction assessment may be outlined as follows.

STEP 1: For a transactions t, the transactions related flows on all network lines $MW_{t,k}$ $(k \in K)$ are first calculated using optimal power flow model considering the nodal power injections only involved in that transactions.

STEP 2: The magnitude of MW flow on every line is multiplied by its length L_k (in miles) and the cost per MW per unit length of line C_k (in $/MW-MILE), and summed over the all network lines as:

$$MWMILE_t = \sum_{k \in K} C_k L_k MW_{t,k}$$

The above process is repeated for each transaction $t \in T$, including one comprised of the utility's native generators and loads. Finally,the responsibility of transaction t to the total transmission capacity cost is determined by:

$$TC_t = Total\_\cos t \frac{MWMILE_t}{\sum_{t \in T} MWMILE_t}$$

The MW MILE method recovers the fixed transmission cost in the restructured power system.

b) MVA-Mile Method

In the above method i.e. in MW mile method reactive power changes in the facilities caused by the transmission have not been considered. Reactive power flow can effect line losses and voltage magnitude when customer loading is heavy, reactive power flow can push bus voltages, top change transformer settings or circuit loading to their limits, or when oppositely oriented can bring them off limits. The MVA mile method, reflect the actual customer loading condition.

In MVA mile method both are red power flow and reactive power flow is taken into consideration. According to MVA mile method, the costs are allocated proportional to the charge in the line MW flows and line MVAR flows caused by transmission transaction and length of the line in miles. Two power flows executed successfully, with and without the wheeling transaction T, yield $(\Delta MVAf)T$ the changes in MVA flows in all transmission line facilities. The transaction cost CT in $/hr for a transaction T is given by the following equation

$$C_{WT} = \frac{C*\sum_f((\Delta MVA_f)_T * L_f)}{\sum_T((\sum_f \Delta MVA_f)_T * L_f)}$$

Where,

L_f = Length of transmission line f.

$(MVA_f)_T$ = MVA power flow in facility f due to transaction T

$(\Delta MVA_f)_T$ = Change in power flow in facility f due to transaction T due to transaction T.

VIII. OPTIMAL POWER FLOW

The optimal power flow is a very large and very difficult mathematical programming problem. Almost every mathematical programming approach that can be applied to this problem has been attempted and it has taken developers many decades to develop computer codes that will solve the OPF problem reliably. The main objective of optimal power flow is to minimize the generation cost in the power system. There are two constraints in the optimal power flow. In the equality constraints generation balances the load. In the inequality constraints generations mismatches the load. The IEEE-14 bus system is solved using mat lab software in Optimal Power Flow method using the Interior Point algorithm. Traditionally, classical optimization methods were used to effectively solve OPF. But more recently due to incorporation of FACTS devices and deregulation of a power sector, the traditional concepts and practices of power systems are superimposed by an economic market management. So OPF have become complex. In recent years, Artificial Intelligence (AI) methods have been emerged which can solve highly complex OPF problems.

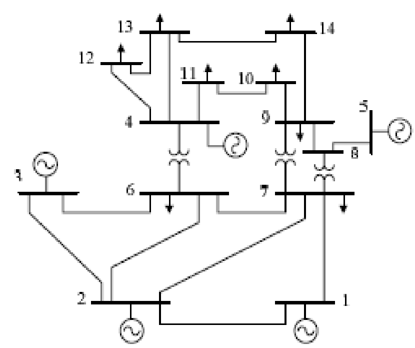

Fig 3.IEEE-14 BUS SYSTEM

The figure 3 shows the general IEEE 14 bus system diagram.

IX. EXPERIMENTALRESULT

BILATERAL TRANSACTIONS

TABLE 1: WheelingTransactions

From bus	To bus	Magnitude transaction
10	4	10MW

TABLE 2: WHEELING COST

From bus	To bus	MW MILE method	MVA MILE method
2	4	-1.8	-1.9
3	4	-2.57	3.2
4	5	14.06	-18.81
4	7	32.62	32.91
4	9	29.49	31.08

9	10	61.31	61.13
10	11	-14.06	-11.39

a) COMPARISION OF BILATERAL TRANSACTIONS

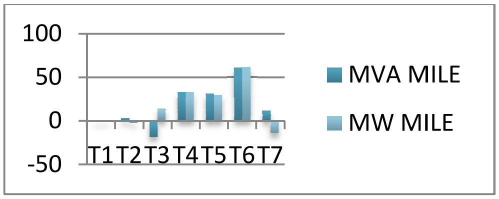

Fig. 4. Comparision Between MW-MILE and MVA MILE Method in Bilateral Transactions

TABLE 3 : MULTILATERAL TRANSACTIONS

From bus	To bus	Magnitude Of Transactions
7,11,12	9,10,13,14	50MW

TABLE 4 : WHEELING COST

From bus	To bus	MW MILE method	MVA MILE method
4	7	9.62	27.96
4	9	11.75	33.26
6	11	50.78	154
6	12	8.9	23.08
6	13	9.73	29.47
7	8	67.54	-211
7	9	15.54	44
9	10	24.40	72.72
9	14	2.73	9.03
10	11	6.24	4.7
12	13	2.13	-18.26
13	14	-0.77	-4.01

b) COMPARISION OF MULTILATERAL TRANSACTIONS

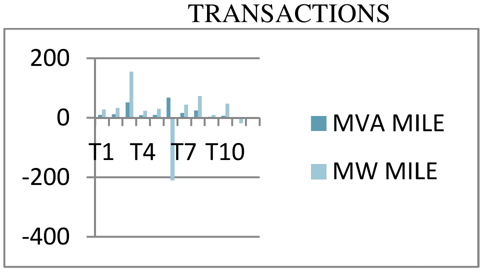

Fig. 5. Comparision Between MW-MILE and MVA MILE Method in Multilateral Transactions

X. CONCLUSION

The wheeling charges are calculated inIEEE14 Bus system using the MW-MILE method and MVA MILE method under the open access transmission system. The different wheeling charges are calculated and compared the results.The wheeling charges are used in transmission of electric power .

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