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Wheeling Prices Methodology: A Review

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Abstract: The open access transmission of electrical power from a seller to a buyer through a transmission network owned by third group is called wheeling. One of the key issues in newly emerged deregulated electrical power market/industry is assessment of power wheeling prices. Assessment and analysis of electrical power wheeling prices has become a challenging task as now several factors are to be incorporated in the study like introduction of competition, pricing policy, transmission constraints ,system operation conditions, various investment options, accommodation of several transactions, tariff components etc. In this paper the previously done research work on assessment and analysis of electrical power wheeling prices has been presented as an overview. In this overview paper various issues in assessment of power wheeling prices, various methods so far available for calculating/ assessing power wheeling prices and case studies of several countries have been discussed.

Keywords: **Embedded cost, Wheeling prices, Marginal cost .**

I. INTRODUCTION

Wheeling can be defined as the use of the transmission facilities of one network to deliver power of and for another entity or entities [1, 2]. On other words, wheeling can be defined as “The use of some party’s (or parties) transmission system(s) for the benefit of other parties” [3]. More precisely, it can be defined as “The transmission of electrical power from a seller to a buyer through the network owned by a third party.”

Wheeling therefore occurs on any AC interconnection containing at least two parties [4]. It will be very much useful for all countries, especially those developing countries which are moving toward the unbundling of electricity supply industry (ESI) [5]. Retail wheeling would allow customers to purchase their electricity directly from different suppliers rather than from the distributing utility in much the same way that customers can now choose their long distance telephone carriers [6, 7, 8, 9, 10]. Electricity transmission and wheeling service pricing become a more complex and more important task within the ongoing deregulation of electric power industry; it has significant impacts on the market efficiency, the development of transmission systems, the sitting of power plant, the demand growth and its geographical distribution. Transmission pricing discuss how to allocate the entire cost of a transmission system all the system users [11].

In wheeling prices several methods are be there. Marginal cost method, embedded cost method, incremental cost method and the other method are apply for calculate wheeling rates in different countries. These methods have different significance and also several drawbacks. In this paper we will discuss about different methodologies of retail wheeling prices in different countries and problem occurs in different countries relate to wheeling prices. Finally we will discuss about conclusion or future scope of the topic.

I. METHODS FOR CALCULATING WHEELING PRICES

Wheeling is major factor in restructured power system. Different countries apply different method according to their need. We can classified all available methods into following main categories. These categories are representing by following figure as:

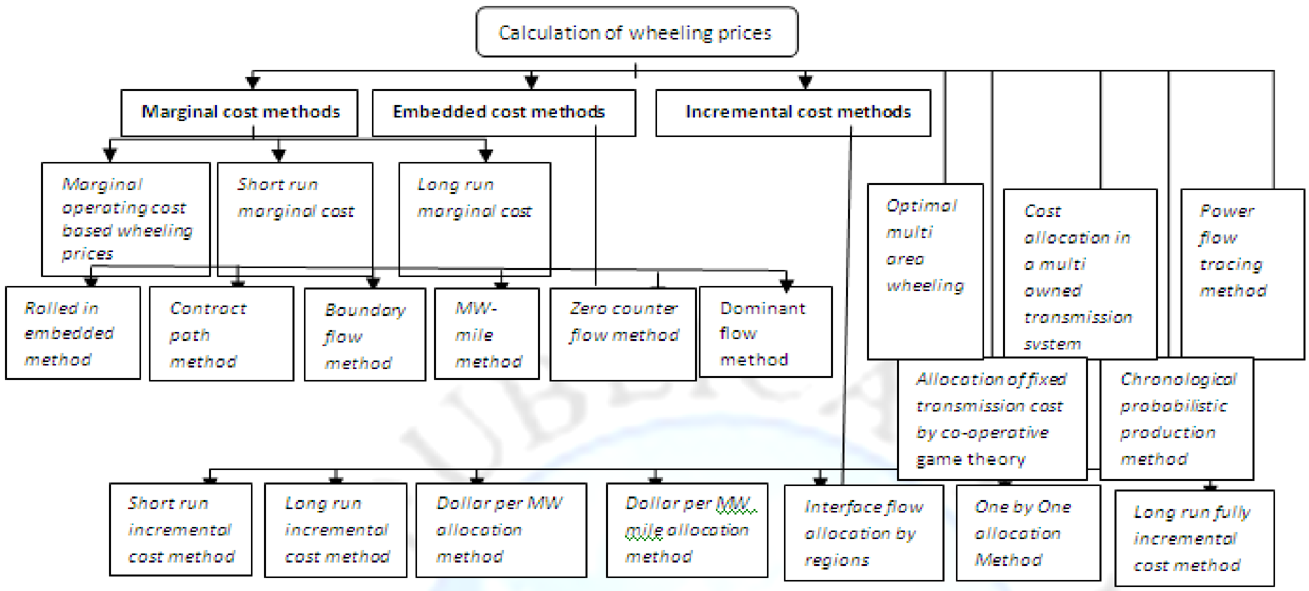

Fig.1: Different methods for calculating of wheeling prices

MARGINAL COST METHODS:

Marginal cost can be defined as the requirements needed to pay for any new capacity on the transmission system [12, 14, 15]. The annual marginal capacity cost (MCC) of a transmission service transaction can be defined as [13]:

$$\mathrm{MCC} = \sum_{f\epsilon F_N} \frac{|\Delta MW_{f,l}| X\ MC_f}{\sum_{s\epsilon S_N} |\Delta MW_{f,s}|} \qquad \text{….. (i)}$$

EMBEDDED COST METHODS:

Embedded cost methods allocate the embedded capital costs and the average annual operation (not production) and maintenance costs of existing facilities to a particular wheeling, these facilities include transmission, sub transmission and substation facilities [18]. On an annual basis, the embedded cost of transmission service transaction can be defined as [24]:

$$\mathrm{ECC} = \sum_{f\epsilon S} \frac{|\Delta MW_{f,l}| X\ EC_f}{\sum_{s\epsilon S} \ |\Delta MW_{f,s}|} \qquad \text{…………(ii)}$$

Where EC_f is the annual embedded cost of facility f which is the sum of depreciation, embedded cost of capital, taxes and expenses. S,F are the sets of all sales S and facilities F in a given year. In these category six types methods are available which are as follows:

The Rolled in embedded method assumes that the entire transmission system is used in wheeling, irrespective of the actual transmission facilities that carry the wheeled power [25]. The cost of wheeling as determined by this method is independent of the distance of the wheel, which is the reason that the method is also called the postage stamp method [26].
This method is based upon the assumption that the wheel is confined to flow along a specified electrically continuous path through the wheeling company's transmission system [26]. This method overcomes some limitation of the rolled in methods, but has been criticized as having no obvious grounding on economic theory [25].This method incorporate changes in MW boundary flows of the wheeling company due to a wheel either on a line basis or on a net interchange basis, into the cost of wheeling [27]. Two power flows, executed successively for every year with and without [26] each wheel, yield the changes in either individual boundary line or net interchange MW flows.

According to MW-Mile method, embedded costs of transmission systems are allocated proportionally to the change in the real power flows caused by the transaction in the transmission line and length of the line [29, 32]. This method can be further divided into three categories [28]: (a) MW-mile negative (b) MW-mile Positive (c) MW-mile gross. In this method, there is no charge for the agent whose power flow is in the opposite direction of the net flow [30]. The Zero Counter flow method only taxes the positive flows, this method assumes that the negative flows are beneficial for the network, therefore in these cases the transactions are not paid but also they do not have credit[31].

This method is a combination of MW-mile and zero counter flow methods as part of an attempt to overcome their drawbacks [30]. Incremental cost will be considered to evaluate transmission charges for wheeling transaction [33]. Short run incremental cost method is the pricing method entails evaluating and assigning the operation costs associated with a new transmission transaction to that transaction [18]. Costs associated with each wheeling increment are evaluated separately [37]. The Long run fully incremental cost method accounts for the change in total costs incurred in providing the transmission services. The change in total costs includes the investment costs for reinforcements to accommodate a transmission service; and the change in production costs and incremental maintenance and operation costs incurred due to the transmission service [38].

INCREMENTAL COST METHODS:

Incremental cost can be defined as the revenue requirements needed to pay for any new Facilities that are specifically attributed to transmission service customers [18]. In incremental cost pricing method, only the new transmission costs caused by wheeling transactions, that is, the the cost of reinforcements and change in operating costs [35]. Dollar per MW mile allocation method the unit cost in the megawatt mile method is bound per energy transaction, whereas our unit profit is not [36]. In Interface flow allocation by regions the wheeling cost allocations may be more desirable to be more desirable to be allocated by regions than by companies, with all inputs provided by the region [18].One by one allocation method the wheeling the cost of reinforcements and change in operating costs [35]. Dollar per MW mile allocation method the unit cost in the megawatt mile method is bound per energy transaction, whereas our unit profit is not [36].

In Interface flow allocation by regions the wheeling cost allocations may be more desirable to be more desirable to be allocated by regions than by companies, with all inputs provided by the region [18].One by one allocation method the wheeling The long run incremental cost method provides an analytical framework for estimating the cost that be found in a market operating under conditions of perfect competition [34]. Dollar per MW allocation method allocates the wheeling costs for complete wheeling increments by developing an annual cost per MW wheeled for both the cost of reinforcements and change in operating costs [35]. Dollar per MW mile allocation method the unit cost in the megawatt mile method is bound per energy transaction, whereas our unit profit is not [36].
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OTHERS METHODS:

An important consideration in wheeling is when a transaction involves several parties, that is, optimal multi Area wheeling [39]. Power from seller to buyer flows through several intermediate utilities. Allocation of Fixed transmission cost by Co-operative Game theory method allocates transmission costs to participants involved in the decentralized power systems in an equitable manner [40, 41]. In game theory both coincidence and non coincidence peaks taken into consideration. Cost allocation in a multi owned transmission system method is used for allocating transmission costs among users of a centralized transmission service [42, 43]. Chronological probabilistic production method is for the integrated analysis of generation and transmission systems in terms of production costing and wheeling rate calculation [44].

Power flow tracing method is the new method of assessing the transmission cost related to active power losses [11]. The power flow method is suitable to estimate the performance of the system. This method is simple, intuitive and is based on complete AC power flow. The cost allocation has been performed separately for sources and consumers, tracing the active power flow.

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II. CASE STUDIES

India: [45, 46, 47] - Power sector across the world is undergoing a lot of restructuring; the Ministry has allowed wheeling of power and recommended a 2% charge. However, some states do not allow wheeling, while others have imposed 20% wheeling charges, In wheeling, Contract path method is presently applied for determination of wheeling charges for State Electricity Board (SEB) , National Thermal Power Corporation (NTPC), Western Regional Electricity Board (WREB) supported this method. Southern Regional Electricity Board (SERB) and Industrial Development Bank of India (IDBI) pointed out that MW-mile method is most scientific but too complex to be applied in present conditions.

Chile [48, 49**] -** The first experiment in transforming a government-owned and -operated power industry began in Chile in 1980.Transmission open access is receiving increasing attention by power utilities and regulatory state bodies worldwide. The first challenge is one of efficiently regulating a monopoly that permits competition to take place. The second challenge is defining a pricing scheme for the transmission services that provides coherent economic incentives. If marginal costing is used to price transmission services, an additional difficulty arises as the income will not be sufficient for financing the investment (past or future), given the economies of scale. Under the open access fee structure, alternative allocation methods are formulated and evaluated.

Brazil: [50, 51**] -** Brazil adopted the Investment Cost Related Price (ICRP) to determine the transmission tariffs. The ICRP model is used for providing appropriate occasional signals for generation and demand connected to the transmission system. This methodology mixes the marginal cost method with the postage stamp which is used to assure the Revenue Reconciliation. This approach must be judicious because it can distort the economical signal of the marginal method.

Japan:[52,53,54]-In Japan, people expect the electric utilities to continue to be responsible for transmission planning to meet the steadily growing demand. Because they are especially interested in long term stability of energy supply. the electric utility industry council therefore suggests that for full cost recovery. The present transmission prices in Japan fail to give appropriate geographical signal. Therefore calculate regional transmission cost allocation method is more beneficial in Japan.

England: [55, 56] - England has been one of the leaders in developing spot electricity market. In England addition to providing incentives to use the transmission system efficiently, the transmission tariffs are required to provide cost recovery for the grid owners. Distributing the costs not covered through marginal pricing is a cost allocation problem that requires some kind of allocation goals.

Kenya:[57,58]-Commercial energy in Kenya is dominated by petroleum and electricity which are the prime movers of modern sector economy. At the national level 22% of the total energy consumption followed by petroleum, electricity at 9% therefore Kenya must choose to generate cost effective electricity or methods and increase efficiency in energy consumption.

USA:[59,60]- In USA estimate of the future price of electricity as traded on the wholesale, short-term (spot) market at the USA trading hub. This price represents the marginal cost of electricity and is used by the Council in assessing the cost-effectiveness of conservation and new generating resource alternatives. The price forecast is also used to estimate the cost implications of policies affect in power system composition or operation.

IV. CONCLUSION

In the fast emerging Deregulated Power System scenario, Wheeling prices settlement has become crucial task. Power transmission technology is continually changing and evolving. New technology may have a significant role to play in the future. In transmission such set up turns out to be a cost based system and for their implementation cost calculation must be necessary. A review on the Wheeling prices available in the literature. The problems encountered in Wheeling prices are also discussed. A critical survey about Wheeling prices problems and used methods in countries like India, Chile, Brazil, Japan, England, Kenya ,USA has been carried out in this paper. This review is helpful for decide and declare wheeling prices for different regions.

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