Certain Considerations In Pricing Unbundled Transmission Services

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Abstract - **In deregulated environment, the transmission network is considered to be the key factor of the electricity markets. One of the important issues in this context is how to charge the users for the use of transmission facilities in the fair way and at the same time allowing the transmission utilities to recover their transmission costs. Several methodologies have been developed to recover the cost of transmission services and to estimate the power contributed by single generating unit in lines and loads. Both developed methods attempt to allocate the charge of the use of the transmission system.**

This paper describes certain aspects to be considered in pricing the unbundled transmission services. These aspects cover the type of transmission services, the costs related to the services and the methods used to calculate the costs of transmission services. This paper also proposes a new approach to allocate the costs of the transmission services among the transmission user utilising the properties of MW-mile based method. A case study based on a 6-bus system is used to highlight the merit of the proposed approach over the existing approaches. The case study results show that the proposed approach provides a better economic signal in allocating the charges to the transmission user.

Index terms – Deregulation, Transmission services, MW-mile method, postage stamp method and locational charges. [1]

I. INTRODUCTION

The electric utility industry throughout the world has been undergoing significant changes due to the process of deregulation. Under the deregulation scheme, the electricity businesses have unbundled into three components: generation, transmission and distribution. The interaction among these components would be on pure commercial bases. In the case of transmission, transmission (wheeling) services represent unbundled services. Since then, the pricing of the transmission services has become one of the major issues. The pricing issue refers to the way the cost of transmission services is satisfactorily allocated among all involved participants, taking into account as accurately as possible the real impact of every transaction on the transmission system.

Many methods have been used or proposed to evaluate the costs of transmission services. Most methods attempt at least two basic measurements: the amount of transmission capacity used and the per-unit cost of transmission capacity [4]. These methods can be classified into one of these categories; embedded cost, incremental or marginal cost. The concept of these methods has been discussed by some of the authors [1,2,4,5] to show their ability to provide reasonable economic signal. Among these methods, the embedded cost methods are used commonly throughout the utility industry. This method offered several benefits, i.e. practical and fair to all parties and easy to measure and provides an adequate remuneration of transmission systems.

There are four types of embedded cost methods extensively used to allocate the transmission transaction cost namely; postage stamp, contract path, distance based MW-mile and power flow based MW-mile method. The MW-mile method is more widely used as a basis of locational use of system charges since it has been shown to be more reflective of actual usage of the transmission system in allocating the transmission cost. This method allocates the charges for each wheeling participant based on the extent of use of transmission facilities by these transactions [3,6,7,8,9]. These allocated charges are then added up over all transmission facilities to evaluate the total price for use of transmission system. Meanwhile, the postage stamp method is commonly used to remunerate the remaining total transmission cost. However, this method has its drawback due to the lack of undertaking of the actual operation.

II TRANSMISSION SERVICES

Transmission services generally can be defined in two manners: point-to-point transmission services (PTP) and branch-based transmission services (BB) or network services. PTP transmission service is defined as the transmission of power between two nodes, the source node and the sink node or in other word the service is between specified delivery and receipt points. BB transmission service is defined as the transmission of power over each branch. This service allows the transmission user a complete access to the system with no specification on the points of delivery or receipt, nor any additional charge for change of schedules [10].

For the PTP transmission services, the key issue is to calculate the cost of each type of service while the BB transmission services is to determine the usage of each transaction of each branch. For both services, the cost calculated can be total cost, average cost, marginal cost and so on. Figure 1 illustrates the two types of transmission services.

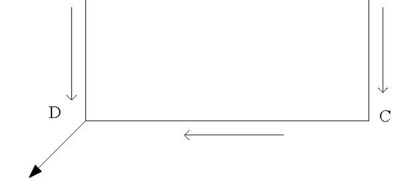

Figure 1 Two Types of Transmission Services

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In the system, there are 4 nodes; A, B, C and D and 4 lines; AB, BC, CD and AD. There are 6 types of PTP transmission services, A-B, A-C, A-D, B-C, B-D and C-D, and 4 types of BB transmission services, AB, BC, CD and AD. If there is a transaction to transmit 1MW power from node A to node D, this transaction requires one type of PTP service, which is from A to D or 4 types of BB services, AB, BC, CD and AD. Hence the amount power required for PTP service, A to D service is 1MW. However the amount of power for BB services are difficult to determine especially when there are several transactions taking place.

In general, the costs arising from transmission services can be divided into several cost elements and can be classified as fixed costs and variable costs. These cost elements include the costs of construction, maintenance and operation of transmission network; costs of losses, congestion costs and costs of ancillary services which can be used by the transmission utility to charge the users due to the service offered. The costs of transmission network are mainly fixed costs, because transmission capacity cannot be adjusted in the short run and maintenance and operation costs are hardly dependent on the actual use of the system. On the other hand, the costs of losses can be split into smaller fixed part concerning constant or voltage-dependent losses, and a greater variable part concerning current-dependent losses. Meanwhile the short –term congestion (i.e. those do not concern network reinforcement) are exclusively variable costs because if the system were not used at all, there would not be any congestion. The costs of ancillary services are partly more or less fixed (voltage control; precautions for system restoration), partly variable (reactive power supply; metering and settlement) and partly of mixture nature (frequency control).

III. RECOVERING COST OF TRANSMISSION SERVICES

In the context of recovering the cost of transmission services, the transmission utilities must have a means to charge for the transmission services rendered. This is to ensure that they are able to recover the transmission revenue requirement. Revenue requirement of transmission service reflects to the costs associated with all components needed to pay for a transmission facilities such as return of investment (usually depreciation), return on investment, taxes and expenses (operating, maintenance, administrative and other expenses that are related or allocated to the facility). The cost of facility depends on whether the cost basis is embedded, incremental or marginal.

As mentioned earlier, the embedded cost methods are commonly used throughout the utility industry to allocate the cost of transmission services. These methods have been suggested to allocate such pricing since the application of marginal cost in pricing the transmission services has shown to be ineffective mainly due to revenue reconciliation problems. In these methods, transmission system is assumed to be one integrated facility and all costs to meet transmission system revenue requirements are distributed across all customers. These methods which have pro and con in allocating the transmission cost has been discussed intensively by some authors[5, 11,12]. These methods can be written mathematically as shown in equations (1), (2) and (3) respectively;

A. Postage Stamp Method

$$WC_t = TC \bullet \frac{P_t}{P_{peak}} \tag{1}$$

where WC_t wheeling charge for transaction t

TC total transmission cost

P_t power of transaction

P_{peak} system peak load

B. Contract Path Method

$$WC_t = \sum_k TC_k \bullet \frac{P_t}{\overline{P_k}} \tag{2}$$

where k the transmission lines in path

TC_k the transmission cost in path

$\overline{P}_k$ transmission line capacity in path (MW)

C. MW-mile method

$$WC_t = \sum_i C_i \bullet \frac{\sum_i \Delta P_{i,t}}{\sum_i \overline{P_{i,t}}} \tag{3}$$

where i = indicates transmission lines

C_i = transmission cost

ΔP = change or impact in line flow due to transaction t in MW

$\overline{P}$ = transmission line (circuit) capacity in MW

ΔP can be either positive or negative flow impacts. Negative ΔP occurs when the lines loading decreases due to wheeling transaction while positive ΔP occurs when the lines loading increases. Depending upon the sign of ΔP, four approaches can be distinguished:

a) absolute impact : the absolute value of positive and negative ΔP are added.

$$\sum_i |\Delta P_i| \tag{4}$$

b) only positive impact : only positive value of ΔP are added.

$$\sum_i + \Delta P_i \tag{5}$$

c) net impact: the negative value of ΔP are subtracted from positive value of ΔP.

$$\sum_i \pm \Delta P_i \qquad (6)$$

d) profit sharing impact: the proposed approach where the negative value of ΔP is shared between the transmission owner and users using the profit sharing factor, r. This factor is determined according to the willingness of the transmission owner to share the profit with the transmission users.

$$\sum_i \Delta P_{ps} = \sum_i + \Delta P_i + \frac{1}{r} \sum_i \left| - \Delta P_i \right| \quad (7)$$

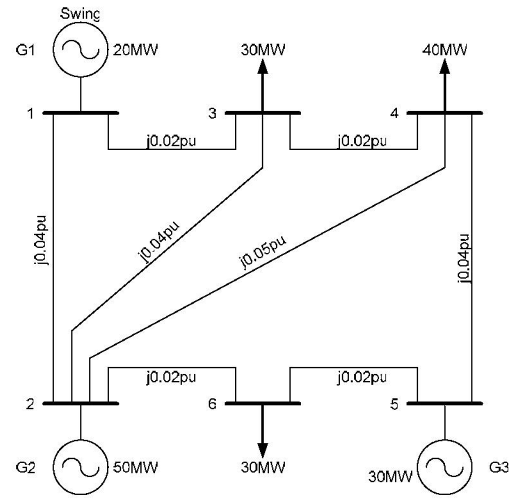

Figure 2 A Simple 6-Bus System

IV. CASE STUDY

Consider a simple 6 bus system comprising three generator at buses 1, 2 and 5 to serve a total demand of 100 MW at buses 3, 4 and 6 as shown in Figure 2. For simplicity the capacity of all circuit is assumed to be 50MW and the annual cost of each circuit is assumed to be RM50000. We assume the generators pay 100% of the transmission cost of services to the transmission utility. The profit sharing factor, r is set to equally share. The transmission service pricing methodologies implemented by two transmission utilities; Electricity Supply Board National Grid (ESBNG), Republic Ireland, Electric Reliability Council of Texas Interconnection System (ERCOT), Texas, USA and the proposed approach are used to investigate their ability to provide better economic signals to trading parties.

ESBNG has designed two separate elements of transmission charge; firstly, locational charges derived using the Reverse MW-mile approach (net impact approach). Secondly, a postage stamp capacity charge based on per kW is used to recover the remaining total transmission cost since the locational charges is not sufficient to remunerate this cost. This cost, which is associated with unused capacity, is distributed among the generators based on an average rate without taking into account their location[13]. Meanwhile, the total capital cost of the transmission in ERCOT is 70 % recovered by a postage stamp and another 30% by vector absolute megawatt mile approach (absolute approach)[14]. On the other hand, the proposed approach is being used with the postage stamp method to determine the locational charges and non-locational charges respectively.

TABLE 1 TOTAL MW-MILE IMPACTS

	ESBNG	*ERCOT*	*Proposed*
G1	19.1687	35.1523	31.1564
G2	62.9424	69.8971	57.8292
G5	29.1235	50.1358	38.4383

Table 1 depicts the total MW-mile impacts based on the ESBNG, ERCOT and proposed approach.

It can be observed that there's a similarity among the transmission utilities on the use of MW-mile method to allocate the transmission costs. However, there are some differences in the approach used to determine the total MW-mile impact. The difference occurs because the transmission utility, e.g. ESBNG considers the reward or credit for the transmission users due to their contribution in counter flow while ERCOT has ignored it. Furthermore, the difference is also due to the method use to determine the wheeling charge. For instance, in the case of the ESBNG the wheeling charge is determined based on the circuit capacity while the ERCOT is based on the total actual capacity used.

TABLE 2 TOTAL GENERATION PAYMENT FOR ESBNG

Bus Number	Generation (MW)	Locational payment *(RM)*	Average payment *(RM)*	Total Payment *(RM)*
1	20	19170	57750	76920
2	50	62940	144380	207320
5	30	29130	86630	115760
Total	100	111240	288760	400000

TABLE 3 TOTAL GENERATION PAYMENT FOR ERCOT

Bus Number	Generation (MW)	Locational payment *(RM)*	Average payment(*RM)*	Total Payment *(RM)*
1	20	27182	56000	83182
2	50	54049	140000	194049
5	30	38769	84000	122769
Total	100	120000	280000	400000

TABLE 4 TOTAL GENERATION PAYMENT FOR PROPOSED APPROACH

Bus Number	Generation (MW)	Locational Payment (RM)	Average Payment (RM)	Total Payment (RM)
1	20	3115.4	54515.2	85671.6
2	50	57829.2	136288.1	194117.3
5	30	38438.3	81772.8	120211.1
Total	100	127423.9	272576.1	400000

Table 2, Table 3 and Table 4 show the total generation payment based on the three different methods. It can be seen that there are significant differences on the total locational payment as a results of the methods used. The proposed approach generates a higher payment and followed by the ERCOT and ESBNG. This is solely due to the approach that they use to determine the total MW-mile impact.

In the context of revenue remuneration, the generators pay higher average payment in the case of the ESBNG and followed by the ERCOT generators. It can be observed that the proposed approach successfully produce less average payment for the generators compared to the other two transmission utilities. These results show that there is a possibility to reduce 'unfair' payment among the generators.

V. CONCLUSIONS

This paper presented certain aspects that the transmission utility has to consider prior of pricing their transmission services. These aspects which cover the type of transmission services, the costs related to the services and the pricing methods are designed to recover the cost of existing transmission system. It can be observed that the MW-mile methodology is widely used by the transmission utilities to determine the locational use of system charges while the postage stamp method is commonly used to determine the non-locational use of system charges. The proposed approach introduced in the paper provides an intuitive way in allocating the charges for the negative flow, which could benefit both parties in the trading.

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