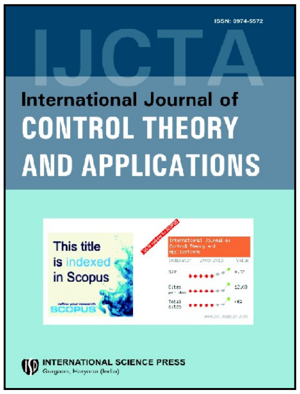


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# Comparative Analysis of Different Wheeling Charge Methodologies

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***Abstract:*** In the restructured power system need to develop the transmission cost arrangement that can offer the suitable economic evidence to power fairs, like generations, transmission firms and customers. This paper recommends an analytical method for allotting the wheeling charge built with the help of MW-mile & MVA-mile method. Expenses of Wheeling are the greatest essential parameter for recuperating the spent budget. Allocation of the expenses built on transmission ability also wheeling space can be done by MW-mile & MVA-mile methods. These methods are demonstrated in IEEE-14 bus system.

***Keywords:*** Restructured power system, wheeling charge, MW-mile & MVA-mile method

## I. INTRODUCTION

Electricity is essential one in a day to day life. Electrical power can be utilized mainly by traction and welding for industrial application. In domestic application, lighting plays major role. Other than that air-conditioners, TV, office equipment with computers and also Electrical energy is required to run the machineries in the industrial. Generation, transmission and distribution of energy essential stay consummate at slightest budget then extreme efficiency. Earlier the electrical power trades in the world are functioning in regulated, dominant market.

High power consuming industries dictate the complete ability above all deeds now generation, transmission and distribution. These enterprises frequently ensure preserved the belongings and tasks of these three deeds and are denoted as upright assimilated practicalities. At present, these upright assimilated conveniences remain undertaken via the Govt. voguish voluminous portions of the world.

## II. DEREGULATION

Electricity generation, transmission and distribution are accomplishment self-governing, there is a war midst generators used for clients. [Happ, H. H-1994] Uppermost reimbursements since the deregulation stay, economy electricity, competent bulk enlargement forecasting, budget minimization, supplementary optimal then superior provision. [Bialek J-1998] As the electrical power resource manufacturing everywhere the world has proficient a period of hurried then permanent amendment. [Lee W.J. et.al - 2001] The essential for further efficiency in power production and carriage has commanded to a restructuring of the power sectors in some nations conventionally below control of federal and state governments.

## III. OPEN ACCESS TRANSMISSION SYSTEM

The Open Access Same-Time Information System (OASIS) stands an Internet-based system for earning amenities allied to electric power transmission located in North America. It is the primary means by which high-voltage transmission lines are aloof for stirring extensive magnitudes of electricity. OASIS permits posting, viewing, uploading and taking of transmission transfer capability in standardized Protocols. [Marangon Lima J.W-1996] The data posted on OASIS should clearly identify pardon amenity is existing, which demands were conventional, repudiated, interrupted or Curtailed, authorizing business decisions to be made solely from the OASIS-derived in formation. SaskPower Open Access Transmission Tariff (OATT) provides open and equitable access for wholesale power suppliers to the SaskPower power grid.

## IV. "WHEELING"

The stint "wheeling" has many explanations. Wheeling is the expenditure of transmission or distribution lavatories of a system to transmit power of and for another one. The fig.1, shows the general wheeling diagram.

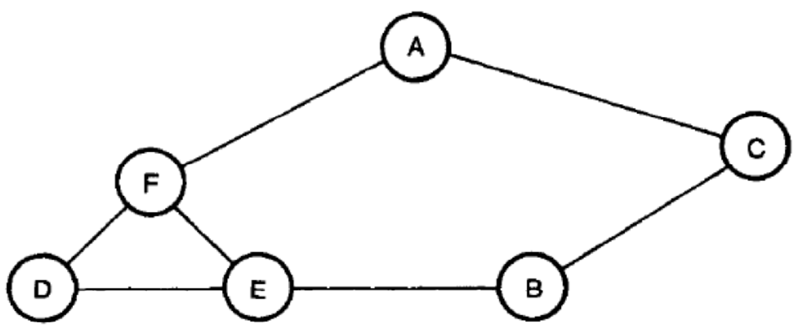


**Figure 1: General wheeling diagram**

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

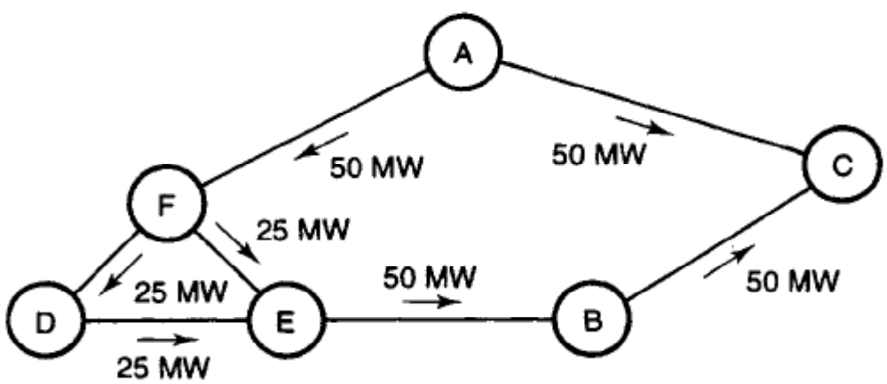


**Figure 2: Six interconnected wheeling diagram**

Consider the six interrelated control areas shown in Figure2.Considerthe six interconnected control areas. Areas A plus C negotiate the auction 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 contains a trade negotiated between two accomplices, with price, quantity and other trade data known only by the parties involved. [Gowtham J. et.al-2011]In the power market one buyer and seller are involved in the bilateral transactions. Since bilateral transactions do not arise on planned exchanges, such transactions are discussed 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. [Park J et.al - 1998] It is contrasted with exchange trading, which occurs via these facilities. [Karthikeyan R. et.al-2011] An exchange has the benefit of facilitating liquidly, 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. [Wood A.J et.al – 1996] The multi-lateral transactions based on bilateral transactions among market participants.

## VII. WHEELING CHARGE CALCULATION

### (a) MW - Mile Method

Line by line method is also called as MW-Mile method. The modification in the magnitude of power flow on the system affected by wheeling transaction is taken into deliberation in order to assist in the share of the circling costs of each of the wheeling transaction. The main advantage is the transmission length. This stabs to elucidate the defects 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. Cost of the wheeling assigned according to tangible scheme norm closes whenever necessary in the MW - mile method. [Karthikeyan R. et.al-2011]Therefore, Dual power flow accomplishments are looked-for thru one devouring natural loads only and wheeling transaction comes into play wheeling transaction comes into piece in only one time. The power flow- mile on every transmission line of the structure owed to a specific wheeling deal is premeditated via earning the merchandise of the transmission line span and the modification in the enormousness of the power flow instigated via the deal. Apiece the transmission line power flow- loads stay totaled up to symbolize the quantity of the transmission possessions hand-me-down via the agreeing task. Calculation up the merchandise of every transmission line span and some measures of the influence ready by the transmission competence near the bulk of the structure to get total system capacity. This aid tin is dealings by some replacements such as evaluating the temperature built ranking, heave impedance loading, tangible power flows. [Sundararaju K et.al-2011] In the imaginative MW-Mile practice DC power movement invention stood secondhand to appraisal the norm of secure transmission amenities by wheeling transactions besides the process for multi-transaction impost can be bounded by way of follows.

STEP 1: For a transactions t, transactions associated movements on everything network lines $MW_{t,k}$ ($k \in K$) stay first deliberate via optimal power flow exemplary allowing for the nodal power additions lone convoluted hip that transactions.

STEP 2: The amount of MW movement on each line is increased via his length $L_k$ (in miles) and the price 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 overhead method is continual for every transaction t ∈ *T*, comprising one comprised of the utility's native generators in addition to loads. Lastly, the accountability of transaction t to the total transmission ability charge is indomitable by:

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

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

### (b) MVA-Mile Method

MW mile method reactive power variations in the amenities instigated via the transmission require not measured. Reactive power flow can effect line losses and voltage magnitude when customer loading is heavy, reactive power flow can thrust bus voltages, top change transformer settings or circuit loading to their boundaries, or when oppositely oriented can carry 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 remain assigned proportional toward the charge in the line MW flows and line MVAR flows initiated via transmission operation and length of the line in miles. Dual power flows accomplished successfully, with the wheeling transaction T and without the wheeling transaction T, yield (**D**MVAf ) T the variations in MVA flows in all transmission line facilities. The transaction cost CT in $/hr for a transaction T is given by the following equation

$$C_{WT} = \frac{c * \Sigma_f \left( (\Delta MVA_f)_T * L_f \right)}{\Sigma_T \left( (\Sigma_f \Delta MVA_f)_T * L_f \right)}$$

Where,

$L_f$ = Transmission line length f.

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

$(\Delta\ MVA_f)_T$ = Change in power flow in facility flowing toward operation T owing to task T.

## VIII. OPTIMAL POWER FLOW

The ideal power flow is a very large and very challenging mathematical programming problem. Virtually every mathematical programming approach that can be realistic to this problem takes stood attempted and it has full developers many decades to cultivate computer codes that determination solve the OPF problem steadfastly. 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. Occasionally, classical optimization techniques were charity to well answer OPF. Then the additional newly due to assimilation of FACTS devices and deregulation of a power sector, the traditional ideas and observes of power systems are covered by cost-effective bazaar administration. So OPF have developed complex. In latest years, Artificial Intelligence (AI) techniques have been developed which can answer highly complex OPF problems.

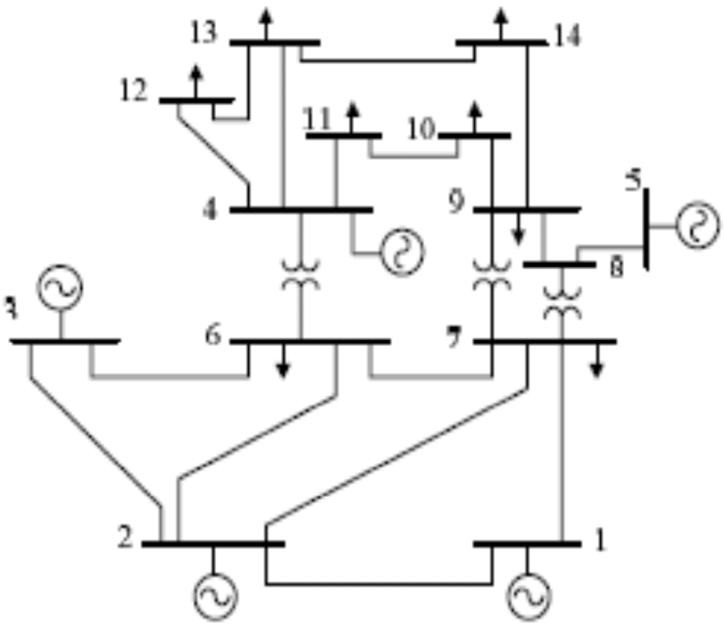


**Figure 3: IEEE-14 Bus System**

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

**Table 1**
**Optimal Power Flow Result**

| *Branch* | *From bus* | *To bus* | *From bus Power injection P(MW)* |
|---|---|---|---|
| 1 | 1 | 2 | 129.67 |
| 2 | 1 | 5 | 64.66 |
| 3 | 2 | 3 | 55.59 |
| 4 | 2 | 4 | 48.92 |
| 5 | 2 | 5 | 37.28 |
| 6 | 3 | 4 | -11.21 |
| 7 | 4 | 5 | -49.16 |
| 8 | 4 | 7 | 22.85 |
| 9 | 4 | 9 | 14.84 |
| 10 | 5 | 6 | 42.06 |
| 11 | 6 | 11 | 6.09 |
| 12 | 6 | 12 | 7.65 |
| 13 | 6 | 13 | 17.12 |
| 14 | 7 | 8 | -8.50 |
| 15 | 7 | 9 | 31.34 |
| 16 | 9 | 10 | 6.49 |
| 17 | 9 | 14 | 10.20 |
| 18 | 10 | 11 | -2.53 |
| 19 | 12 | 13 | 1.48 |
| 20 | 13 | 14 | 4.88 |

## IX. EXPERIMENTALRESULT

### (a) Bilateral Transactions

**Table 2**
**Wheeling Transactions**

| *Transactions* | *From Bus* | *To Bus* | *Magnitude Transaction* |
|---|---|---|---|
| 1 | 6 | 13 | 10mw |
| 2 | 7 | 9 | 15mw |

**Table 3**
**Wheeling Cost**

| *Line* | *Wheeling power* | *Line lengt-h $L_k$* | *Cost per miles $C_k$* | *Line cost* | *Wheeling cost* |
|---|---|---|---|---|---|
| 5-6 | -0.54 | 230 | 35 | 8050 | -2568 |
| 6-11 | -0.47 | 340 | 35 | 11900 | 3304 |
| 6-12 | 1.82 | 95 | 35 | 3325 | 3575.31 |
| 6-13 | 7.17 | 230 | 35 | 8050 | 3410.0 |
| 12-13 | 1.17 | 110 | 35 | 3850 | 2661.32 |
| 13-14 | -1.16 | 100 | 35 | 3500 | -2398 |

**Table 4**
**Multilateral Transactions**

| *Bus Power Injection* | *Bus Power Removal* | *Magnitute of Transactions* |
|---|---|---|
| 6,7,8,11 | 9,13,14,10 | 50 |

**Table 5**
**Wheeling Cost**

| *Line* | *Wheeling power* | *Line length$L_k$* | *Cost per mile* | *Line cost* | *Wheeling cost* |
|---|---|---|---|---|---|
| 4-7 | -5.6 | 200 | 35 | 7000 | -42199 |
| 4-9 | 2.96 | 300 | 35 | 10500 | 33458 |
| 5-6 | 1.52 | 230 | 35 | 8050 | 13172 |
| 6-11 | -2.54 | 340 | 35 | 11900 | -32539 |
| 6-12 | 2.84 | 95 | 35 | 3325 | 10165 |
| 6-13 | 11.22 | 230 | 35 | 8050 | 97233 |
| 7-8 | -16.41 | 220 | 35 | 7700 | -133974 |
| 7-9 | 25.8 | 150 | 35 | 5250 | 145815 |
| 9-10 | -2.51 | 200 | 35 | 7000 | -18914 |
| 9-14 | 6.28 | 220 | 35 | 7700 | 52056 |
| 10-11 | -7.51 | 130 | 35 | 4550 | -36785 |
| 12-13 | -2.8 | 110 | 35 | 3850 | -11604 |
| 13-14 | 3.86 | 100 | 35 | 3500 | 14543 |

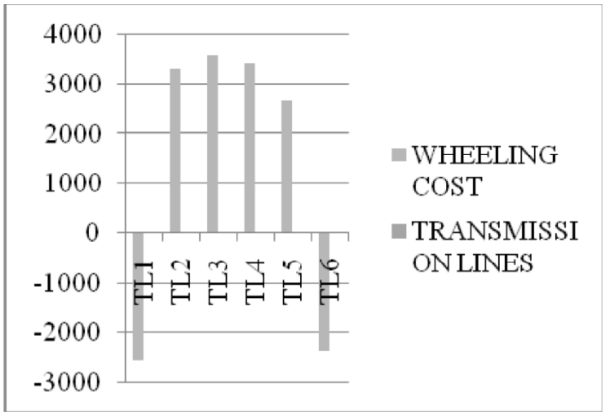


**Figure 4: Bilateral Transactions**

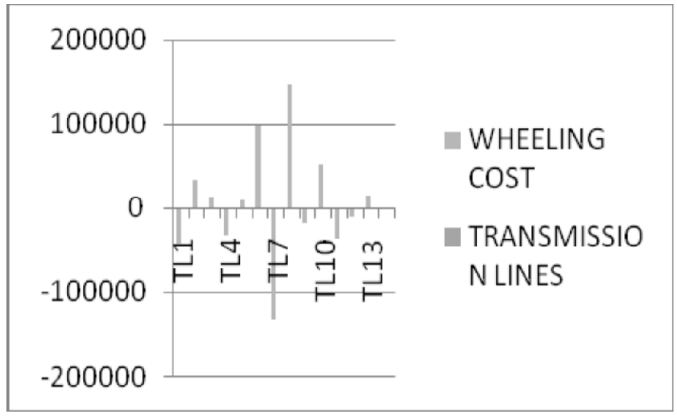


**Figure 5: Multilateral Transactions**

## CONCLUSION

The wheeling charges are calculated in IEEE14. Bus system using both MW-Mile & MVA - Mile methods under the open access transmission system. In MW – Mile method the real power transfer through the transmission line taken into account, But in MVA- Mile method both the real and reactive powers are considered. In future any one of the recent optimization technique is incorporated with this traditional OPF method.

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