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CALCULATIONS OF ELECTRICAL POWER COST IN RESTRUCTURED POWER SECTOR: A CASE STUDY

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ABSTRACT
This paper presents different methods for electrical cost of transmission and distribution to its customer through different transactions under restructured environment of Electrical power sector. There are different methods for calculate the cost on the basis of various criteria. In this paper explanation of different methods is given and tries to explain the best of them. There is IEEE 9 bus system is considered for the calculations. For the calculation of rate some transaction assumed on different buses and load is taken. This transaction is used in Megawatt. These transactions are bilateral and free from the direction of power flow direction, reactive and active power both are considered and power factor of the system included. Calculation of the flowing power at the different busses using load flow has been calculated. Load flow calculation provide power flow in transmission line and this power can use for the calculation of the cost of transmission power. After that we can calculate the price of electricity with different transaction on different values and without transaction. Auction system or mechanism is used in restructured electrical power sector for transparent and better than other way to calculate electricity cost.

KEYWORDS: Cost Calculation, Transactions, Restructuring, Bilateral Transaction, MATLAB coding, Power Sector Reform.

INTRODUCTION
The economic development and growth of a developing or developed nation depends on providing well grounded and low-cost power to the consumers. It is calculated that the per capita electricity consumption and demand should increase in India. Low per capita or individual consumption, insufficiency of energy management, larceny at retail end is a few of the problems infesting the electrical power industry. In the Restructure power sector 'correct' cost of electrical power transmission services is useful for providing economic signals in the field of efficient short-run operations, long-term capital investments, and recovery of costs and equitable allocation of costs among participants. In deregulated electrical power sector there are overall electrical power system is restructured in mainly three parts, theses are distribution, generation and transmission. Electricity cost is mainly depending on the electrical power transmission system and this is independent from generation and distribution mechanism. In deregulation conditions there are various methods for calculation of embedded cost [1].
Restructuring of the electrical power industry in the developing and industrialized countries uplift new independent power producers (IPPs) to involve into the power market. In the time period of 1996, independent power producers accounted for not more than 3% of the market for new power plant, compared with less than 5% from previous year, independent power producers (IPPs) were first established in the United States of America (USA) and the United Kingdom's (UK) following deregulation [2].

COMPONENTS OF RESTRUCTURED MARKET
In a developed restructured market main components are described below. They are the main part of the restructured Electrical Power Sector.[2]

- Independent Power Producers (IPPs) who generate electrical power for public use from different sources and also generate profit on equity
- Merchant generators who have no long term contracts they have limited time and can supply base load or peak load electrical power for the consumers
- Bilateral Transactions
- Bidding

- Vertically integrated facilities are used in the electrical power market
- Transco, Genco and Disco as Transmission, Generation and Distribution Corporations.
- Electrical Power marketers

COSTING IN A RESTRUCTURING MARKET

Restructuring and Deregulation of the electrical power industry in the mechanized and developing countries encourage new independent power producers (IPPs) to enter into the electrical power transmission and generation market. Here we take example of Nigeria. In 1996[2], independent power producers (IPPs) accounted for 3% of the market for new Electrical power plant, compared with less than 5% of last 10 years, independent power producers (IPPs) were first established in the united states of America (USA) and the united kingdom's (UK) following restructuring and deregulation. In India also now restructuring is in process like Odisha and Andhra Pradesh, Chhattisgarh are example. They have lain out to other countries that require personal finance and fund their fatten request for electrical power. In other countries like Nigeria before this time of transition to restructuring and deregulation, electricity cost per KW hour is currently between N4 and N6 for single phase resident or consumers and between N6 and N8 for industrial consumers. While maximum demand consumers paid between N8 and N12 KW/hr. Table 1 and 2 shows the comparison between regulated and deregulated electricity market [2].

Table 1. Electricity Costing in Regulated Market in Nigeria

User	Date	Regulated Market Per Killowatt hr (Ni)	Source
Single phase Resident	July 22, 2011	4 to 6	Naija Technology Guide July 22, 2011
Industrial		6 to 8	
Maximum Demand		8 to 12	

Table 2. Electricity Costing in Deregulated Market in Nigeria

User	Date	Deregulated Market Per Killowatt hr (Ni)	Source
Single phase Resident	July 22, 2013	2.58 + Subsidy	Naija Technology Guide July 22, 2013
Industrial		5.6 + Subsidy	
Maximum Demand		8.2 + Subsidy	

OVERVIEW OF COSTING METHODS

(4.1) **Mega Watt-mile method**: According to Mega Watt-mile method, electricity cost of electrical transmission system is allocated directly proportion to the change in the transmission line Mega Watt flows caused by the electrical transmission transaction and length of the transmission line in miles (1 mile= 1.6 KM). This is also called line-by-line method. This method is equitable among all the above methods.

(4.2) **Mega Volt Amp-mile method**: In all the above methods only active power flow considered, reactive power change or flow in the transmission lines caused by transaction is not considered. Mega Volt Ampere-mile method can take into consideration both active and reactive power loading of the electrical power transmission system caused by the various transaction and hence allocates costing of electrical transmission accordingly [12].

(4.3) **Mega Watt-cost Method**: According to shown Mega Watt-cost method, costing of transmission system are share out proportionally to the change in Mega Watt flows.

(4.4) **Mega Volt Amp-cost method**: It has been conceding that the use of electrical power transmission resources is best measured by monitoring both real or active and reactive power. This proposed MVA-cost method can take into consideration both active or real and reactive power.

CASE STUDY

Here we consider standard IEEE 30 Bus system.

Table 3: Different Transaction's and Buses

Deal or Transaction	Through Bus No.	To Bus No.	Value of Transaction		
			Mega Watt	Mega Volt Amp. Reactive	pf
T1	22	30	30.1	18.4	0.84
T2	27	10	10.1	5.30	0.82
T3	1	8	20.1	8.75	0.95

In addition to this, three different simultaneous bilateral transactions in Mega Watt and Mega Volt Ampere are as shown in above table. 3 and shown in fig.1 are added to this system and power factor of the system is assumed.

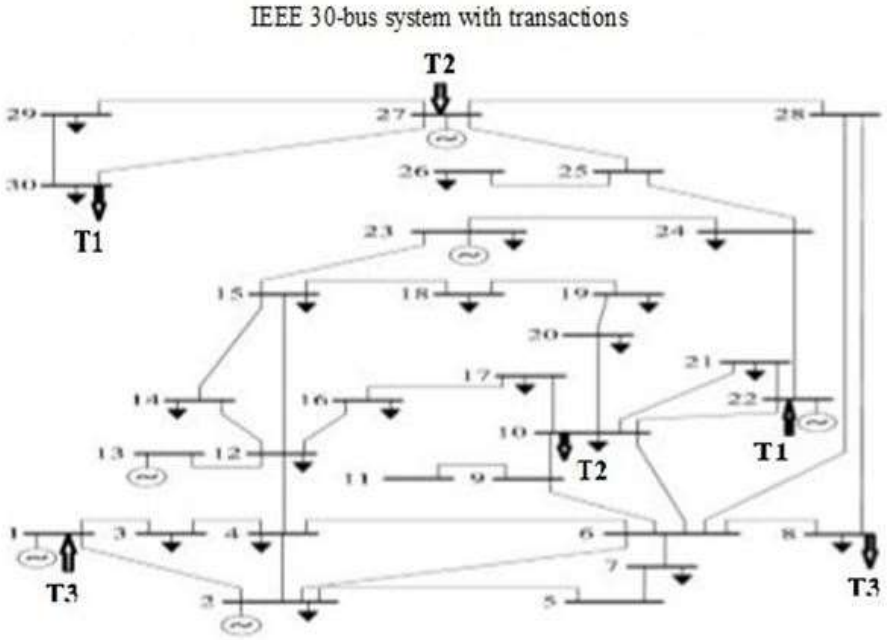

Fig 1

For the specified IEEE 30 Bus system and Annual Fixed Charge Rate (AFCR) is assumed 16% and the calculation is based on this data [7,11]. There are three different transactions T1, T2 and T3 are taken for the calculations. In this system we take 20 different retailers or load centers at different buses through a power pool. In addition to this, three simultaneous bilateral transactions as shown in table-4 and shown in fig-1 are added to this system. IEEE 30-bus Transaction detail provide in Table 4

Table 4: Analysis of electricity cost allocation by different methods

Transaction MW		MW-mile (Rs/hr)	MVA-mile (Rs/hr)	MW-cost (Rs/hr)	MVA-cost (Rs/hr)
T1	30.1	3959	5556	973	650
T2	10.1	543	1151	1223	138
T3	20.1	1834	1329	823	1206
Pool	190	989	1652	635	1667

EXPECTATION FROM RESTRUCTURING

There are several expectations from the power markets in a restructured environment like cost reduction in the overall consumption and quality improvement as well as better options. This includes real time price

calculation, flexibility of demand, signal for market clearing conditions, the demand is not responsive to cost in most of the markets because of the whole sales fluctuations are not passed on to the market[1,5]. Often the retail market has remained under regulation which has to do with slow implementation of real time costing. In the case of industrial and commercial consumer load, they face time-of-use costing or demand charges, in such a case, the time-of-use cost is expected to be high due to the fact that demand is high at particular time[14,17]. Weather-driven costing and demand should well in advance be prepared for in a restructured market due to the fact that the electricity transmission market is volatile and thus special attention should be required to the weather condition and season[2,11]. There are many factor which affect the production and distribution of the transmission of electrical power which require lot of attention in this field. We have to prepare and improve our system that can continuously provide their service.

CONCLUSION

The methods for calculating transmission system cost to simultaneous transaction and pool participant has been analyzed. The results of Mega Watt-cost and MVA-cost method have been compared with the best conventional methods with the help of IEEE 90 bus system. From the analysis it is very much clear that Mega Watt-cost and MVA-cost method is fairest among all the existing and conventional methods as it is able to overcome all drawbacks of existing methods. It can be easily, accurately and conveniently applied under all circumstances in a modern restructured power system. Smart -grid and Micro-grid is also can used for various transaction requirements. There is utilization of smart grid during peak load and fixed time demands [18,19].

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