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A Comparison of Fixed Cost Based Transmission Pricing Methods

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Abstract In the restructured power market, it is necessary to develop an appropriate pricing scheme that can provide the useful economic information to market participants, such as generation, transmission companies and customers. Proper pricing method is needed for transmission network to ensure reliability and secure operation of power system. Accurately estimating and allocating the transmission cost in the transmission pricing scheme still remains challenging task. This paper gives an overview of different costs incurred in transmission transaction, types of transmission transactions and the transmission pricing methodologies. Embedded as well as Incremental cost methods are explained. It mainly focussed on determining the embedded transmission cost by various methods and compared the results for 6bus, IEEE 14bus and RTS 24 bus systems.

Keywords Bialek Tracing, Embedded Cost, GGDF, MVA-Mile, MW-Mile, Postage Stamp, Tracing

1. Introduction

The rapidly changing business environment for electric power utilities all around the world has resulted in unbundling of services provided by these utilities. With the introduction of restructuring into the electric power industry, the price of electricity has become the focus of all activities in the power market. The objective of transmission pricing is to recover all or part of the existing and new cost of transmission system. Pricing of transmission services plays a crucial role in determining whether providing transmission crucial role in determining whether providing transmission services is economically beneficial to both the wheeling utility and the wheeling customers. Engineering analysis which deals mainly with determining the feasibility and the cost of providing transmission services is only one of many considerations in the overall process of pricing transmission services. So, it is important to distinguish between transmission costs and prices.

1.1. Categories of Transmission Transactions

The following are the categories[2,3] of transmission transactions:

1.1.1. Firm Transmission Transactions

These transactions are not subject to discretionary interruptions and are specified in terms of MW of transmission capacity that must be reserved for the transaction. The transco makes arrangements for enough capacity on the network to meet these transaction needs. These could either be on a long-term basis, in the order of years or on short-term contracts (up to one year).

1.1.2. Non-firm Transmission Transactions

These transactions may be curtailable or as-available. Curtailable transactions are ongoing transactions that may be curtailed at the utility's discretion. As-available transactions are short-term, mainly economy, transactions that take place when transmission capacity becomes available at specific areas of the system at specific times.

1.1.3. Long-term Transmission Transactions

A long-term transaction takes place over a period spanning several years. Long-term transmission transaction is long enough to allow building new transmission facilities. Transmission service provided as part of long –term firm power sales is an example of long-term transaction[3].

1.1.4. Short-term Transmission Transactions

A short-term transmission transaction may be as short as a few hours to as long as a year or two and as such are not generally associated with transmission reinforcements. Short term transaction may be a bilateral contract or pool trading[3].

1.2. Components of the Transmission Cost

The major components of the transmission cost of transmission transactions are:[17]

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1.2.1. Operating Cost

This is the cost due to generation rescheduling and redispatches to minimize the system losses, relieve congested transmission lines and enhance the system voltage profile.

1.2.2. Opportunity Cost

Benefits of all the transactions that the utility forgoes due to operating constraints. It is defined as costs that may be encountered in the transmission constrained case where the wheeling may prevent the transmission capacity. In other words it is the profit obtained to ISO during congestion in the system.

1.2.3. Reinforcement Cost

Capital cost of new transmission facilities needed to accommodate the transaction. It also includes the installation of additional reactive power resources to support the transaction.

1.2.4. Embedded Cost

The allocated cost of existing transmission facilities used by the transmission transaction. It includes:

Investment costs (including returns and depreciation of capital equipment) which is the highest proportion of the overall cost.

Administrative and general costs including scheduling and coordination services, billing and accounting staff, and salaries.

Investment for operation and maintenance costs.

Cost of voltage control and reactive power support.

Operating cost, opportunity cost and reinforcement cost constitute the incremental cost of the transmission transaction. Incremental costs are two types. They are short run and long run incremental costs. "Short-Run Incremental Cost" refer to operating cost and opportunity cost, "Long-Run Incremental Cost" refers to operating cost, opportunity cost and reinforcement cost. "Congestion Cost" is also called opportunity cost and "Embedded Cost" is also called existing system cost.

2. Transmission Pricing Methods

The main objective of any transmission pricing method is to recover the transmission system cost plus some profit. Transmission pricing methods are the overall processes of translating transmission costs into overall transmission charges. These methods are shown in Figure 1:

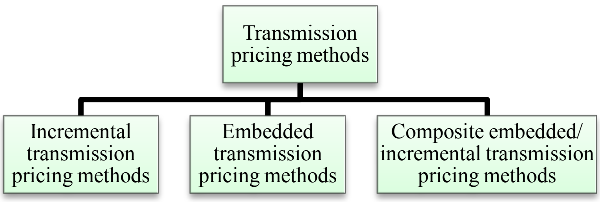

Figure 1. Different transmission pricing methods.

2.1. Incremental Transmission Pricing

These pricing methods allocate the incremental cost (i.e., variable cost) of the transmission transaction. Figure 2 shows different types of incremental pricing methods.

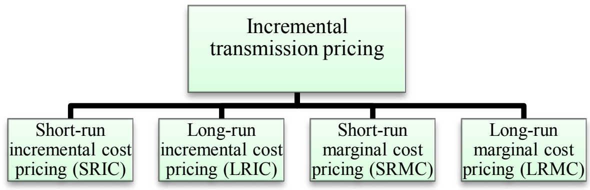

Figure 2. Types of incremental transmission pricing methods.

2.1.1. Short-run Incremental Cost Pricing (SRIC)

This pricing methodology entails evaluating and assigning the operating costs associated with a new transmission transaction to that transaction. The transmission transaction operating costs can be estimated using an optimal power flow (OPF) model that accounts for all operating constraints including transmission system (static or dynamic security) constraints and generation scheduling constraints.

2.1.2. Long-run Incremental Cost Pricing (LRIC)

This pricing methodology entails evaluating all long-run costs (operating and reinforcement costs) necessary to accommodate a transmission transaction and assigning such costs to that transaction. The reinforcement cost component of a transmission transaction can be evaluated based on the changes caused in long-tem transmission plans due to the transmission transaction.

2.1.3. Short- run Marginal Cost Pricing (SRMC)

The short-run marginal cost of a Transco is the cost of supplying an additional 1 MW of power in a transaction. SRMC is the difference in marginal costs of supply bus and delivery bus. The marginal costs of two buses can be determined from the optimal power flow solution as the dual variables associated with the demand balance equation. The transaction price can be determined by multiplying the power transaction with the SRMC to obtain SRMC based price.[4,5,6,7] SRMC takes into consideration the variable costs incurred by the transaction i.e., the operating cost but not the reinforcement cost.

$$\mathrm{SRMC}_t = \sum_{i \in B_t} BMC_i * P_{i,t} \quad (1)$$

where, BMC_i is the bus i marginal cost, $P_{i,t}$ is the injected power at bus i due to transaction t and B_t is the set of transmission buses involved in the transaction t. The bus marginal cost of power can be calculated using OPF sensitivity methods[12].

SRMC over the life of the transaction could be estimated using a detailed chronological production simulation model that incorporates all transmission constraints. SRMC prices for a transmission transaction can be negative.

Merits

Gives correct price signals to generators and loads for efficient location and operation.

Demerits

Recovers operating costs only.

Provides distorted cost messages in the presence of constraints.

Deters transmission investment.

Volatility of the price.

2.1.4. Long-run Marginal Cost Pricing (LRMC)

LRMC determines the present value of future investments required to support a marginal increase in demand at different locations in the system, based on peak scenarios of future demands and supply growth[8]. In this pricing methodology the marginal operating and reinforcement costs of the power system are used to determine the prices for a transmission transaction.

2.2. Embedded Transmission Pricing

These pricing methods allocate the embedded system costs i.e., fixed cost among transmission system users. Embedded pricing methods can be categorized as in Figure 3:

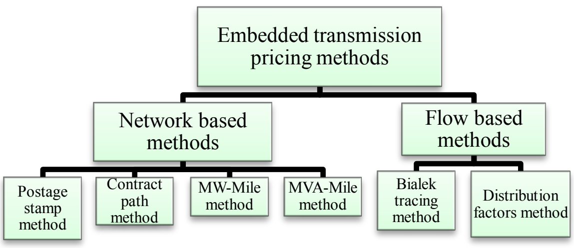

Figure 3. Types of embedded transmission pricing methods.

2.2.1. Network Based Methods

These methods depend on the structure of the transmission system but do not recognize the physical laws governing its operation[8].

a) Postage Stamp Method

Postage-stamp rate method is traditionally used by electric utilities to allocate the fixed transmission cost among the users of firm transmission service. This method is an embedded cost method, which is also called the rolled-in embedded method. This method does not require power flow calculations and is independent of the transmission distance and network configuration. The magnitude of the transacted power for a particular transmission transaction is usually measured at the time of system peak load condition:

$$R_{T=}TC*(P_t/P_{peak}) \quad (2)$$

Where R_t is the transmission price for transaction t, TC is the total transmission charges and P_t and P_{peak} are transaction t load and the entire system load at the time of system peak load condition[13]. The main purpose of using this methodology is the entire system is considered as a centrally operated integrated system. This method is simpler. Since this method ignores the actual system operation, it is likely to send incorrect economic signal to transmission customers.

b) Contract Path Method

In this method a specific path between the points of delivery and receipt is selected for a wheeling transaction. This path is called the "contract path" and is selected by the utility company and the wheeling customer usually without performing a power flow study to identify the transmission facilities that are actually involved in the transaction[13]. This method also ignores the actual system operation.

c) Distance Based MW-Mile Method

This method allocates the transmission charges based on the magnitude of transacted power and the geographical distance between the delivery point and the receipt point i.e., it is the product of power due to a transaction times the distance this power travels in the network[8]. This method is DC power flow based method.

$$TC_t = TC \times \frac{\sum_{k\in K} C_k L_k MW_{t,k}}{\sum_{t\in T}\sum_{k\in K} C_k L_k MW_{t,k}} \quad (3)$$

In (3)
- TC_t =cost allocated to transaction t
- TC =total cost of all lines in $
- Lk =length of line k in mile
- Ck =cost per MW per unit length of line k
- $MW_{t,k}$ =flow in line k, due to transaction t
- T =set of transactions
- K =set of lines

d) MVA-Mile Method

The MVA-Mile method is an extended version of the MW-Mile method. It takes into consideration both real power and reactive power where as MW-Mile method considers only real power. This method also allocates the transmission charges based on the magnitude of power and the geographical distance between the delivery point and the receipt point. This method is AC power flow based method.

2.2.2. Flow Based Methods

This approach allocates the charges of each transmission facility to a wheeling transaction based on the extent of use of that facility by the transaction. This is determined as a function of magnitude, the path, and the distance travelled by the transacted power. The flow based methods are Bialek tracing method and Distribution factors method.

a) Bialek Tracing Method

This algorithm works only on lossless flows when the flows at the beginning and end of each line are the same. The simplest way of obtaining lossless flows from the lossy ones is by assuming that a line flow is an average over the sending and receiving end flows and by adding half of the line loss to the power injections at each terminal node of the line[14].

The total flow P_i through node i (i.e., the sum of inflows or outflows) may be expressed, when looking at the inflows as[15]

$$P_{ij}^g = \frac{P_{ij}^g}{P_i^g}\sum_{k=1}^{n}[A_u^{-1}]_{ik} P_{Gk}\,;\, j \in \alpha_i^d \quad (4)$$

In (4)

$$P_i^g = \sum_{j\in\alpha_i^u} \left|P_{ij}^g\right| + P_{Gi}$$

$$[A_u]_{ij} \quad = \quad 1 \qquad i=j$$

$$= -\frac{|P_{ji}|}{P_j} \qquad j \in \alpha_i^u$$

$$= 0 \qquad \text{otherwise}$$

and

P_{ij}^g = an unknown gross line flow in line i-j

P_i^g = an unknown gross nodal power flow through node i

A_u = upstream distribution matrix

P_{Gk} = generation in node k

α_i^d = set of nodes supplied directly from node i

α_i^u = set of buses supplying directly to bus i

b) Distribution Factors Method

Distribution factors are calculated based on DC load flows. These factors are used to determine the impact of generation and load on transmission flows. The various distribution factors are Generation shift distribution factors (GSDF's) and Generalized Generation/ load distribution factors (GGDF's/GLDF's) have been used extensively in power system security analysis to approximate the transmission line flows and generation /load values. GSDF's or A factors provide line flow changes due to a change in generation. These factors can be used in determining maximum transaction flows for bounded generation and load injections. GGDF's are applied to estimate the contribution by each generator[15,16] to the line flow on the transmission grid and GLDF's determine the contribution of each load to line flows.

3. Results

Tables 1 to 8 present the cost of one MW generation for each generator using various pricing methods applied to 6 bus system, IEEE-14 bus system and RTS 24 bus systems. 6 bus system[19] has generators at bus numbers 1, 2, 3. In this paper line lengths are assumed to be proportional to the line reactance. For transformers line lengths are neglected and are taken as zero. Postage stamp method doesn't consider system line lengths, and hence gives a very inferior result compared to other methods. MW-Mile method uses DC power flow solution and accounts for line lengths. MVA-Mile method uses AC power flow and also accounts for the line lengths. GGDF method uses DC power flow and Power transfer Distribution factors for pricing and traces the actual power flow of each line by each participant. Bialek tracing method uses AC power flow algorithm and it also traces the actual power flow of each line by each participant. The results shows that, power flow tracing based methods present more accurate pricing compared to postage stamp method, MW-Mile method and MVA-Mile method. Tables 1, 2, 3, 4 illustrates cost per MW generation for each generator using various methods for 6 bus system Tables 5, 6, 7 illustrates cost per MW generation for each generator using various methods for IEEE-14 bus system[18] which has Generators at bus numbers 1, 2.Flow based Bialek tracing method is the best way of transmission pricing, which considers AC power flow and total line flows. Table 8 demonstrates the results obtained for RTS 24 bus system[20] containing 10 generators. In all the methods for all bus systems transmission charges are allocated to generators only.

Table 1. Postage Stamp Method Results for 6 Bus System

Line k	Line cost C_k ($)	Postage stamp method		
		G1	G2	G3
		$C_kMW_{1,k}$	$C_kMW_{2,k}$	$C_kMW_{3,k}$
1	10	97.05	97.05	97.05
2	10	145.647	145.647	145.647
3	10	118.766	118.766	118.766
4	10	9.9452	9.9452	9.9452
5	10	110.92	110.92	110.92
6	10	51.64	51.64	51.64
7	10	88.094	88.094	88.094
8	10	64.42	64.42	64.42
9	10	145.39	145.39	145.39
10	10	14.028	14.028	14.028
11	10	5.699	5.699	5.699
Total	110	851.5992	851.5992	851.5992
Loss cost ($)		84.46295		
Total cost of each generator ($)		879.75	879.75	879.75
Total cost ($)		2639.26		
Each transaction cost ($)		36.666	36.666	36.666
Cost ($/MW)		0.3381	0.7333	0.6111

Table 2. MW-Mile Method Results for 6 Bus System

Line k	Line cost C_kL_k($)	**MW-Mile method**		
		G1	G2	G3
		$C_kL_kMW_{1,k}$	$C_kL_kMW_{2,k}$	$C_kL_kMW_{3,k}$
1	5780	48799.306	48799.306	48799.306
2	2890	40043.035	40043.035	40043.035
3	4630	51091.240	51091.240	51091.240
4	2890	1785.7399	1785.7399	1785.7399
5	2890	31286.763	31286.763	31286.763
6	5780	31248.418	31248.418	31248.418
7	4050	33450.487	33450.487	33450.487
8	6940	39168.677	39168.677	39168.677
9	1160	17369.841	17369.841	17369.841
10	11560	15585.863	15585.863	15585.863
11	5780	577.7244	577.7244	577.7244
Total	54350	310407.1	310407.1	310407.1
Total cost ($)		931221.297755		
Each transaction cost ($)		18116.666	18116.666	18116.666
Cost ($/MW)		181.1667	362.3333	301.9444

Table 3. MVA-Mile Method Results for 6 Bus System.

Line k	Line cost C_kL_k($)	MVA-Mile method		
		G1	G2	G3
		$C_kL_kMW_{1,k}$	$C_kL_kMW_{2,k}$	$C_kL_kMW_{3,k}$
1	5780	62662.8052	62662.8052	62662.8052
2	2890	47445.2794	47445.2794	47445.2794
3	4630	59595.4346	59595.4346	59595.4346
4	2890	10631.3720	10631.3720	10631.3720
5	2890	57534.290	57534.290	57534.290
6	5780	46444.7241	46444.7241	46444.7241
7	4050	41204.1692	41204.1692	41204.1692
8	6940	76575.1978	76575.1978	76575.1978
9	1160	30106.1825	30106.1825	30106.1825
10	11560	18560.1565	18560.1565	18560.1565
11	5780	17827.2732	17827.2732	17827.2732
Total	54350	468586.885	468586.885	468586.885
Total cost ($)		1405760.655195		
Each transaction cost ($)		18116.666	18116.666	18116.666
Cost ($/MW)		167.0674	362.3333	301.9444

Table 4. GGDF Method and Bialek Tracing Method Results for 6 Bus System.

Line k	Line cost $C_k L_k$ ($)	GGDF method			Bialek Tracing method		
		G1	G2	G3	G1	G2	G3
		$C_kL_kMW_{1,k}$	$C_kL_kMW_{2,k}$	$C_kL_kMW_{3,k}$	$C_kL_kMW_{1,k}$	$C_kL_kMW_{2,k}$	$C_kL_kMW_{3,k}$
1	5780	200960.504	35530.054	19032.529	168052.644	0.0	0.0
2	2890	103219.682	6108.325	10801.098	126504.836	0.0	0.0
3	4630	136657.198	18674.924	2058.401	164786.76	0.0	0.0
4	2890	27007.031	21371.361	43021.173	3244.213	5579.07	0.0
5	2890	5478.859	47746.705	40634.726	35534.37	61108.42	0.0
6	5780	36626.461	47000.107	10118.685	33306.7059	57277.515	0.0
7	4050	69622.344	47810.813	17081.696	40071.716	68911.298	0.0
8	6940	11617.052	15767.633	113355.452	2359.01832	4056.8019	126087.205
9	1160	12781.947	5942.611	33384.964	907.872	1561.268	48524.9051
10	11560	49460.832	22753.456	25456.698	36607.791	13805.576	0.0
11	5780	29615.045	1510.971	26370.900	6068.986	1581.2868	2457.914
Total	54350	683046.962	270216.965	341316.327	617444.916	213881.248	177070.024
Total cost ($)		1294580.25535			1008396.1893		
Each transaction cost ($)		28676.169	11344.443	14329.387	33278.716	11527.65745	9543.6257
Cost ($/MW)		286.761	226.888	238.823	306.888	230.5531	159.06

Table 5. Postage Stamp Method Results for IEEE-14 Bus System.

Line k	Line cost C_k($)	Postage stamp method	
		$C_kMW_{1,k}$	$C_kMW_{2,k}$
1	10	784.4853	784.4853
2	10	377.4858	377.4858
3	10	366.3253	366.3253
4	10	280.5858	280.5858
5	10	207.5823	207.5823
6	10	118.1756	118.1756
7	10	308.2598	308.2598
8	10	140.3549	140.3549
9	10	80.3806	80.3806
10	10	220.4746	220.4746
11	10	36.7807	36.7807
12	10	38.9408	38.9408
13	10	88.7531	88.7531
14	10	0	0
15	10	140.3549	140.3549
16	10	26.1255	26.1255
17	10	47.11	47.11
18	10	19.0019	19.0019
19	10	8.0814	8.0814
20	10	28.2408	28.2408
Total	200	3317.499	3317.499
Loss cost ($)		133.942211	
Total cost of each generator ($)		3384.47	3384.47
Total cost ($)		6768.94016	
Each transaction cost ($)		100	100
Cost($/MW)		0.43	2.5

Table 6. MW-Mile and MVA-Mile Method Results for IEEE-14 Bus System.

Line k	Line cost C_kL_k($)	MW-Mile method		MVA-Mile method	
		$C_kL_kMW_{1,k}$	$C_kL_kMW_{2,k}$	$C_kL_kMW_{1,k}$	$C_kL_kMW_{2,k}$
1	59.17	4375.0468	4375.0468	4680.9	4680.9
2	223.04	7931.2383	7931.2383	8431.0044	8431.0044
3	197.97	6933.9228	6933.9228	7260.6853	7260.6853
4	176.32	4868.756	4868.756	4948.772	4948.772
5	173.88	3556.1915	3556.1915	3611.3018	3611.3018
6	171.03	2065.1668	2065.1668	2014.3851	2014.3851
7	42.11	1312.5645	1312.5645	1321.508	1321.508
8	0	0	0	0	0
9	0	0	0	0	0
10	0	0	0	0	0
11	198.9	627.0084	627.0084	815.321	815.321
12	255.81	965.0617	965.0617	1046.638	1046.638
13	130.27	1109.4895	1109.4895	1248.831	1248.831
14	0	0	0	0	0
15	0	0	0	0	0
16	84.5	261.7488	261.7488	282.21	282.21
17	270.38	1341.242	1341.242	1362.2593	1362.2593
18	192.07	269.355	269.355	397.638	397.638
19	199.88	144.4277	144.4277	178.554	178.554
20	348.02	866.3673	866.3673	1030.715	1030.715
Total	2723.35	36627.5879	36627.5879	38630.728925	38630.728925
Total cost ($)		73255.175833		77261.457849	
Each transaction cost ($)		1361.675	1361.675	1361.675	1361.675
Cost ($/MW)		6.2177	34.0419	5.8593	34.0419

Table 7. GGDF Method and Bialek Tracing Method Results for IEEE-14 Bus System.

Line k	Line cost C_kL_k ($)	**GGDF method**		**Bialek Tracing method**	
		$C_kL_kMW_{1,k}$	$C_kL_kMW_{2,k}$	$C_kL_kMW_{1,k}$	$C_kL_kMW_{2,k}$
1	59.17	9075.845	325.752	9306.547	0
2	223.04	14634.561	1227.914	16788.656	0
3	197.97	11543.006	2324.839	11817.217	3005.3024
4	176.32	7892.390	1845.121	8033.773	2043.113
5	173.88	5558.716	1553.666	5927.922	1507.563
6	171.03	3334.272	796.061	3629.637	567.394
7	42.11	2105.733	519.395	2440.359	193.466
8	0	0	0	0	0
9	0	0	0	0	0
10	0	0	0	0	0
11	198.9	1078.765	175.251	1564.289	124.013
12	255.81	1635.514	294.609	1982.86	157.196
13	130.27	1882.477	336.501	2292.032	181.707
14	0	0	0	0	0
15	0	0	0	0	0
16	84.5	434.823	88.674	345.759	54.049
17	270.38	2251.659	430.824	2137.757	334.18
18	192.07	437.725	100.984	852.085	67.551
19	199.88	246.963	41.892	359.889	28.531
20	348.02	1486.422	246.312	2149.112	170.376
Total	2723.35	63598.877	10307.8025	69627.899	8434.447
Total cost ($)		73906.67975		78062.34683831	
Each transaction cost ($)		2343.522	379.827	2429.098	294.251
Cost ($/MW)		10.701	9.4957	10.4452	7.3563

Table 8. Comparison of Various Methods for RTS 24 Bus System.

	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10
Postage stamp method Total cost= 60082.95										
Each transaction cost ($)	34	34	34	34	34	34	34	34	34	34
Cost ($/MW)	-0.126	0.177	0.113	0.057	0.158	0.219	0.085	0.085	0.113	0.0515
MW-MILE method Total cost= 277997.312276										
Each transaction cost ($)	212.34	212.34	212.34	212.34	212.34	212.34	212.34	212.34	212.34	212.34
Cost ($/MW)	-0.585	1.1059	0.7078	0.3593	0.9876	1.3699	0.5309	0.5309	0.7078	0.3217
MVA-MILE method Total cost= 271847.739937										
Each transaction cost ($)	212.34	212.34	212.34	212.34	212.34	212.34	212.34	212.34	212.34	212.34
Cost ($/MW)	-0.792	1.1059	0.7078	0.3593	0.9876	1.3699	0.5309	0.5309	0.7078	0.3217
GGDF method Total cost= 862526.4524										
Each transaction cost ($)	378.98	199.63	302.87	313.04	94.39	65.43	168.64	164.79	155.09	280.51
Cost ($/MW)	-1.044	1.0398	1.0096	0.5297	0.439	0.4221	0.4216	0.412	0.517	0.425
Bialek tracing method Total cost = 262640.92634										
Each transaction cost ($)	0	14.45	113.72	391.49	109.11	88.64	124.02	259.301	420.07	602.59
Cost ($/MW)	0	0.0753	0.3791	0.6624	0.5075	0.5719	0.3101	0.6483	1.4	0.913

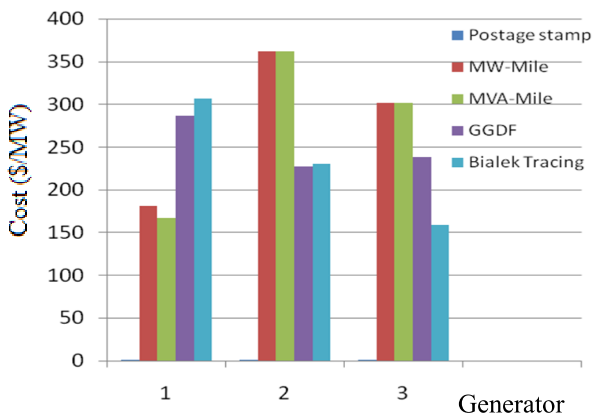

Figure 4. Comparison of 6 bus system results for different methods.

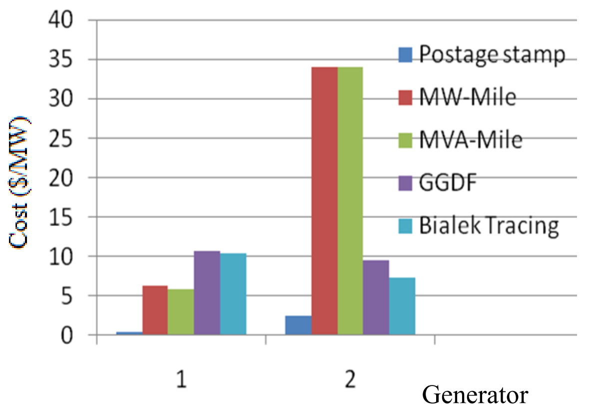

Figure 5. Comparison of 14 bus system results for different methods.

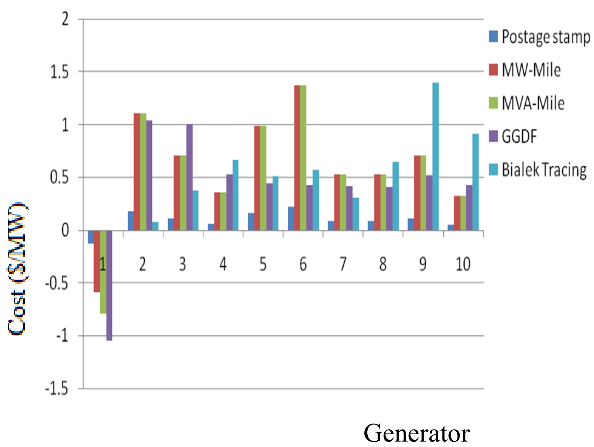

Figure 6. Comparison of 24 bus system results for different methods.

Figures 4, 5 and 6 show the cost per MW for 6 bus, 14 bus and 24 bus systems. Since postage stamp method values are near to zero, they are not visible in Figure 4. In Figure 6 at bus 1 i.e., at slack bus cost per MW is negative for all methods except for Bialek tracing method in which cost per MW is zero. Here slack bus generation is negative. Except Bialek remaining all methods calculates cost per MW for slack generator with negative generation as it is but only Bialek doesn't calculate any charges for slack generator because it has been treated by Bialek as a load bus. This is the one advantage in Bialek method.

4. Conclusions

In this paper embedded cost based methods of transmission pricing have been discussed. Different cost components incurred by the transmission transaction were explained. Case studies of postage stamp method, MW-Mile method, MVA-Mile method, Distribution factors method and Bialek tracing method for 6bus, IEEE14bus and RTS24 bus systems are presented. Postage stamp method for calculating embedded cost provides a very inferior solution compared to other network based and flow based methods. Bialek tracing method is the best way of transmission pricing, among all embedded cost based methods. It is observed that combination of incremental and embedded cost based methods could result in the recovery of true transmission system costs.

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