USAGE BASED POWER FLOW FOR TRANSMISSION LINE COST ESTIMATION IN BILATERAL POWER MARKET USING POWER FLOW TRACING PRINCIPLE

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Abstract:
The deregulation of electric power sector produces various issues in supplying the power to the transmission lines and loads. The transmission cost in the restructured power market exhibits several impacts on the transmission pricing. The loss in the transmission lines occur either due to power contributed by the generator or by the power shared by the load. Therefore, the transmission pricing calculations depend on both generator and load power flow. Many transmission pricing schemes are adopted to determine the transmission cost. This paper introduces a new method to calculate the transmission cost using usage based power flow. The power usage in the transmission lines is determined with the help of power flow tracing principle. The power flow tracing is achieved by maximizing the real power flow in generator bus. The optimization of real power is done by applying Particle Swarm Optimization (PSO) algorithm. This method of pricing is tested on IEEE 30 bus system and Indian Utility-69 bus system under bilateral power market.
Keywords: deregulated power system, power flow tracing, transmission pricing methods

1. Introduction

The cost allocation of transmission services in the deregulated electricity markets is a major issue for transmission open access. The cost of the basic transmission services corresponds primarily to the fixed transmission cost that is also referred to as the embedded transmission facility cost. The cost of the transmission network can be interpreted as the cost of operation, maintenance and planning of the transmission system. All the users of the transmission facilities (generators and loads) should pay for the network usage of the system following an efficient transmission pricing mechanism that is able to recover transmission costs and allocate them to transmission network users in a proper way. Due to the nonlinear nature of power flow equations, it is very difficult to decompose the network flows into components associated with individual customers. The power flow in a power system network is traced from the basic tracing methods such as node, common and graph methods [1].

The voltage and current tracing methods are applied to find the power contribution by generator and load extraction by the loads using proportional sharing principle [2]. The power flow on each branch of the network with multiple sources is determined from the power incidence degree between the source branches and a network is formed based on power supply path analysis [3].

The transmission line pricing is estimated from load distribution factor and the generator tracing is done optimally [4]. The transmission pricing using tracing principle, Distribution factors or Rudnick method, Bialek method and Minimum "power distance" method are applied and compared [5].The conventional MW-mile and MVA mile has been applied to determine the wheeling price by tracing the power flow using GA based on Generalized Generation Distribution Factor (GGDF) [6]. An analytical approach based on Transaction Impact Factor has been applied to find out the transaction cost in both bilateral and multilateral power markets [7]. The transmission pricing at contigency conditions using Line Outage Impact Factor (LOIF) Line Outage Loss Impact Factor (LOLIF) and Usage based transmission pricing with MW-mile method at contigency condition with application of PSO has been discussed [8]

The pricing comparison has been done on Wangensteen model and the original optimal power flow model in which the locational prices are equal to the Lagrange multipliers associated with the power flow equations have been proposed. Hogan's model and the modified optimal power flow model express the Locational prices as equal to the reference bus (node) price [9].

The transmission pricing is calculated from the traced power flow in which generator sequence is traced using breadth first search technique [10]. Based on marginal participation factor method with PSS/E Software, the transmission line cost is allotted and evaluated with MATLAB [11]. With the inclusion of power factor in the pricing calculation, the transmission pricing using MW-mile method has been executed [12-13]. A flow based method for transmission charging on Indian power sector has been proposed and the types of MW –mile methodologies are also discussed [14].

The paper is summarized as follows: Section 2 explain about the proposed methodology. Section 3 describes the power flow tracing methods. Section 4 defines the transmission pricing calculations. Section 5 shows the problem formulation. Section 6 demonstrates about implementation of PSO algorithm. Section 7 analyses the results and discussion. Section 8 verifies the sensitivity analysis of PSO. Section 9 concludes the paper.

2. Proposed Methodology

This paper introduces a new pricing method which makes use of usage based power flow for the calculation of transmission cost. The flow diagram of the proposed work is shown in Figure 1.

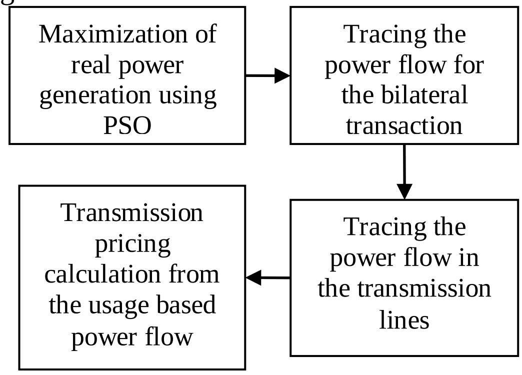

Fig 1 Flow diagram of the proposed work

The usage based power flow is traced by maximizing the real power generation at load buses. The power flow with optimal tracing process is done using Particle Swarm Optimization (PSO) algorithm. The real power generation is maximized by adding Independent Power Producer (IPP) at the load buses. The bus with maximized real power generation limit is identified for bilateral transaction. The generator tracing is concerned to proceed for transmission pricing calculations in this paper. The traced power flow from the transmission lines are utilized to determine the transmission pricing in the bilateral power market. The usage based power flow is taken for calculating the transmission cost of the bilateral power market. The various transmission pricing methods are tested IEEE 30 and Indian utility 69 bus test systems and results are compared.

3. Power Flow Tracing

The proposed transmission pricing is based on tracing the power flow through the transmission network in a bilateral power market downstream from generators to loads. The tracing requires a power flow solution and is obtained by running Newton Raphson method. The system nodes are divided into two different categories namely sending end node and receiving end node. Sending end node is a node, at which all the lines are incident to it and carries outflows to other nodes. Receiving end node is a node, at which all of its incident lines carry inflows towards it.

Optimal tracing approach is involved to trace the power flow without any Matrix inversion [15]. The proposed work aims at maximizing the real power generation at load buses. The power flow tracing results for IEEE 30 bus system is shown in Annexure B.

The detailed formulation of tracing is given as follows,

3.1 Generator Contribution

The contribution of power in transmission lines due to generation are given by Eqn. (1),

$$P_{Gi} = \frac{X_{km}}{X_T} * P_{km,Gi} \quad (1)$$

Where,

P_{Gi} - power flow extraction from the load Lj; Lj=1,2,…M

X_{km} – reactance between lines k and m

X_T - total reactance of the all connected transmission lines

$P_{km,Gi}$ - Power flow in the transmission line k-m due to the connected generators

3.2 Load Extraction

In load tracing problem, transmission line flows at the receiving end are specified. Similar to generation tracing formulation, load tracing with the nonzero entries of the modified bus incidence matrix are obtained. The extraction of power in transmission lines due to load is given by Eqn. (2),

$$P_{Lj} = \frac{X_{km}}{X_T} * P_{km,Lj} \quad (2)$$

Where,

P_{Lj}- Real power extraction from the load Lj

X_{km}– reactance between lines k and m

X_T - total reactance of the all connected transmission lines

$P_{km,Lj}$- Power flow in the transmission line k-m due to the Loads Lj

4. Transmission Pricing Calculation

One of the most challenging issues in the restructured market environment is the "fair" allocation of the transmission costs to the transmission network users. The corresponding pricing scheme reflects the actual usage of the transmission line network. The 'Proposed' method utilizes usage based power flow to determine the transmission line cost. By applying an optimization technique the power flow in the transmission network is traced. From the traced power flow, the costs in the transmission line are calculated. It uses downstream algorithm to determine transmission usage charges which are allocated from generators to transmission lines. Transmission pricing using MW-mile method is given as,

$$C_{Mw-Mile} = TCX \frac{\sum_{K\in k} C_k L_k MW_{t,k}}{\sum_{t\in T}\sum_{K\in k} C_k L_k MW_{t,k}} \quad (3)$$

The transmission line cost is estimated from Total Power flow (TPF) in all the transmission lines and Usage Power Flow (UPF) at a particular transmission line. The ratio between these two power flows are multiplied with Transaction Cost (TC) gives transmission cost (C_{tn}) of the Proposed method. The transmission cost using the proposed method is given as,

$$C_{proposed} = \frac{P_{i,j}}{P_T} * (cost/2) \quad (4)$$

Where,

P_{ij} – Usage Power Flow

P_T – Total Power Flow

cost – Transaction Cost

5. Problem Formulation

The transmission pricing in the deregulated power market is calculated from the traced power flow. The problem formulation for the optimization problem is written as,

Objective function

$$\textbf{F= Maximize (g)} \quad (5)$$

Where,

g- Real power generation adding IPP

The equation of real power generation and real power load are taken from generator contribution as given by Eqn. (1), load extraction as given by Eqn.(2) and the loss allocation from these tracing are also defined by Eqn.(3).

The above mentioned objective function has to satisfy the following constraints,

Equality constraints,

$$(P_{gi} + P_{g,IPP}) - P_{di} - \sum_{i=1}^{n} |V_i||V_j||Y_{ij}| \cos(\theta_{ij} + \delta_i - \delta_j) = 0 \quad (6)$$

$$Q_{gi} - Q_{di} - \sum_{i=1}^{n} |V_i||V_j||Y_{ij}| \sin(\theta_{ij} + \delta_i - \delta_j) = 0 \quad (7)$$

Inequality Constraints

i) Real Power Limits: $P_{gi}^{\min} \le P_{gi} \le P_{gi}^{\max}$ (8)

ii) Reactive Power Limits: $Q_{gi}^{\min} \le Q_{gi} \le Q_{gi}^{\max}$ (9)

iii) Bus Voltage Limits: $V_i^{\min} \le V_i \le V_i^{\max}$ (10)

iv) Line Flow Limits: $S_{ij} \ge S_{ij}^{\max}$ (11)

The equality constraints (6) satisfy the real power balance while adding real power generation using IPP at load buses and adding real power demand at load buses. The constraints (7) represent the reactive power balance at load buses. The inequality constraints (8) and (9) show the upper and lower limits of real and reactive power of generator. The voltage limit constraint (10) presents the upper and lower boundary limit of bus voltage magnitude. Constraint (11) ensures that the line loading should not exceed its maximum line flow limit so as to create congestion in transmission lines.

6. PSO Algorithm

The traditional PSO [16] model was described by Dr.Kennedy and Dr.Eberhart in 1995. It consists of a number of particles moving around in the search space, each representing a possible solution to a numerical problem. Each particle has a position vector X_i^k and a velocity vector V_i^k.

The power flow from the maximized real power generation to the transmission lines are attained using PSO technique. Here, the real power generation at load buses is maximized without exceeding the transmission line limits. This maximized power flow in the transmission lines is applied to estimate the transmission line cost. In this paper, Particle Swarm Optimization (PSO) has applied to trace the power from generator to transmission lines and from load to the transmission lines.

Step by step Procedure for maximizing the real power

Step1: Initialization: Base case power flow for the standard system has been run. Real power generation and real power load is taken as control variables. The population size and number of iterations have been chosen. Initial searching points and velocities are randomly selected.

Step 2: Evaluation of fitness function

The real power generation has been maximized by adding IPP at each load buses. From the objective function, fitness value is evaluated for each particle. The new position and velocities are calculated using the equations,

$$X_i^{k+1} = X_i^k + V_i^{k+1} \tag{12}$$

$$v_{k+1}^i = w_k v_k^i + c_1 r_1 (p_k^i - x_k^i) + c_2 r_2 (p_k^g - x_k^g) \tag{13}$$

Step 3: checking the convergence

If the optimum value of generation is reached, then the real power demand at each bus will be maximized. The maximization of load is attained without exceeding the line flow limits. In case, the line flow is within the limit, stop the iterations. Else, update the position and velocity of particles until the objective function is satisfied.

A detailed flowchart showing steps involved in applying PSO algorithm for power flow tracing problem using usage based power flow is shown in Fig 2. The convergence characteristics of PSO for maximizing real power generation at Indian Utility 69 bus system is shown in Fig 3.

Parameter selection in PSO algorithm:

The parameters selected for PSO algorithm are; Population size 60, epoch as 20, number of iteration as 500, Number of trails as 3, range of acceleration factor lies between 2 and 4 and the weighting factor for the particle varies from 0.8 to 0.9.

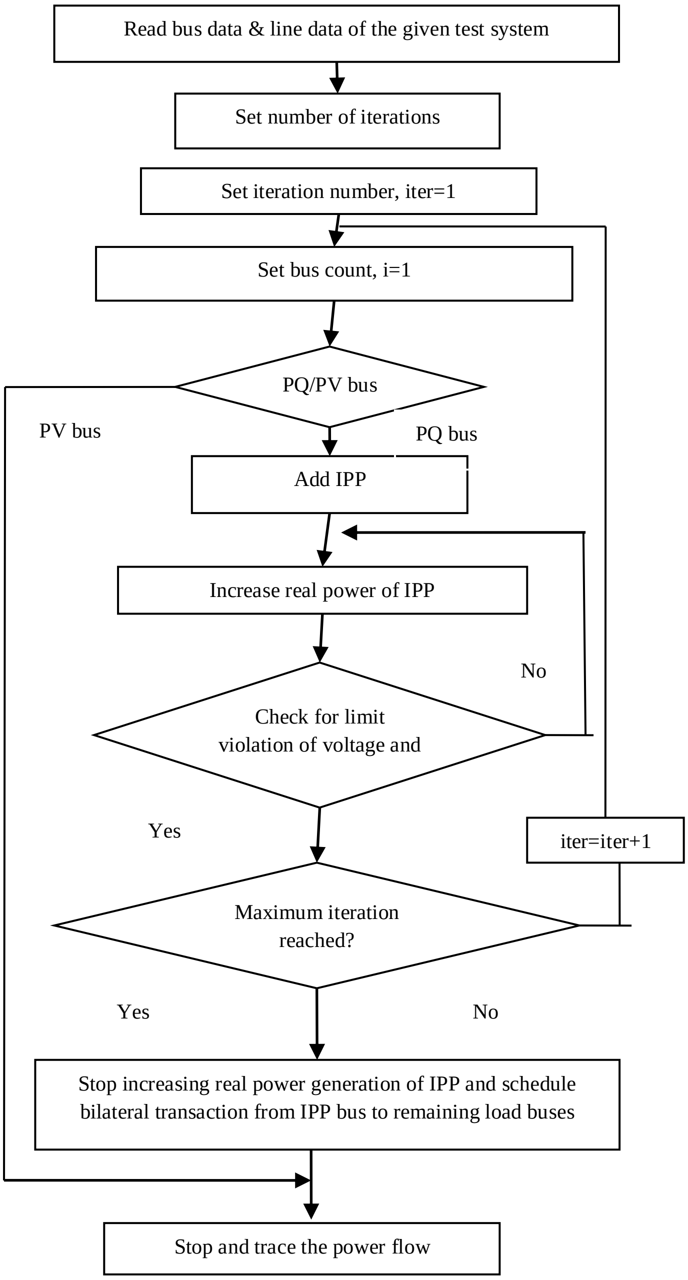

Fig 2 Flowchart for tracing of power flow using PSO

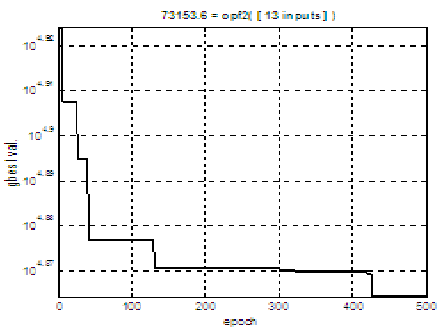

Fig 3 Convergence characteristics of PSO for Indian Utility 69 bus system

7. Results and Discussions

In this paper, power flow tracing based approach is applied to determine the transmission cost. Transmission cost is calculated from the power flow tracing results. IEEE 30 bus system has 6 generator buses, 24 load buses and 41 transmission lines. In this test system also, the IPP is added on one of the load buses for maximization of real power generation. Therefore, the test system has been modified with 7 generator buses and 23 load buses.

7.1 Bilateral transaction

The same modification has carried over for Indian Utility 69 bus system which has 27 generator buses, 52 load buses and 99 transmission lines. By the addition of IPP, the system has 28 generator bus and 52 load buses.
In all the test systems, the number of transmission lines remains unchanged. Transmission cost estimation using proposed method is tested on standard bench mark systems namely IEEE 30 bus system and Indian Utility 69 bus system. The bilateral transaction for the test systems are given in Table 1 .

Table 1 Bilateral Transaction for IEEE 30 Bus system

Transaction Number	T1	T2	T3	T5	T6
Transaction In Mw	↑ 157.02	↓ 70.3	↓ 54.7	↓ 122.4	↓ 85.7
Generated Power flow	194.33	36.72	28.74	0	0

Table 1 represents the transaction from between buses in IEEE 30 bus system, the maximum power generated bus is identified as bus number. Therefore, the transaction is carried over between bus 7 to any generator bus. Here, T1 is the transaction between bus 1 and bus 7. Likewise, T2 is between bus 2 and bus 7, T3 is between bus 5 and bus 7, T5 is between bus 5 and bus 7 and T6 is between bus 6 and bus 7.

Table 2 Bilateral Transaction for Indian Utility 69bus System

Transaction Number	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13
Transaction In Mw	0	↓1050	↑330	↑460	250	↑190	↑133	↑420	↑840	↑55	↑175	↑165	100
Generated Power flow	900	1100	350	500	250	200	150	450	850	60	200	200	100

Table 2 represents the transaction from between buses in Indian Utility 69bus System, the maximum power generated bus is identified as bus number. Therefore, the transaction is carried over between bus 7 to any generator bus. Here, T1 is the transaction between bus 1 and bus 7. Likewise, T2 is between bus 2 and bus 7, T3 is between bus 5 and bus 7, T5 is between bus 5 and bus 7 and T6 is between bus 6 and bus 7. The selection of bilateral contract is given in Appendix A.

7.2 Transmission pricing - IEEE 30 bus system

The tracing of power flow is obtained using PSO algorithm. The cost per MW of transaction is considered as 50$/MW. The transmission pricing results obtained for IEEE 30 bus system with Mw-mile method and proposed method is shown in Table 3.

Table 3 Transmission Pricing calculation for IEEE30 Bus test System

Connected Generators	***Power Flow***	$TC_{MW\text{-}mile}$	$TC_{proposed}$
G1	157.02	320.37	14.046
G2	70.3	143.43	6.289
G3	54.7	111.61	4.893
G6	122.4	249.73	10.949
G8	85.7	174.85	7.666
Total cost of transmission in ($/Mw)		***1000***	***50***

From Table 3, it is proved the proposed method gives the least value of 50$/MW for the transmission cost in bilateral transactions compared with Mw-mile method.

7.3 Transmission pricing for Indian Utility 69 bus test system:

The pricing method involved in this paper makes use of power flow tracing results. The comparison of transmission pricing for Indian Utility 69 bus system is shown in Table 2.

Table 3 Transmission Pricing calculation for Indian Utility 69 Bus test System

Connected Generators	***Power Flow***	***$TC_{MW\text{-}mile}$***	***$TC_{proposed}$***
G1	900	838.98	20.762
G13	1100	1025.42	19.821
G14	350	326.27	23.352
G15	500	466.1	22.645
G21	250	233.05	23.822
G31	200	186.44	24.508
G36	150	139.83	24.293
G39	450	419.49	22.881
G52	850	792.37	20.998
G53	60	55.93	24.717
G57	200	186.44	24.058
G58	200	1864.44	24.058
G60	100	93.22	24.529
Total cost of transmission ($/Mw)		***4950***	***300***

From Table 4, it is shown that the proposed method yields a transmission cost estimation of 300$/MW and MW-mile method gives a cost of 4950 $/Mw for Indian utility 69 bus system.

7.4 Comparison

The transmission pricing of the 'Proposed' method is compared with MW mile method.

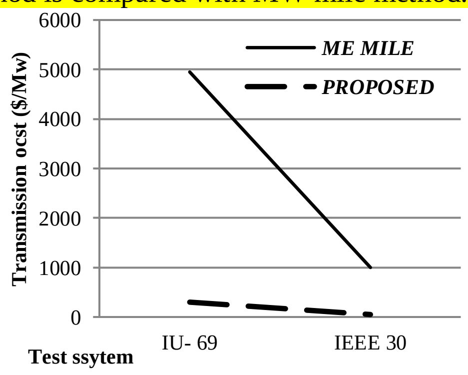

Figure 4 comparison of transmission pricing for IEEE 30 and Indian Utility 69 bus system

Figure 4 shows the comparison of transmission pricing of IEEE 30 bus system and Indian Utility(IU) 69 bus system using Mw-mile method and the proposed method.

It is therefore inferred that the proposed method significantly reduces the transmission pricing in bilateral market many folds compared with the MW-mile method. This has proven the suitability of the proposed method in transmission cost estimation.

8. Sensitivity Analysis of PSO algorithm in proposed method

The application of PSO algorithm for transmission pricing is validated through sensitivity analysis of the test systems studied. The sensitivity analysis indicates the consistency and efficacy of the algorithm in proposed work. For each test system the sensitivity of the algorithm is tested by varying number of iterations over a wide range from 20 to 500. The performance of PSO algorithm based on sensitivity analysis is shown in Table 5 for various test systems studied. It is inferred from Table 5, the results of best case and worst case conditions are much nearer. This proves the consistency of PSO algorithm and its suitability in applying for the proposed work.

Table 5 PSO Performance Evaluation

TEST SYSTEM / Parameter	IEEE 30 Bus System	Indian Utility 69 Bus System
No. of trials	500	500
Mean value	19775.37778	74636.43
Standard Deviation	10.50259171	26.38796
Best case	7.2278e+004	1.5225e+004
Worst case	8.0162e+004	3.6833e+004

9. Conclusion

This paper has presented a new method for transmission line cost estimation in bilateral deregulated power market. Owing to the non-linear and dynamic characteristics of power system network, the power flows in the transmission lines are highly varying. Hence, the estimation of transmission line cost based on this varying power flow is a challenging issue. This has initiated the application of usage based power flow to calculate the transmission line cost. The results of the proposed method compared with other methods for identified test systems IEEE 30 bus system and Indian Utility 69 bus system. From the comparative results, it is proved that the usage based power flow ('Proposed' method) gives lesser transmission cost for power transaction in contrast with other methods. Although, the transmission cost value is increasing when the order of bus increases, the percentage of reduction in transmission cost achieved for the proposed method is highly appreciable. This work has limited its scope for real power generation and load. However, based on the power flow tracing principle the reactive power generation and load can also be suitably addressed.

Nomenclature:

n - Number of buses

δ_i, δ_j - Bus voltage angle of i, j bus

θ_{ij} -Admittance angle

P_{gi}, Q_{gi} - Real & reactive power generation at i th bus

P_{di}, Q_{di} - Real & reactive power demand at i th bus

$P_{g,\,IPP}$ - Real power generation of IPP

$|V_i|$ - Voltage magnitude at ith bus

$|V_j|$ - Voltage magnitude at jth bus

$|Y_{ij}|$ -Admittance value between ith & jth bus

δi - Voltage angle at ith bus

δj - Voltage angle at ith bus

θ_{ij} - Admittance angle between ith & jth bus

$P_{gi}^{\min}, P_{gi}^{\max}$ - Minimum and maximum limits of real power at bus i

$Q_{gi}^{\min}, Q_{gi}^{\max}$ - Minimum and maximum limits of reactive power at bus i

$V_i^{\min}, V_i^{\max}$ - Minimum and maximum limits of voltage at bus i

S_{ij} - Line flow capacity in MVA

$S_{ij}^{\max}$ - Maximum Line capacity in line i-j

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Table A1 Bilateral Contract for IEEE 30 Bus System by Maximize IPP, Load

Bus No.	Maximization Of Real Power At Load Buses Using PSO	Bilateral Transaction between load buses	Maximization Of Real Power At Load Buses Using PSO
3	122	7-3	67.8
4	130	7-4	21.2
5	122.8	7-5	98.75
6	110	7-6	58.2
7	187.4	-	-
8	67.1	7-8	5.0
9	128.3	7-9	85.0
10	133.4	7-10	5.8
11	75.1	7-11	64.5
12	115	7-12	57.0
14	45.3	7-14	31.9
15	52	7-15	36.81
16	40	7-16	32.0
17	38.0	7-17	32.4
18	36.3	7-18	28.9
19	42.1	7-19	24.8
20	38	7-20	29.3
21	70.6	7-21	28.0
24	20	7-24	0.4
25	31.0	7-25	1.2
26	19.4	7-26	12.0
28	70.3	7-28	27.0
29	30.9	7-29	15.7
30	36.4	7-30	20.2

Table A2 Bilateral Contract for Indian Utility 69 Bus System by Maximize IPP, Load

Bus No.	Maximization Of Real Power At Load Buses Using PSO	Bilateral Transaction between load buses	Maximization Of Real Power At Load Buses Using PSO	Bus No.	Maximization Of Real Power At Load Buses Using PSO	Bilateral Transaction between load buses	Maximization Of Real Power At Load Buses Using PSO
2	196.3	7-2	42.0633	35	1.0	7-35	13.9975
3	37.5	7-3	118.553	37	1.0	7-37	15.4446
4	94	7-4	713.89	38	2.0	7-38	14.3739
5	128	7-5	258.889	40	8.3	7-40	12.1638
6	18	7-6	157.129	41	15.2	7-41	105.208
7	260.3	-	-	42	1.0	7-42	98.5895
8	51	7-8	38.6558	43	3.0	7-43	10.6631
9	63.5	7-9	35.0038	44	0.5	7-44	16.9345
10	74	7-10	256.93	45	0.2	7-45	13.0937
11	70	7-11	40.0786	46	1.0	7-46	13.2466
12	46	7-12	8.56164	47	1.0	7-47	12.3827
16	3.0	7-16	17.7606	48	13.0	7-48	9.96872
17	67.5	7-17	118.031	49	13.3	7-49	7.01039
18	55.5	7-18	39.8237	50	13.7	7-50	11.3441
19	20	7-19	91.6543	51	10.3	7-51	10.595
20	49	7-20	130.282	54	1.0	7-54	12.2779
22	32	7-22	107.17	55	6.2	7-55	11.3582
23	23	7-23	166.072	56	0.7	7-56	11.5188
24	52	7-25	303.145	59	5.3	7-59	158.864
25	1.0	7-25	134.407	61	10.8	7-61	10.1082
26	49.3	7-26	89.5762	62	18.7	7-62	9.81841
27	21.2	7-27	9.98827	63	5.3	7-63	9.35474
28	33.0	7-28	11.2232	64	3.3	7-64	228.978
29	10.3	7-29	11.2015	65	0.0	7-65	107.968
30	10.0	7-30	11.3686	66	2.5	7-66	502.115
32	1.0	7-32	11.6236	67	3.7	7-67	307.796
33	1.0	7-33	29.8997	68	4.1	7-68	86.0375
34	0.8	7-34	13.2315	69	3.8	7-69	12.5762

Appendix B Power flow tracing – IEEE 14 bus system

The power flow in transmission lines are traced using PSO in terms of generator tracing and load tracing. The occurrence of loss in the transmission lines has been found from the generator tracing and load tracing. The contribution of power flow from the generator to transmission line is known in generator tracing. The extraction of power from load to transmission lines is found in load tracing. The power flow in transmission lines due to the contribution of generator is given in Table B1. In IEEE 30 bus system; there are 6 generator buses and 24 load buses.

Table B1Power flow tracing in transmission lines for IEEE 30 bus test system

From	To	Base	3	4	5	6	7	8	9	10	11	12	14	15	16	17	18	19	20	21	24	25	26	28	29	30
1	2	21.04	20.84	8.45	7.21	2.55	-0.83	26.23	4.13	4.46	12.99	7.49	3.33	4.19	9.28	15.74	16.87	11.35	14.15	18.32	21.71	36.86	16.71	25.39	18.72	17.3
1	3	20.5	-[illegible]	-8.45	-7.21	-2.55	0.83	29.12	-4.13	-4.46	11.48	-7.49	1.58	2.42	8.32	14.12	14.16	6.3	11.26	17.95	21.66	14.3	14.14	27.1	17.48	15.34
2	4	18.63	-9.48	-15.4	-13.42	-5.59	0.12	28.96	-6.66	-8.38	9.5	-10.7	2.12	2.68	8.19	11.85	12.78	3.03	8.62	16.28	20.55	5.13	12.13	27.99	15.58	13.45
3	4	17.88	97.09	-0.92	-9.67	-4.98	-1.59	26.28	-6.56	-6.88	9.01	-10.1	-0.93	-0.06	5.81	11.6	11.65	3.86	8.78	15.38	19.02	11.79	11.64	24.27	14.92	12.82
2	5	14.36	5.8	3.85	4.29	-0.59	-18.42	18.28	-0.26	0.42	8.53	1.9	6.35	6.92	8.86	10.63	11.23	7.42	9.47	12.38	14.73	8.64	11.12	17.36	12.64	11.56
2	6	21.66	2.7	-1.63	-0.64	-11.5	-4.23	30.31	-10.85	-9.31	8.7	-5.98	3.64	4.93	9.32	13.42	14.6	6.28	10.83	17.27	22.42	8.95	14.41	28.1	17.82	15.4
4	6	17.58	54.44	61	56.24	-[illegible]	-21.52	12.9	-22.11	-6.2	-2.35	18.25	7.38	11.22	6.56	9.39	11.17	15.18	11.56	7.55	12.84	17.72	12.53	7.22	13.1	11.31
5	7	14.25	5.78	3.84	4.28	-0.6	-18.61	18.1	-0.26	0.42	8.49	1.95	6.27	6.85	8.81	10.57	11.16	7.39	9.42	12.3	14.61	8.6	11.05	17.17	12.55	11.49
6	7	8.7	17.17	19.13	18.68	23.61	-63.63	4.9	23.26	22.57	14.44	21.02	16.71	16.11	14.12	12.38	11.77	15.55	13.52	10.65	8.34	14.34	11.88	5.86	10.39	11.44
6	8	23.82	24.09	24.01	24.03	23.89	24.06	-24.4	24.14	24.12	23.35	22.67	20.59	22.14	22.27	24.14	22.63	24.13	24.14	24.19	24.06	23.45	22.56	17.08	22.26	21.69
6	9	7.27	12.43	12.79	10.65	10.28	11.37	29.73	-64.75	-37.13	-23.52	-[illegible]	-5.73	-6.89	-6.12	-6.4	0.52	-9.17	-7.36	-4.18	4.22	-3.01	1.45	27.56	5.81	4.3
6	10	4.15	7.11	7.31	6.09	5.88	6.5	16.99	-11.94	-21.22	-1.11	-8.04	-3.28	-3.94	-3.5	-3.66	0.3	-5.24	-4.2	-2.39	2.41	-1.72	0.83	15.75	3.32	2.46
9	11	0	0	0	0	0	0	0	0	0	-64.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	10	7.27	12.43	12.79	10.65	10.28	11.37	29.73	64.25	-37.13	40.88	-14.0	-5.73	-6.89	-6.12	-6.4	0.52	-9.17	-7.36	-4.18	4.22	-3.01	1.45	27.56	5.81	4.3
4	12	11.06	24.48	24.87	25.2	12.03	12.39	34.14	1.24	-16.71	13.16	-46.8	-14.0	-16.4	-0.23	6.32	5.53	-15.9	-1.86	16.3	18.82	-8.46	3.53	36.77	9.61	7.22
12	13	-16.2	0	0	0	-9.02	-10.27	0	0	-20.34	-3.39	0	0	0	0	-1.44	0	-27.1	-11.1	-0.56	-0.53	-40	-20.8	0	-15.7	-16.3
12	14	4.68	4.03	4.04	4.35	3.79	3.89	6.07	2.45	3.43	4.29	9.46	-21.5	-4.71	4.85	4.2	1.05	1.02	1.95	4.41	4.37	4.6	4.18	6.56	4.39	4.06
12	15	6.07	3.75	3.66	5.18	2.78	3.18	13.41	-2.49	1.11	4.24	26.12	-10.6	-29.6	8.09	4.2	-7.66	-9.04	-5.44	4.99	3.42	5.71	3.22	14.67	4.47	2.91
12	16	5.31	5.49	5.97	4.46	3.29	4.39	3.46	-9.92	-12.11	-3.17	19.84	7.01	6.8	-24.3	-11.88	0.95	8.01	1.57	-3.75	0.37	10.02	5.82	4.34	5.33	5.39
14	15	-1.55	-2.19	-2.18	-1.87	-2.43	-2.33	-0.18	-3.76	-2.79	-1.94	3.15	15.82	-10.9	-1.37	-2.02	-5.16	-5.2	-4.27	-1.82	-1.88	-1.63	-2.06	0.31	-1.84	-2.17
16	17	1.76	1.94	2.41	0.9	-0.26	0.84	-0.07	-13.61	-15.76	-6.73	15.98	3.47	3.25	15.88	-15.53	-2.55	4.44	-1.95	-7.38	-3.21	6.38	2.24	0.79	1.77	1.83
15	18	7.2	7.85	8.22	6.84	6.46	7.17	3.86	-2.08	-4.6	1.48	13.41	11.97	15.96	3.13	1.83	-15.6	-12.4	-12.3	1.02	4.36	10.83	8.27	4.7	7.63	8.01
18	19	3.93	4.56	4.92	3.55	3.18	3.89	0.64	-5.37	-7.83	-1.76	10	8.6	12.48	-0.1	-1.39	15.98	-15.7	-15.6	-2.27	1.11	7.47	4.98	1.43	4.34	4.72
19	20	-5.58	-4.96	-4.6	-5.97	-6.33	-5.63	-8.86	-14.92	-17.37	-11.27	0.43	-0.95	2.88	-9.61	-10.9	6.33	31.87	-25.3	-11.8	-8.4	-2.08	-4.54	-8.08	-5.18	-4.8
10	20	7.85	7.21	6.85	8.24	8.61	7.89	11.23	17.5	20.04	13.67	1.78	3.19	-0.65	11.96	13.3	-4.09	-28.6	-31	14.25	10.73	4.3	6.79	10.41	7.44	7.06
10	17	7.27	7.1	6.62	8.14	9.31	8.19	9.15	23	25.17	15.86	-6.73	5.57	5.81	-6.66	-31.57	11.62	4.58	10.99	16.59	12.32	2.68	6.8	8.24	7.27	7.21
10	21	-4.43	1.19	2.07	-1.88	-3.21	-0.98	14.43	5.25	22.9	4.34	-12.9	-13.3	-12.2	-11.5	3.06	-6.33	3.95	3.21	-31.5	-12.48	-9.49	-9.25	13.23	-5.61	-6.83
10	22	-5.06	-1.76	-1.24	-3.56	-4.35	-3.03	6.1	0.76	11.14	0.1	-10.0	-10.2	-9.58	-9.2	-0.65	-6.18	-0.13	-0.56	-11.7	-9.75	-8.02	-7.88	5.62	-5.75	-6.47
21	22	-21.97	-16.38	-15.5	-19.44	-20.7	-18.54	-3.24	-12.26	5.13	-13.25	-30.5	-30.9	-29.7	-29.0	-14.52	-23.8	-13.6	-14.3	21.16	-30.03	-27.03	-26.7	-4.35	-23.15	-24.3
15	23	-10.92	-14.52	-14.9	-11.75	-14.3	-14.55	0.95	-12.41	-5.31	-7.42	7.11	-15.7	8.47	-4.7	-7.85	-5.48	-10.2	-5.73	-6.07	-11.17	-14.99	-15.3	1.89	-13.25	-15.5
22	24	-4.46	-8.25	-9.05	-5.18	-5.48	-6.93	3.86	9.07	15.97	3.71	-1.17	-10.7	-5.27	4.86	4.93	-1.15	-7.26	0.13	9.29	-15.66	-12.4	-9.26	1.63	-5.89	-7.02
23	24	2.03	5.24	6.04	2.13	2.47	3.96	-2.51	-5.1	-6.68	-5.47	3.66	9.28	5.11	-7.28	-3.73	-1.48	14.16	3.14	-9.36	-14.56	6.31	2.59	-1.56	2.87	4.12
24	25	-11.18	-11.86	-11.8	-11.8	-11.8	-11.79	-7.38	-5.21	0.21	-10.55	-6.31	-10.4	-8.93	-11.4	-7.54	-11.3	-2.24	-5.5	-9.34	-6.13	-15.08	-15.5	-9.03	-11.8	-11.7
25	26	3.54	3.54	3.54	3.54	3.54	3.54	3.54	3.54	3.54	3.54	3.54	3.54	3.54	3.54	3.54	3.54	3.54	3.54	3.54	3.54	3.54	-15.2	3.54	3.54	3.55
25	27	-14.96	-15.66	-15.6	-15.68	-15.6	-15.58	-11.1	-9	-3.6	-14.2	-10.0	-14.2	-12.6	-15.2	-11.2	-15.1	-5.91	-9.18	-13.1	-9.9	10.94	-0.76	-12.8	-15.7	-15.6
28	27	-11.45	-10.15	-10.5	-10.44	-11.1	-10.32	24.65	-9.91	-10.04	-13.72	-17.0	-27.2	-19.5	-18.9	-9.9	-17.1	-9.98	-9.93	-9.71	-10.29	-13.26	-17.6	26.34	-19.06	-21.9
27	29	6.16	6.16	6.16	6.16	6.16	6.16	6.16	6.16	6.16	6.16	6.16	6.16	6.16	6.16	6.16	6.16	6.16	6.16	6.16	6.16	6.16	6.17	6.16	-15.39	-9.25
27	30	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.11	6.16	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.11	7.11	7.11	-1.54	-15.1
29	30	3.68	3.68	3.68	3.68	3.68	3.68	3.68	3.68	3.68	3.68	3.68	3.68	7.1	3.68	3.68	3.68	3.68	3.68	3.68	3.68	3.68	3.68	3.68	12.5	-11.8
8	28	-6.29	-6.02	-6.1	-6.08	-6.22	-6.05	9.49	-5.97	-5.99	-6.76	-7.43	-9.51	3.68	-7.83	-5.97	-7.47	-5.98	-5.97	-5.93	-6.05	-6.66	-7.55	-13.0	-7.85	-8.43
6	28	-5.05	-4.01	-4.31	-4.24	-4.77	-4.15	15.39	-3.82	-3.92	-6.86	-9.49	-17.5	-7.96	-11	-3.81	-9.62	-3.87	-3.83	-3.65	-4.12	-6.49	-9.94	-31.6	-11.1	-13.3