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Tracing Of Power Using Bialek's Tracing Method In A Deregulated Power System

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Abstract— *The transmission network plays a very important role in competitive electricity markets. In a Deregulated power system, the transmission network is the key mechanism for generators to compete in supplying large users and distribution companies. In a competitive environment, proper transmission pricing can meet revenue expectations, help and support efficient operation of electricity markets, encourage investment in optimal locations of generation and transmission lines, and adequately reimburse owners of transmission assets. In this view tracing the flow of electricity has gain significance as its solution helps in evaluating fair and transparent tariff. Electricity tracing methods would make it possible to charge the consumers and/or generators on the base of actual transmission capacity used. This paper focuses on electricity tracing using Bialek's tracing algorithm. Case study carried out using an IEEE 30-bus system & simulated using Power world Simulator.*

Keywords-*component; Deregulated power system, Bialek's power tracing method, Proportional sharing principle.*

1. INTRODUCTION

Worldwide power system operation in many power supply systems, has been changes due to the constant restructuring of the industry [1]. The changing of operation from regulated power system to re-regulation or deregulation is to increase competition and bring consumers economic benefits and new choices. In deregulated power system all the functions in power, i.e. generation, transmission, distribution and retail sales are different companies devoted to each function. For the consumers the electricity bill now involves at least two components: one from the distribution and transmission network- operator responsible for the network and services, and the other from the system that generates the electrical energy[2].

The regulated power industry is changed to deregulated power system which led to a important increase in power wheeling transactions. In market structure a transmission system uses multiple generation and load entities that do not enclose the transmission system [3]. In deregulated power system it is very important to know the function of individual generators and loads to transmission lines and power transfer between individual generators to loads[4,9]. Basically different power tracing methods are there but here we use Bialek's power tracing method. This tracing method helps to know the power transfer between individual generators to loads.

2. POWER TRACING METHOD

Tracing methods determine the contribution of transmission users to transmission usage. Tracing methods may be used for transmission pricing and recovering fixed transmission costs[3,9]. In this paper, we discuss the Bialek's tracing method. By using this power tracing method we can know role of individual generators and loads to transmission lines and power transfer between individual generators to loads. Tracing methods are generally based on the so-called proportional sharing principle.

2.1. *BIALEK'S TRACING METHOD*

In Bialek's tracing method, it is assumed that nodal inflows are shared proportionally among nodal outflows. This method uses a topological approach to determine the contribution of individual generators or loads to every line flow based on the calculation of topological distribution factors. This method can deal with both dc and ac power flows that is, it can be used to find contributions of both active and reactive power flows[5].

Bialek's tracing method is used to determine how much of a particular generators output supplies a particular load or how much of a particular load is supplied by a particular generator. Topological distribution factors calculated in this method are always positive, therefore this method would eliminate the counter flow problem. The main principle used to trace the power flow will be that of proportional sharing principle explained next. This method uses either the upstream looking algorithm or the downstream looking algorithm[3,9].

In the upstream looking algorithm, the transmission usage/supplement charge is allocated to individual generators and losses are apportioned to loads. In the downstream looking algorithm, the transmission usage/supplement charge is allocated to individual loads and losses are apportioned to generators.

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2.2. PROPORTIONAL SHARING PRINCIPLE

The proportional sharing principle is based on kirchhoff's current law and is topological in nature. It deals with a general transportation problem and assumes that the network node is a perfect mixer of incoming flows. Practically the only requirement for the input data is that Kirchhoff's current law must be satisfied for all the nodes in the network. In this respect the method is equally applicable to ac as well as dc power flow. Figure1 illustrates the basic principal to trace the flow of electricity where four lines are connected to bus i two with inflows and two without flows. The nodal sum i.e. total incoming or total outgoing power at node i is equal to 100 MW. According to proportional sharing principle,

The 30MW out flowing in line i-m consists of

$$\frac{30MW}{100MW} \times 20MW = 6MW$$

Supplied by line j-i, and

$$\frac{30MW}{100MW} \times 80MW = 24MW$$

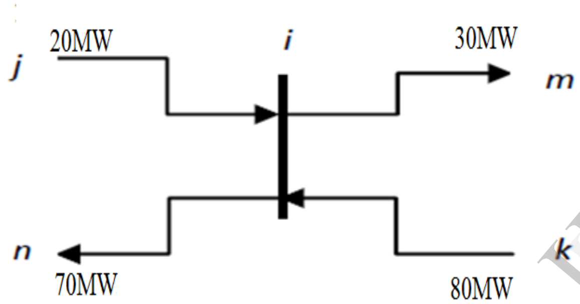


Fig: Proportional Sharing Principle

Supplied by line k-i. In the same way, the 70MW out flowing in line i-n consists of

$$\frac{70MW}{100MW} \times 20MW = 14MW$$

Supplied by j-i, and

$$\frac{70MW}{100MW} \times 80MW = 56MW$$

Supplied by line k-i.

Bialek's tracing algo is based on the proportional sharing principle with two tracing algorithms viz upstream and downstream looking algorithm the description of these methods are given in section below respectively.

2.2.1. TRACING OF POWER USING UPSTREAM LOOKING ALGORITHM:

The total flow , the inflow to the i^{th} bus, is the sum of all the inflows through the lines connected to the bus and the local bus injection.

$$P_i = \left(\sum_{j\in\Re} |P_{i-j}|\right) + P_{Gi} \quad \text{for i=1,2,……n} \qquad ….(1)$$

where $\Re$ is the set of nodes directly supplying node i, implying power flow towards i^{th} node. If the line losses are neglected, then $|Pj-i| = |Pi-j|$. Equation (1) can be further expanded to become:

$$P_i = \left(\sum_{j\in\Re} \left|\frac{P_{j-i}}{P_j} P_j\right|\right) + P_{Gi} \quad \text{for i=1,2,……n} \qquad ….(2)$$

By defining $Cji=(Pj-i)/ j$ to express relationship between line flow and the nodal flow at the Jth node, using proportional sharing principle $|Pj-i| = CjiPj$, substituting this in (2) yields:

$$P_i - \sum_{j\in\Re} C_{ji} P_j = P_{Gi} \text{ or } A_u P = P_G \qquad ….(3)$$

P is the vector of gross nodal flows; PG is the vector of nodal generations, while $Au$is called the Upstream matrix, which elements can be generalized as follow:

$$[A_u]_{ij} = \begin{cases} 1 & for\ i = j \\ -C_{ji} = -\frac{|P_{j-i}|}{P_j} & for\ j\varepsilon\Re \\ 0 & otherwise \end{cases} \qquad ...(4)$$

The i^{th} element of $p = A_u^{-1} P_G$ shows the participation of the k^{th}generation to the i^{th} nodal flow and determines the relative participation of the nodal generations in meeting a retailer's demand, given as:

$$P_i = \sum_{k=1}^{n} [A_u^{-1}]_{ik} \ P_{Gk} \quad \text{for i=1,2,……n} \qquad ….(5)$$

A line out flow in line *j-i* from node *i* can be therefore calculated using proportional sharing principle ,as

$$P_{j-i} = \frac{P_{j-i}}{P_i} \sum_{k=1}^{n} [A_u^{-1}]_{ik} \ P_{Gk} \quad \text{for i=1,2,……n} \qquad ….(6)$$

Finally, load demand at the i^{th} bus, applying the proportional methodology is given by:

$$P_{Li} = \frac{P_{Li}}{P_i} P_i$$

$$P_{Li} = \frac{P_{Li}}{P_i} \sum_{k=1}^{n} [A_u^{-1}]_{ik} \ P_{Gk} \quad \text{for i=1,2,……n} \qquad ….(7)$$

This equation shows the contribution of the i^{th} system generator to the k^{th} load demand and can be used to trace where the power of a particular load comes from.

2.2.2. TRACING ELECTRICITY USING DOWNSTREAM LOOKING ALGORITHM:

The total flow Pi, the outflow to the i^{th} bus, is the sum of all the outflows through the lines connected to the bus and the local bus load

$$P_i = \left(\sum_{l\in\mu} |P_{i-l}|\right) + P_{Li} \quad \text{for i=1,2,……n} \qquad ….(8)$$

where μ is the set of nodes directly supplied from node i, implying power flowing from the i^{th} node. If the line losses are neglected, then $|Pl{-}i| = |Pi{-}l|$ .Equation (8) can be further expanded into:

$$P_i = \left(\sum_{l\in\mu} \left|\frac{P_{l-i}}{P_l} P_l\right|\right) + P_{Li} \quad \text{for i=1,2,……n} \qquad ….(9)$$

Defining $cli = |Pl{-}i| / Pl$ expressing relationship between line flow and the nodal flow at the lth node and using proportional sharing principle, $|Pl{-}i| = cliPl$. Substituting this in (9) yields

$$P_i - \sum_{l\in\mu} C_{li} P_l = P_{Li} \quad \text{or} \quad A_d P = P_L \qquad ….(10)$$

P is the vector of net nodal powers; PL is the vector of nodal load demands, while Ad is called the Downstream matrix, which elements can be generalized as follow:

$$[A_d]_{il} = \begin{cases} 1 & for\ i = l \\ -C_{li} = -\frac{|P_{l-i}|}{P_l} & for\ l\epsilon\mu \\ 0 & otherwise \end{cases} \qquad ...(11)$$

The i^{th} element of $p = A_d^{-1} P_L$ shows the distribution of the i^{th} nodal power between all the loads in the system. In summation form,

$$P_i = \sum_{k=1}^{n} [A_d^{-1}]_{ik}\ P_{Lk} \quad \text{for i=1,2,……n} \qquad ….(12)$$

The inflow to node i from line i-l can be calculated using the proportional sharing principle as

$$P_{i-l} = \frac{P_{i-l}}{P_i} \sum_{k=1}^{n} [A_d^{-1}]_{ik}\ P_{Lk} \quad \text{for i=1,2,……n} \qquad ….(13)$$

this equation allows to determine how the line flows supply individual loads. The generation at a node is also an inflow and can be calculated using the proportional sharing principle as

$$P_{Gi} = \frac{P_{Gi}}{P_i} P_i$$

$$P_{Gi} = \frac{P_{Gi}}{P_i} \sum_{k=1}^{n} [A_d^{-1}]_{ik}\ P_{Lk} \quad \text{for i=1,2,……n} \qquad ….(14)$$

This equation again shows that the share of the output of the generator used to supply the load demand. The results obtained in case of equation (7) and equation (14) are same.

3. RESULTS AND DISCUSSION

IEEE 30-bus system is simulated using power world simulator which involve different transaction locations. This approach has been tested on IEEE 30-bus system using Matlab simulation program. IEEE 30-bus system power world simulator diagram shown in figure 1.

3.1. CONTRIBUTION OF GENERATORS TO LINE FLOW:

Table 1 depicts the contribution of generators to line flows, Pij, is the power flow in line i-j, PGi, is the contribution of generator Gi(connected to bus i) to the line flows. The graphical representation of table 1 is shown in figure 2. It can be seen that generator G5, G8, G11 and G13 contribute zero power to the transmission system. The contribution of generators to loads is shown in table 2 and the graphical representation is shown figure 3.Table 3 depicts the contribution of line flows to loads and the graphical representation is shown in figure 4. Again it can be seen that load L1 is free from transmission system use. This is due to fact that power is available locally for this load by generator G1 which can be seen in figure 4. Results are also verified in table 1,2 and 3 and a slight mismatch is there because of losses in the system. Proportional sharing of losses can also be done for more accurate results.

IEEE 30-bus system data is shown in tables also, line data for test system is shown in table 4, load flow results shown in table 5, power flow results with generator and load data record is shown in table 6, and the transformer data record and shunt capacitor data records are shown in table 7 and table 8.

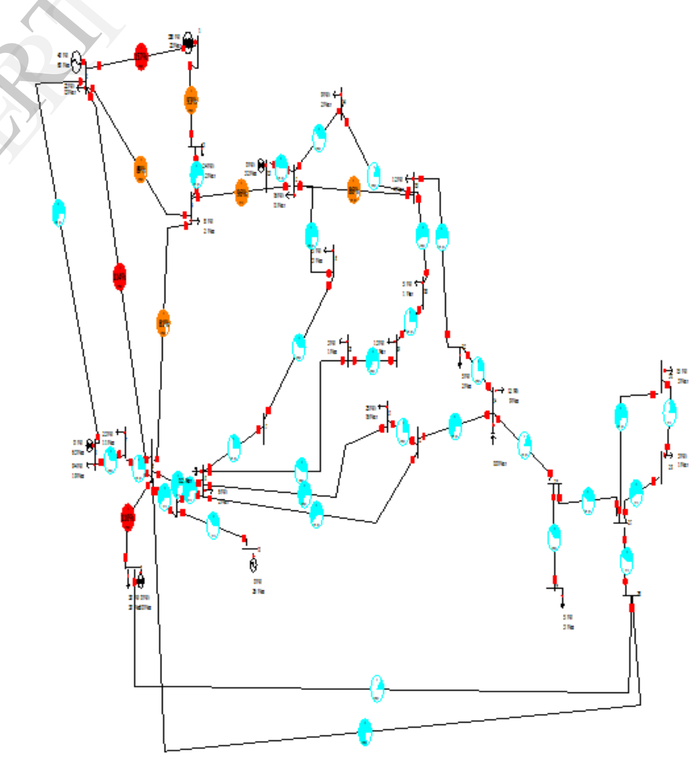
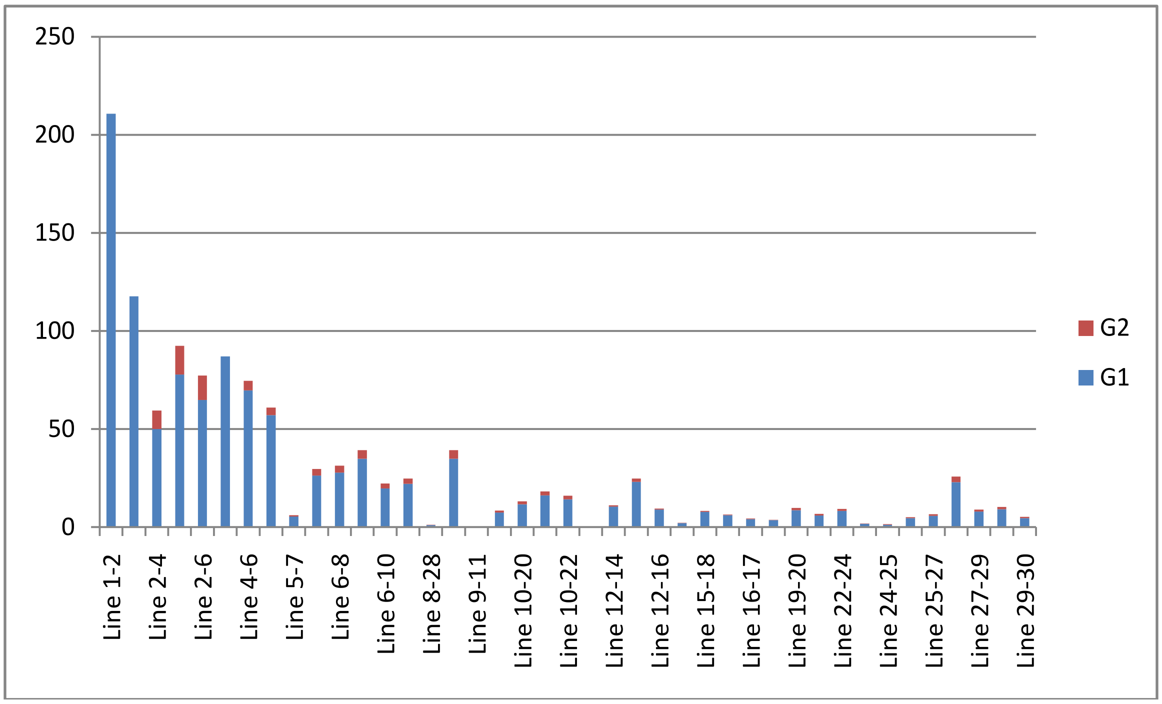


Figure 1: IEEE 30-bus system simulated in power world simulator

Table 1: Contribution of generators to line flows

From Number	To Number	P_{ij},trans	P_{G1},Line	P_{G2},Line	P_{G5},Line
2	1	-210.7	210.7	0	0
1	3	117.7	117.7	0	0
2	4	59.4	49.936	9.464	0
2	5	92.4	77.748	14.652	0
2	6	77.2	64.896	12.304	0
3	4	87.1	87.1	0	0
4	6	74.5	69.751	4.749	0
4	12	61	57.007	3.993	0
5	7	-6.1	5.4087	0.6913	0
6	7	29.6	26.256	3.344	0
6	8	31.3	27.737	3.563	0
6	9	39.2	34.793	4.407	0
6	10	22.2	19.658	2.542	0
6	28	24.8	22.082	2.718	0
8	28	1.1	0.9736	0.1264	0
9	10	39.2	34.793	4.407	0
9	11	0	0	0	0
10	17	8.4	7.449	0.951	0
10	20	13.1	11.6198	1.4802	0
10	21	18.2	16.139	2.061	0
10	22	16	14.212	1.788	0
12	13	0	0	0	0
12	14	11.1	10.375	0.725	0
12	15	24.7	23.09	1.61	0
12	16	9.5	8.893	0.607	0
14	15	2.2	2.05	0.15	0
15	18	8.3	7.757	0.543	0
15	23	6.4	5.983	0.417	0
16	17	4.4	4.117	0.283	0
18	19	3.7	3.459	0.24	0
19	20	-9.7	8.61	1.0897	0
21	22	-6.7	5.9548	0.7452	0
22	24	9.2	8.172	1.028	0
23	24	1.8	1.681	0.119	0
24	25	-1.5	1.244	0.256	0
25	26	5.1	4.544	0.556	0
25	27	-6.5	5.788	0.712	0
28	27	25.7	22.878	2.822	0
27	29	8.9	7.916	0.984	0
27	30	10.2	9.083	1.117	0
30	29	-5.2	4.6245	0.5756	0

Figure 2: Contribution of generators to line flows

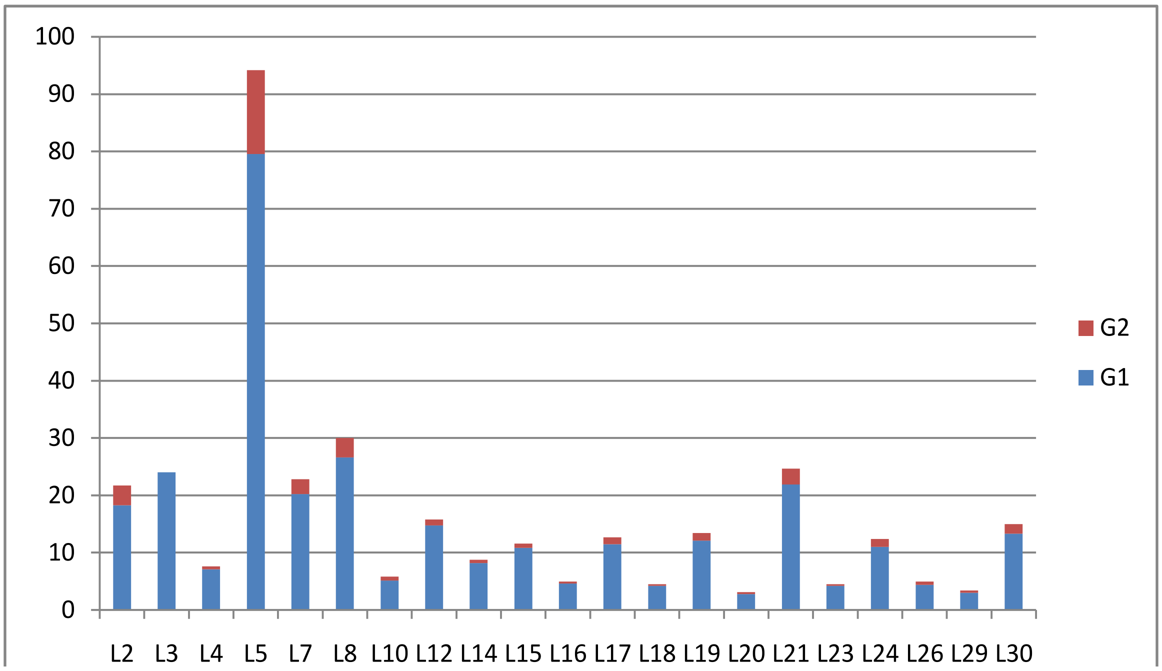


3.2. CONTRIBUTION OF GENERATORS TO LOAD:

Table 2: Contribution generators to loads

Name of Bus	Load MW	P_{G1},Load	P_{G2},Load	P_{G5},Load
2	21.7	18.237	3.46	0
3	24	24	0	0
4	7.6	7.109	0.491	0
5	94.2	79.527	14.673	0
7	22.8	20.224	2.576	0
8	30	26.585	3.415	0
10	5.8	5.1436	0.6564	0
12	15.79	14.756	1.034	0
14	8.74	8.169	0.571	0
15	11.56	10.804	0.756	0
16	4.94	4.624	0.316	0
17	12.69	11.467	1.223	0
18	4.51	4.215	0.295	0
19	13.39	12.069	1.329	0
20	3.1	2.7499	0.3503	0
21	24.67	21.8897	2.7803	0
23	4.51	4.216	0.294	0
24	12.27	10.981	1.389	0
26	4.94	4.401	0.539	0
29	3.38	3.006	0.374	0
30	14.95	13.307	1.643	0

Figure 3: Contribution of generators to loads

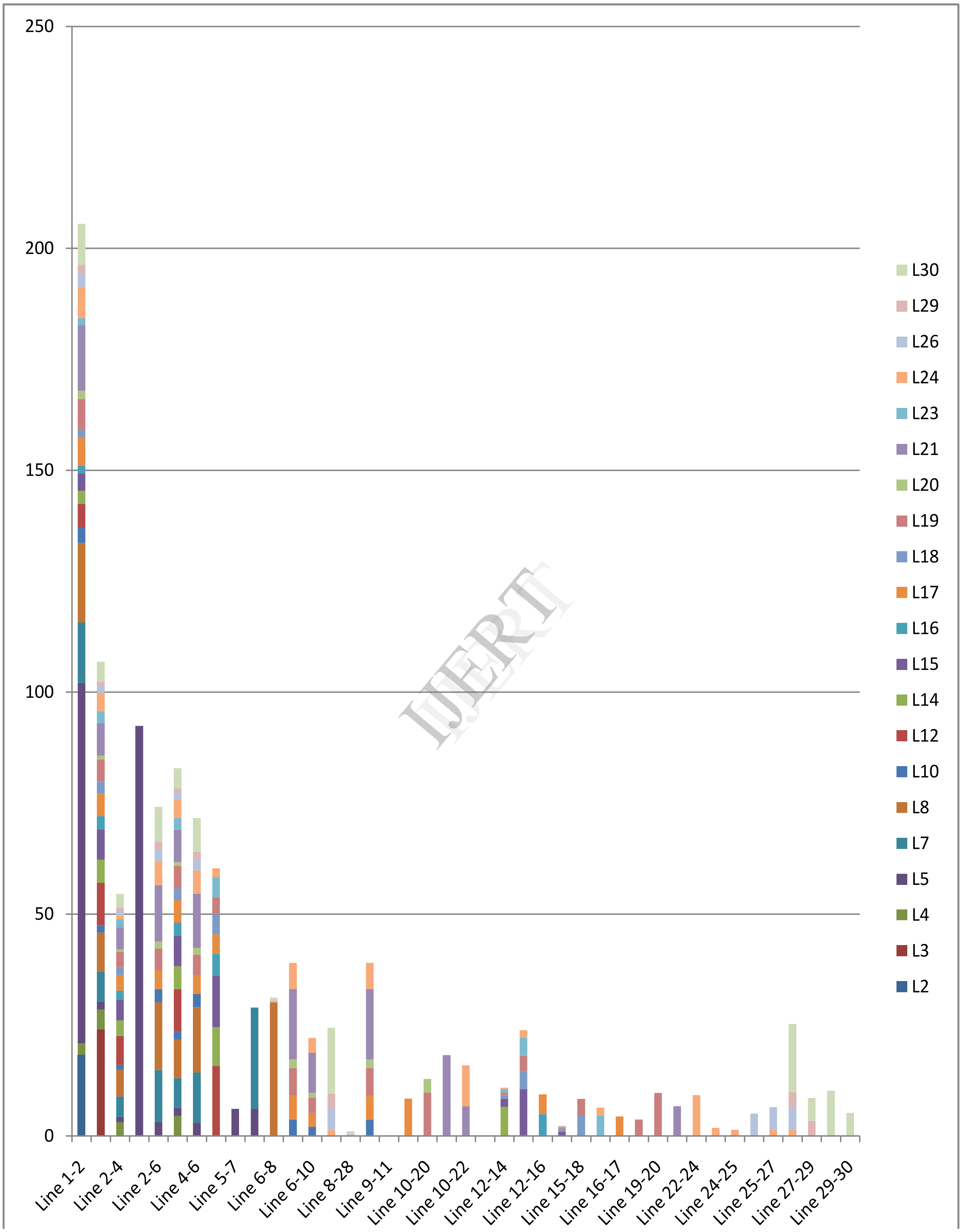


3.3. CONTRIBUTION OF LINE FLOWS TO LOAD:

Table 3: Contribution of line flows to loads

	L2	L3	L4	L5	L7	L8	L10	L12	L14	L15	L16	L17	L18	L19	L20	L21	L23	L24	L26	L29	L30
1-2	18.24	0	2.589	81.29	13.61	17.85	3.452	5.381	2.979	3.939	1.684	6.498	1.537	7.034	1.845	14.82	1.537	6.928	3.059	2.028	9.237
1-3	0	24	4.518	1.781	6.716	8.759	1.752	9.513	5.196	6.873	2.937	5.069	2.681	5.032	0.905	7.270	2.681	4.168	1.5	0.995	4.53
2-4	0	0	3.082	1.215	4.579	5.974	1.155	6.487	3.543	4.689	2.003	3.458	1.829	3.438	0.618	4.97	1.829	0.846	1.024	0.678	3.094
2-5	0	0	0	92.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2-6	0	0	0	3.104	11.71	15.27	2.952	0	0	0	0	4.275	0	4.937	1.578	12.67	0	5.4	2.616	1.734	7.898
3-4	0	0	4.518	1.781	6.716	8.759	1.752	9.513	5.196	6.873	2.937	5.069	2.681	5.032	0.905	7.270	2.681	4.168	1.5	0.995	4.53
4-6	0	0	0	2.996	11.29	14.73	2.947	0	0	0	0	4.125	0	4.764	1.522	12.23	0	5.211	2.524	1.673	7.622
4-12	0	0	0	0	0	0	0	15.8	8.75	11.56	4.94	4.4	4.56	3.75	0	0	4.57	1.98	0	0	0
5-7	0	0	0	6.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6-7	0	0	0	6.1	22.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6-8	0	0	0	0	0	30.1	0	0	0	0	0	0	0	0	0	0	0	0.059	0.218	0.145	0.659
6-9	0	0	0	0	0	0	3.703	0	0	0	0	5.363	0	6.193	1.979	15.89	0	5.873	0	0	0
6-10	0	0	0	0	0	0	2.097	0	0	0	0	3.037	0	3.507	1.121	9.003	0	3.326	0	0	0
6-28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.351	4.921	3.262	14.86
8-28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.059	0.218	0.145	0.659
9-10	0	0	0	0	0	0	3.703	0	0	0	0	5.363	0	6.193	1.979	15.89	0	5.874	0	0	0
9-11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10-17	0	0	0	0	0	0	0	0	0	0	0	8.4	0	0	0	0	0	0	0	0	0
10-20	0	0	0	0	0	0	0	0	0	0	0	0	0	9.75	3.12	0	0	0	0	0	0
10-21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18.2	0	0	0	0	0
10-22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6.7	0	9.2	0	0	0
12-13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12-14	0	0	0	0	0	0	0	0	6.54	1.87	0	0	0.81	0.605	0	0	0.806	0.25	0	0	0
12-15	0	0	0	0	0	0	0	0	0	10.57	0	0	4.101	3.397	0	0	4.101	1.652	0	0	0
12-16	0	0	0	0	0	0	0	0	0	0	4.95	4.4	0	0	0	0	0	0	0	0	0
14-15	0	0	0	0	0	0	0	0	0	0.981	0	0	0.409	0.303	0	0	0.409	0.147	0	0	0
15-18	0	0	0	0	0	0	0	0	0	0	0	0	4.57	3.8	0	0	0	0	0	0	0
15-23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4.57	1.8	0	0	0
16-17	0	0	0	0	0	0	0	0	0	0	0	4.4	0	0	0	0	0	0	0	0	0
18-19	0	0	0	0	0	0	0	0	0	0	0	0	0	3.7	0	0	0	0	0	0	0
19-20	0	0	0	0	0	0	0	0	0	0	0	0	0	9.7	0	0	0	0	0	0	0
21-22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6.7	0	0	0	0	0
22-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9.2	0	0	0
23-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.8	0	0	0
24-25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.4	0	0	0
25-26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5.06	0	0
25-27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.4	5.06	0	0
28-27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.4	5.06	3.38	15.4
27-29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3.38	5.2
27-30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10.2
29-30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5.2

Figure 4: Contribution of line flows to loads



4. BUS DATA AND LOAD FLOW RESULTS:

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Table 4: Line data for the test system

From Number	To Number	Status	Branch Device Type	Xfrmr	R	X	B	Lim A MVA
2	1	Closed	Line	NO	0.0192	0.0575	0.0264	130
1	3	Closed	Line	NO	0.0452	0.1652	0.0204	130
2	4	Closed	Line	NO	0.057	0.1737	0.0184	65
2	5	Closed	Line	NO	0.0472	0.1983	0.0209	130
2	6	Closed	Line	NO	0.0581	0.1763	0.0187	65
3	4	Closed	Line	NO	0.0132	0.0379	0.0042	130
4	6	Closed	Line	NO	0.0119	0.0414	0.0045	90
4	12	Closed	Transformer	YES	0	0.256	0	65
5	7	Closed	Line	NO	0.046	0.116	0.0102	70
6	7	Closed	Line	NO	0.0267	0.082	0.0085	130
6	8	Closed	Line	NO	0.012	0.042	0.0045	32
6	9	Closed	Transformer	YES	0	0.208	0	65
6	10	Closed	Transformer	YES	0	0.556	0	32
6	28	Closed	Line	NO	0.0169	0.0599	0.0065	32
8	28	Closed	Line	NO	0.0636	0.2	0.0214	32
9	10	Closed	Line	NO	0	0.11	0	65
9	11	Closed	Line	NO	0	0.208	0	65
10	17	Closed	Line	NO	0.0324	0.0845	0	32
10	20	Closed	Line	NO	0.0936	0.209	0	32
10	21	Closed	Line	NO	0.0348	0.0749	0	32
10	22	Closed	Line	NO	0.0727	0.1499	0	32
12	13	Closed	Line	NO	0	0.14	0	65
12	14	Closed	Line	NO	0.1231	0.2559	0	32
12	15	Closed	Line	NO	0.0662	0.1304	0	32
12	16	Closed	Line	NO	0.0945	0.1987	0	16
14	15	Closed	Line	NO	0.221	0.1997	0	16
15	18	Closed	Line	NO	0.1073	0.2185	0	16
15	23	Closed	Line	NO	0.1	0.202	0	16
16	17	Closed	Line	NO	0.0524	0.1923	0	16
18	19	Closed	Line	NO	0.0639	0.1292	0	16
19	20	Closed	Line	NO	0.034	0.068	0	16
21	22	Closed	Line	NO	0.0116	0.0236	0	32
22	24	Closed	Line	NO	0.115	0.179	0	16
23	24	Closed	Line	NO	0.132	0.27	0	16
24	25	Closed	Line	NO	0.1885	0.3292	0	16
25	26	Closed	Line	NO	0.2544	0.38	0	16
25	27	Closed	Line	NO	0.1093	0.2087	0	16
28	27	Closed	Transformer	YES	0	0.396	0	65
27	29	Closed	Line	NO	0.2198	0.4153	0	16
27	30	Closed	Line	NO	0.3202	0.6027	0	16
30	29	Closed	Line	NO	0.2399	0.4533	0	26

Table 5: Load flow results

From Number	To Number	MW From	Mvar From	MVA From	MW Loss	Mvar Loss
2	1	-210.7	28.5	212.6	9.3	25.28
1	3	117.7	25.4	120.4	6.57	22.14
2	4	59.4	12.7	60.8	2.26	5.27
2	5	92.4	-2.6	92.5	4.31	16.21
2	6	77.2	8.7	77.6	3.75	9.74
3	4	87.1	-8.7	87.5	1.19	3.07
4	6	74.5	-20.2	77.2	0.85	2.96
4	12	61	14.3	62.6	0	10.47
5	7	-6.1	24.7	25.4	0.35	-0.01
6	7	29.6	-13.5	32.5	0.33	0.32
6	8	31.3	-15.9	35.1	0.18	0.24
6	9	39.2	-3.7	39.4	0	3.7
6	10	22.2	4.2	22.6	0	3.19
6	28	24.8	4.8	25.2	0.13	-0.08
8	28	1.1	3.8	4	0.02	-1.72
9	10	39.2	17.1	42.8	0	2.25
9	11	0	-24.5	24.5	0	1.4
10	17	8.4	4.1	9.3	0.03	0.09
10	20	13.1	4.3	13.8	0.21	0.46
10	21	18.2	11.7	21.6	0.19	0.41
10	22	16	10.1	19	0.15	0.31
12	13	0	-30.2	30.2	0	1.4
12	14	11.1	4.1	11.8	0.19	0.39
12	15	24.7	12.2	27.5	0.55	1.08
12	16	9.5	7.1	11.8	0.14	0.3
14	15	2.2	1.5	2.6	0.02	0.02
15	18	8.3	3.5	9	0.1	0.21
15	23	6.4	5.6	8.5	0.08	0.17
16	17	4.4	4.2	6.1	0.02	0.08
18	19	3.7	2.1	4.2	0.01	0.03
19	20	-9.7	-2.8	10.1	0.04	0.09
21	22	-6.7	-4.5	8.1	0.01	0.02
22	24	9.2	5.2	10.6	0.15	0.24
23	24	1.8	3.1	3.6	0.02	0.04
24	25	-1.5	2.1	2.5	0.02	0.03
25	26	5.1	3.4	6.1	0.12	0.18
25	27	-6.5	-1.4	6.7	0.06	0.12
28	27	25.7	10.4	27.7	0	3.47
27	29	8.9	2.7	9.3	0.23	0.44
27	30	10.2	2.7	10.6	0.44	0.83
30	29	-5.2	-0.8	5.2	0.09	0.17

Table 6: Power flow results with generator and load data record

Number	PU Volt	Angle (Deg)	Load MW	Load Mvar	Gen MW	Gen Mvar	Act B Shunt Mvar
1	1.06	0			337.69	22.27	0
2	1.045	0	21.7	12.7	40	60	0
3	1	0	24	12			0
4	1.06	0	7.6	1.6			0
5	1.01	0	94.2	19	0	62.5	0
6	1	0					0
7	1	0	22.8	10.9			0
8	1.01	0	30	30	0	50	0
9	1	0					0
10	1	0	5.8	2			0
11	1.082	0			0	25.91	0
12	1	0	15.79	10.58			0
13	1.071	0			0	31.58	0
14	1	0	8.74	2.26			0
15	1	0	11.56	3.53			0
16	1	0	4.94	2.54			0
17	1	0	12.69	8.18			0
18	1	0	4.51	1.27			0
19	1	0	13.39	4.79			0
20	1	0	3.1	0.99			0
21	1	0	24.67	15.79			0
22	1	0					0
23	1	0	4.51	2.26			0
24	1	0	12.27	9.45			0
25	1	0					0
26	1	0	4.94	3.24			0
27	1	0					0
28	1	0					0
29	1	0	3.38	1.27			0
30	1	0	14.95	2.68			0

Table 7: Transformer data record

From Number	To Number	Type	Status	Tap Ratio
4	12	Fixed	Closed	0.932
6	9	Fixed	Closed	0.978
6	10	Fixed	Closed	0.969
28	27	Fixed	Closed	0.968

Table8: Shunt capacitor data

Bus number	Status	Control Mode	Regulates	Actual Mvar
10	Closed	Fixed	Volt	0.19
24	Closed	Fixed	Volt	0.04

CONCLUSION

In a deregulated power system generation, transmission, and distributions are separate companies. In this power system operation unbundling of the transmission services has occurs, this need to trace the flow of power i.e. it become more and more important to calculate the contributions of individual generators to individual line flows. In this paper, Bialek's power tracing method based on the Proportional Sharing principle is used for power tracing. In this paper both upstream and downstream looking algorithms were used to trace the power. By using upstream looking algorithm trace how much power transfer from particular generator to particular transmission line and from particular generator to particular load. By using downstream looking algorithm trace how much power transfer from particular generator to particular load and from particular transmission line to particular load and those were shown in results.

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