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Active Power Loss Allocation among Generators and Loads in an Interconnected Integrated Energy System

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ABSTRACT

In deregulation, often issues and challenges arise. The issue of power loss allocation is a common and an important one among them. The generators must compensate transmission loss by generating more power. In competitive electricity market environment, no suppliers would want to generate more to compensate this loss as it will increase their production costs. In general both generators and consumers are required to pay for the losses because they both use the network and thus are responsible for the losses occurred. If there is no specified method to handle this problem, maximum percentage of transmission losses is allocated to generator and less percentage of transmission losses to consumers. With this the fuel cost for the generation will increase which is unfair. The main intention of this paper is for fair loss allocation method to share losses only among generators by sharing losses in the each transmission line between corresponding buses and also methods to share losses between generators and consumers thus making both players cover up for the cost of losses in the competitive market

Keywords—Transmission loss, loss allocation, sensitivity factors, B-Coefficients.

I. INTRODUCTION

In a deregulated power system, transmission loss has to be allocated to individual suppliers, consumers, generators and contracts. Loss allocation does not affect generation levels or power flows, however it does modify the distribution of revenues and payments at the network buses among suppliers and consumers. In a deregulated power system, every supplier has to supply the power they want to sell plus the transmission loss corresponding to that transaction. Therefore, system operator has to allocate losses to every individual generation and load. Depending on the contract, a supplier may supply contracted load and the corresponding loss or supply the load and pay for the loss [7] [6].

In later case, the loss may be supplied by a contracted generator or ISO may buy the power to meet the loss from a spot market. Depending upon who will supply the loss, the allocation will vary to some extent. Electric power sellers/buyers submit bids to the pool for the amounts of power that they are willing to trade in the market. Sellers in a power market would compete for the right to supply energy to the grid, and not for specific customers. If a market participant bids too high, it may not be able to sell. On the other hand, buyers compete for buying power, and if their bids are too low, they may not be able to purchase [8]. In this market, low cost generators would essentially be rewarded. An ISO within a Pool Co would implement the economic dispatch and produce a single (spot) price for electricity, giving participants a clear signal for consumption and investment decisions.

In recent years, electricity systems were restructured in order to operate in competitive environment by introducing the market concepts. As a consequence of this paradigm change, several new problems and challenges have arisen [7]. One of these problems is the transmission loss allocation that consists in subdividing the cost of losses into fractions, to be distributed among the transmission system users or market participants (GENCOs, DISCOMs, marketers)[4].This allocation must be accurate and fair. The main difficulty to solve this problem is the losses are a non-linear function of power system state variables. Main significance of loss allocation is the pricing scheme should implement in fairway.

In this paper three different methods are compared to allocate losses among only generators. Among these three approaches, a new method of power flow tracing in power system has been proposed which allocates the transmission losses among generators. Losses in the each transmission line are equally distributed between corresponding buses from this the contribution of generators and loads in total system losses are obtained. The second method is as per the procedure given by J W. Bialek [1]. The third method uses sensitivity factors [2] [3].

In another section three more different approaches are proposed to obtain the losses among generators and loads. In two of the methods, loads are considered as negative generators, which does not change power flow and generation levels and in the third method loss allocation calculation is based on the convergence of the power system.

2. METHODS FOR LOSS ALLOCATION ONLY AMONG GENERATORS

In this section three methods are used and compared to obtain the share of the losses by the generators.

1. Proposed Method

In this method a transmission losses in the each transmission line are equally distributed between the two connecting buses and the shared loss forms a part of the load at that bus. The remaining network then assumed to be lossless. It is done for all transmission lines so the loads or consumers and generators are sharing total system losses proportionally.

The test system having 5buses, 2 generators, 4 loads and 7 transmission lines is shown in Fig. 1.

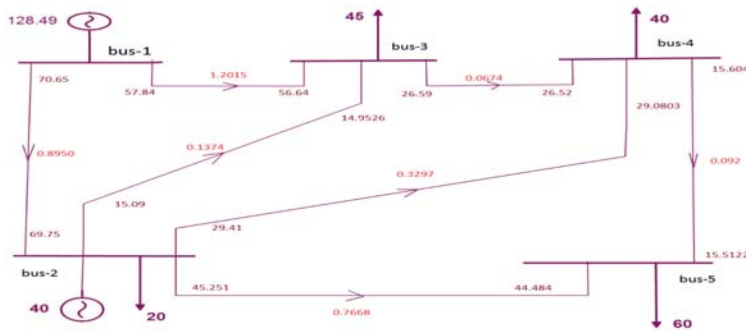

Fig .1. AC power flow in 5 Bus System

The algorithm in this method works only on lossless lines and so flows at the beginning and end of each line should be same. The simplest way of obtaining lossless flows from the lines with losses is by assuming that a line flow is an average of the sending-end and receiving-end flows. Then add half of the line loss to the power injections at each terminal node of that line. So the considered test system Fig.1 with shared losses at each bus will become as the test system shown in Fig.2.

The losses are computed using downstream-looking algorithm [1].

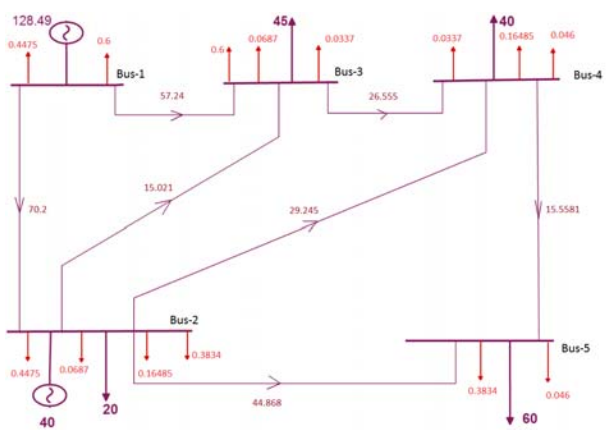

Fig . 2. Line losses allocating on buses (Lossless system)

In this method losses are allocated to individual buses. Losses at each bus are considered as load. Therefore loads at each bus is P_{L1}=0.447 + 0.6=1.0475MW.

P_{L2}=20+0.4475+0.0687+0.16485+0.3834=21.0644MW.

Based on the principal of proportional sharing the following equations can be obtained for down-streaming algorithm [1].

$$A_d\ P = P_L \tag{1}$$

$$A_d^{-1} = \begin{bmatrix} 1 & 0.6370 & 0.9246 & 0.7738 & 0.6722 \\ 0 & 1 & 0.2079 & 0.6230 & 0.9029 \\ 0 & 0 & 1 & 0.4759 & 0.1225 \\ 0 & 0 & 0 & 1 & 0.2575 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

Distribution of Generator 1(P_{G1} =128.49MW) power to the load 1(P_{L1}) where the load is actual load and additional loss at that bus = A_{11}^{-1}* (PG_1/P_1)*L1= 1*(128.49/128.49) *1.047=1.047MW. Similarly distribution of Generator2 (P_{G2} =40MW)capacity to the load2(P_{L2}) is= A_{22}* (PG_2/P_2) * L2= 1*(40/110.198)*21.0644=7.646MW.

TABLE 1 . Distribution of power to the load in proposed method

	G1(MW)	**G2(MW)**	**Total(MW)**
L1	1.047	0	1.047
L2	13.418	7.646	21.064
L3	42.256	3.4488	45.704
L4	31.1416	9.10094	40.2425
	40.6213	19.80529	60.4266
Total Power	**128.484**	**40**	**168.484**

Contribution of generators to the losses is obtained as follows, Generator 1contribution to losses of bus2 is (1.0644/21.064)*13.418=0.678034MW. Generator2 contribution on bus 2 is (1.0644/21.064)*7.646 = 0.38636MW. Similarly G1 and G2 Contribution on losses of other buses are

TABLE 2 . Contribution of generators in the losses in proposed method

	G1(MW)	**G2(MW)**
Bus1	1.047	0
Bus2	0.678034	0.38636
Bus3	0.64944	0.053006
Bus4	0.18997	0.0554
Bus5	0.289331	0.1410
Total loss	**2.8538MW**	**0.63576MW**

Therefore transmission loss allocation among both generators G1and G2 is 2.8538MW and 0.63576MW respectively. Total losses are 2.8538+0.63576=3.489MW. Which is equal to the loss obtained from Ac load flow analysis (P_{Loss} =3.489MW).

2. *Tracing of Electricity using Net Flows*

This is the method mentioned by JW. Bialek[1]. This version of the method traces the flow of electricity in the network when transmission losses are completely removed from the line flows. This will required modifying n^{th} nodal generations while leaving the nodal demands unchanged. For example the real power flow shown in Fig. 1.

According to downstream-looking algorithm [1]

$$A_d P_{net} = P_L \quad (2)$$

$$P_{net} = \begin{bmatrix} 1 & 0.6355 & 0.9239 & 0.7730 & 0.6710 \\ 0 & 1 & 0.2089 & 0.6226 & 0.9024 \\ 0 & 0 & 1 & 0.4769 & 0.1233 \\ 0 & 0 & 0 & 1 & 0.25854 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0 \\ 20 \\ 45 \\ 40 \\ 60 \end{bmatrix}$$

Therefore Net generation of each bus is [1]

PG_{1_net} = (128.49/128.49)*125.4715=125.4715MW

PG_{2_net} = (40 /109.751) * 108.444 = 39.5236MW

According to[1],

Contribution of Generator 1(P_{G1} =125.4715MW) power to the load 2(P_{L2}) where the load at that bus is

A_{12}^{-1}*(PG_{1_net}/P_{1_net})*L2=0.6355*20*(125.4715/ 125.4715) = 12.71MW. Similarly Contribution of Generator 2 (P_{G2}= 39.5236MW) capacity to the load2 (P_{L2}) is 7.2892MW.

TABLE 3. Contribution of generators in the losses

	L2	L3	L4	L5	Total	Losses
G1	12.71	41.5755	30.92	40.26	125.4655	128.49-125.4655 =3.0245MW
G2	7.2892	3.42611	9.07653	19.733	39.52503	40-39.52503 =0.4749MW

Therefore transmission loss allocations among both generators G1and G2 are 3.0245MW and 0.4749MW respectively. Total losses are 3.0245+0.4749=3.499MW, which are approximately equal to the loss obtained from Ac load flow analysis (P_{Loss} =3.489MW).

3. *Apportioning System Losses to Generators Using Sensitivity Co-efficient[3]*

This method, unlike the conventional method uses DC model to calculate line flows and the system power losses. The B-coefficients can be expressed in terms of sensitivity factors, which are evaluated by taking the line flows as a base condition. From these coefficients, it is possible to obtain the contribution to the total system losses from each generator.

Data for Line reactances and resistances are

$X_1 = X_{1\text{-}2} = 0.06$; $X_4 = X_{2\text{-}4} = 0.18$; $X_2 = X_{1\text{-}3} = 0.24$;

$X_5 = X_{2\text{-}5} = 0.12$; $X_3 = X_{2\text{-}3} = 0.18$; $X_6 = X_{3\text{-}4} = 0.03$;

$X_7 = X_{4\text{-}5} = 0.24$; $R_1 = 0.02\ \Omega$; $R_2 = 0.08\ \Omega$; $R_3 = 0.06\ \Omega$;

$R_4 = 0.06\ \Omega$; $R_5 = 0.04\Omega$; $R_6 = 0.01\ \Omega$; $R_7 = 0.08\ \Omega$;

3.1. Evaluation of B-coefficients

The GSD and GGSD factors computed as per the procedure indicated in [3] are given in tables 4 & 5.

TABLE 4. GSD factors for both the generators

m	**A(m,1)**	**A(m,2)**
1	0.6033	-0.24166
2	0.20917	0.05125
3	0.07778	0.148889
4	0.09333	0.15111
5	0.139167	0.1675
6	0.09333	0.01333
7	-0.0004167	-0.02958

TABLE 5. GGSD factors for both the generators

	D(m,1)	**D(m,2)**
1	1.077313	0.232353
2	0.536726	0.378806
3	0.131584	0.202693
4	0.231027	0.2888
5	0.365697	0.39403
6	0.24777	0.16777
7	0.0989438	0.06978

According to[2][3]

$$B_{ij} = \sum_{m=1}^{NL} R_m D(m,i) D(m,j) \qquad (3)$$

Therefore B-Coefficients Matrix is

$$\begin{bmatrix} B_{11} & B_{12} \\ B_{21} & B_{22} \end{bmatrix} = \begin{bmatrix} 0.0586619 & 0.033606896 \\ 0.033606896 & 0.02691063 \end{bmatrix}$$

Power loss is expressed as

$$P_L = P_{g1} B_{11} P_{g1} + P_{g1} B_{12} P_{g2} + P_{g2} B_{21} P_{g1} + P_{g2} B_{22} P_{g2} \quad (4)$$

3.1 Contribution to each generator in total loss

From above equation, the contribution by each generator to total loss

$$P'_{Lg1} = \frac{\Delta P_L}{\Delta P_{g1}} * P_{g1} = 17.39957*128.49 = 2235.67075MW$$

$$P'_{Lg2} = \frac{\Delta P_L}{\Delta P_{g2}} * P_{g2} = 10.7896356*40 = 431.585MW$$

Actual total losses are computed by load flow analysis P_L =3.489MW

$$P_{Lg1} = \frac{P_L}{P'_{Lg1} + P'_{Lg2}} * P'_{Lg1} = 2.92449MW$$

$$P_{Lg2} = \frac{P_L}{P'_{Lg1} + P'_{Lg2}} * P'_{Lg2} = 0.56455MW$$

Generator one Contribution in Total transmission line losses is 2.92449MW.Generator two Contributions in Total transmission line losses is 0.56455MW.

3. METHODS FOR LOSS ALLOCATION AMONG GENERATORS AND LOADS

Generators and loads (or consumers) are part of the network but transmission losses are allocated to only generators. Since loads or consumers are the part of the network, they also need share the losses in transmission lines. In the above section method is proposed and compared for loss allocation to share losses only among generators only. In the current section methods to share losses between generators and consumers are proposed. Three new methods are discussed to allocate the total loss among generator and loads.

1. New Method for apportioning total losses among generators and loads using Generation Shift Distribution factor (GSDF)

The factor which determines the amount of generator capacity that needs to be shifted from one power plant to other power plant to stabilize the outage (or) contingencies is called GSDF.

In general GSD factors are used for calculations with generators only, so for the below discussed method the loads are considered as negative generation. It does not affect the actual generation and power flows and whole network is mathematically satisfied.

Using a DC load flow model, the GSD factor is expressed as [2][3],

$$A(m,i) = \frac{\partial P_m}{\partial P_{gi}} = \frac{\partial}{\partial P_{gi}}\left[\frac{\theta_j - \theta_k}{X_m}\right] = \frac{1}{X_m}\left[\frac{\partial \theta_j}{\partial P_{gi}} - \frac{\partial \theta_k}{\partial P_{gi}}\right]$$

$$A(m,i) = \frac{X_{ji} - X_{ki}}{X_m} \quad (5)$$

Where P_m is the real power flow on transmission line m from sending bus j to receiving bus k. X_{ji} and X_{ki} are the elements of the X matrix. X_m is the reactance of line m

All generation changes are compensated by the reference bus, the total system generation is assumed to be unchanged when summation of P_i is constant[2][3] .since in DC load flow R_m is negligible we have ,

$$\sum_{i=1}^{NG} P_{gi} = \sum_{i=1}^{NLoad} P_i = \text{constant} \quad (6)$$

Where NG is number of generators, NLoad is number of loads

Consider 5bus system having 2 generators, 4 loads and 7 transmission lines which is shown in Fig. 2.

The system power loss is expressed by the summation over all transmission lines as,

$$P_L = \sum_1^7 R_m \; P_m^2. \quad (7)$$

$$P_L = \sum_1^7 R_m \left[\frac{X_{ji} \quad X_{ki}}{X_m}\right]^2 [P_{gi}^2]_1^5 \quad (8)$$

TABLE-6. GSD factors for both the generators and loads

m	A(m,1)	A(m,2)	A(m,3)	A(m,4)	A(m,5)
1	0.6033	-0.2417	-0.0283	-0.0683	-0.1850
2	0.2092	0.0512	-0.1637	-0.1204	-0.0058
3	0.0778	0.1489	-0.2089	-0.1378	0.0539
4	0.0933	0.1511	-0.1356	-0.2122	0.0300
5	0.1392	0.1675	0.0250	-0.0142	-0.5608
6	0.0933	0.0133	0.4400	-0.4467	-0.1433
7	-0.0004	-0.0296	0.1142	0.1521	-0.3029

According to the tracing of electricity by using net flow generation capacity of lossless system is, G1= 125.4655MW G2=39.52503MW

$$\frac{\partial P_L}{\partial P_{g1}} = 2\sum_{m=1}^{7} R_m \left(A(m,1)P_{g1} + A(m,2)P_{g2} + A(m,3)P_{L3} + A(m,4)P_{L4} + A(m,5)P_{L5}\right)A(m,1) \quad (9)$$

Where P_{L3}, P_{L4} , P_{L5} are the negative generations. Each part in this equation is shows the each generator and load contribution on the mth line.

Determining incremental losses for other generators

$$\frac{\partial P_L}{\partial P_{g1}} = 4.67775; \quad \frac{\partial P_L}{\partial P_{g2}} = 1.30346;$$

$$\frac{\partial P_L}{\partial P_{L3}} = -2.0298; \quad \frac{\partial P_L}{\partial P_{L4}} = -2.3753; \quad \frac{\partial P_L}{\partial P_{L5}} = -3.137498$$

The contribution to each generator to total loss

$$P'_{Lg1} = \frac{\Delta P_L}{\Delta P_{g1}} * P_{g1} = 4.67775*125.4655 = 586.8962\text{MW}$$

$$P'_{Lg2} = \frac{\Delta P_L}{\Delta P_{g2}} * P_{g2} = 1.30346*(39.52503-20) = 25.4501\text{MW}$$

$$P'_{LL3} = \frac{\Delta P_L}{\Delta P_{L3}} * P_{L3} = -2.0298 * -45 = 91.341\text{MW}$$

$$P'_{LL4} = \frac{\Delta P_L}{\Delta P_{L4}} * P_{L4} = -2.3753*-40 = 95.012\text{MW}$$

$$P'_{LL5} = \frac{\Delta P_L}{\Delta P_{L5}} * P_{L5} = -3.137498 * -60 = 188.24988\text{MW}$$

The actual total losses are computed by the AC load flow. These loss components due to each generator will follow the ratio given in above calculation. Therefore if P_L is the actual total loss in the system,

$$P_{Lg1} = \frac{P_L}{P'_{Lg1}+P'_{Lg2}+P'_{LL3}+P'_{LL4}+P'_{LL5}} * P'_{Lg1} = 2.074758\text{MW}$$

$$P_{Lg2} = \frac{P_L}{P'_{Lg1}+P'_{Lg2}+P'_{LL3}+P'_{LL4}+P'_{LL5}} * P'_{Lg2} = 0.0899695\text{MW}$$

$$P_{LL3} = \frac{P_L}{P'_{Lg1}+P'_{Lg2}+P'_{LL3}+P'_{LL4}+P'_{LL5}} * P'_{LL3} = 0.322903\text{MW}$$

$$P_{LL4} = \frac{P_L}{P'_{Lg1}+P'_{Lg2}+P'_{LL3}+P'_{LL4}+P'_{LL5}} * P'_{LL4} = 0.335880\text{MW}$$

$$P_{LL5} = \frac{P_L}{P'_{Lg1}+P'_{Lg2}+P'_{LL3}+P'_{LL4}+P'_{LL5}} * P'_{LL5} = 0.665489\text{MW}$$

Therefore transmission loss allocation among both generators G1 and G2 are 2.074758MW and 0.08996957MW respectively. Transmission loss allocation among loads is L3, L4 and L5 is 0.322903MW, 0.335880MW and 0.665489MW respectively.

Total loss is 2.074758+0.08996957+0.32290 +0.335880+ 0.665489 = 3.4889MW which is approximately equal to the loss obtained from Ac load flow analysis (P_{Loss} =3.489MW).

2. New Method for apportioning total losses among generators and loads

In this method by considering lossless system generator capacity, loss contribution of each generator will be distributed to each load and generator. Loss less system generation and loss contribution is to be determined from the 'Tracing of Electricity by using Net Flow'[1].To understand this method consider the 4 bus system with two generators and two loads as shown in Fig. 3.

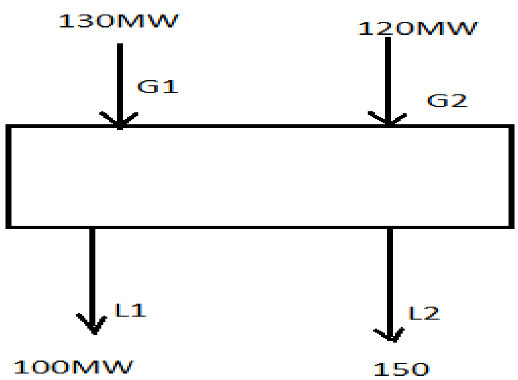

Fig. 3. lossless system of 4 bus system

Let us consider Generator1 (G1) contribution in loads is $PG1_{L1}$=70MW $PG1_{L2}$ =60MW Generator2 (G2) contribution in loads is $PG2_{L1}$ =30MW, $PG2_{L2}$ =90MW. These contributions can be determined from the previous power flow tracing method. Considering AC load flow with the same load, G1 delivers 135MW & G2 delivers 123MW.

Loss at G1 attributed to load L1 (PL_{G1L1})=5*(70/130) Loss at G1 attributed to load L2 (PL_{G1L2})=5*(60/130) similarly PL_{G2L1} =3*(30/120) PL_{G2L2} =3*(90/120).

Distribution of losses

PL_{G1} = 5* (70 / 130)* (130 / 130+ 100)+ 5* (60/130) * (130 / 130+150)

PL_{G2}=3 * (30/120) * (120 / 120+100)+3 * (90/120) * (120 / 120+150)

PL_{L1} =5* (70 / 130) * (100 / 130+100) +3 * (30/120) * (100/ 120+100)

PL_{L2} = 5* (60 / 130) * (150 / 130+150) +3 * (90/120)* (150/ 120+150)

Total system losses are = 8MW.

3. *Method using Tracing of Electricity*

This method is depending on convergence of the power system i.e. power outflow of the node is equal to the power inflow of the node. In this method also loads are considered as negative generation. Consider the 5 bus system as shown in Fig. 1. Therefore P_{Gi}= [128.49; 40-20=20;-45;-40; -60] MW

Distribution matrix is obtained using upstream looking algorithm [1].

$$A_u\ P = P_G \tag{10}$$

$$A_u^{-1} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ 0.5463 & 1 & 0 & 0 & 0 \\ 0.5365 & 0.1665 & 1 & 0 & 0 \\ 0.6996 & 0.4864 & 0.9739 & 1 & 0 \\ 0.9609 & 0.9765 & 0.9593 & 0.9850 & 1 \end{bmatrix}$$

Generator and Load contribution at 2nd Bus

P_2 =90.1992 MW P_{L2} =1.0644MW

Outflow=inflow   therefore

0.5463*128.49 +40*1-20*1 =90.1992

110.1941-20 =90.2

G1+G2 part in total flow is

$G1+G2=\frac{110.1941}{110.1941+20} * 90.2=76.3438MW$ (outflow+losses)

$L2 =\frac{20}{110.1941+20} *90.2 =13.8562MW$

Individual generator contribution in the total flow 76.3438MW

$G1= \frac{0.5463*128.49}{110.1941} *76.3438 =48.6313MW$

$G2 = \frac{40}{110.1941} *76.3438 =27.7125MW$

Individual Generator Contribution in total losses at that

bus Loss at 2nd bus is P_{L2} =1.0644MW

G1 and G2 contribution in loss is

$G1_{\_losspart}=\frac{1.0644}{90.2} *48.6313 =0.57387MW$

$G2_{\_losspart} = \frac{1.0644}{90.2} * 27.7125 = 0.32702MW$

Individual loads contribution in total loss

$L2_{\_losspart} = \frac{1.0644}{90.2} * 13.8562 = 0.16351MW$

TABLE 7. Generator and load contribution in total losses

	G1	G2	L2	L3	L4	L5	Total loss
Bus-1	1.047	0	0	0	0	0	1.047
Bus-2	0.57387	0.32702	0.16351	0	0	0	1.0644
Bus-3	0.39072	0.037748	0.18873	0.25505	0	0	0.7024
Bus-4	0.10832	0.023444	0.01772	0.052811	0.048201	0	0.2445
Bus-5	0.163315	0.051667	0.02583	0.057101	0.052116	0.079365	0.4294
	2.28322	0.439879	0.219939	0.364962	0.100317	0.079365	3.4876

Therefore total loss allocation among generators and loads are G1=2.28322MW, G2=0.439879MW, L2=0.21994MW, L3=0.36496MW, L4=0.100317MW, L5=0.079365MW.

4. RESULTS

1. Comparison between Different Methods for loss allocation among only Generators

(i) For 5 Bus system

TABLE- 8. Comparison table of loss contribution among only generators for 5 Bus system

	Tracing electricity using net flow	Using Sensitivity Coefficients	Proposed Method
G1	3.0245MW	2.92445MW	2.8538MW
G2	0.4749MW	0.56455MW	0.6357MW

(ii) For IEEE14 Bus system

TABLE 9. Comparison table of loss contribution among only generators for IEEE 14 Bus system

	Tracing electricity using net flow	Using Sensitivity Coefficients	Proposed Method
G1	12.384415MW	12.1612MW	11.96507MW
G2	1.167859MW	1.3958MW	1.587348MW

(iii) For IEEE 30 Bus system

TABLE 10. Comparison table of loss contribution among only generators for IEEE 30 Bus system

	Tracing electricity using	Using Sensitivity	Proposed Method
G1	0.057118MW	0.0477MW	0.085949MW
G2	1.678959MW	1.7279MW	1.647188MW
G3	1.291809MW	1.4030MW	1.282031MW
G4	0.027995MW	0.0254MW	0.040857MW
G5	0.153162MW	0.0460MW	0.150992MW
G6	0.197791MW	0.1580MW	0.199729MW

2. New Method for apportioning total losses among generators and loads using Generation Shift Distribution factor (GSDF)

(i) For 5 Bus System

PL_{G1}= 2.074758MW PL_{G2} = 0.08996957MW

PL_{L3} =0.322903MW PL_{L4}=0.335880MW

PL_{L5} =0.665489MW   Total losses = 3.4889MW

(ii) For IEEE 14 Bus System

PLG1 = 8.5863MW   PLG2 =0.1686MW

PLL3 =3.0187MW   PLL4 =0.7968MW

PLL5 = 0.0555MW   PLL6 = 0.1181MW

PLL9 = 0.4403MW   PLL10 =0.1561MW

PLL11 =0.0552MW   PLL12 =0.1064MW

Total losses = 13.502MW

3. New Method for apportioning total losses among generators and loads

   PLG1=2.223644MW PLG2 =0.2257654MW

   PLL2=0.071552MW PLL3 =0.286487MW

   PLL4 =0.23504MW PLL5 =0.4569083MW

   Total losses =3.499MW

4. Method using Tracing of Electricity

   PLG1 = 2.28322MW PLG2= 0.439879MW

   PLL2 = 0.21994MW PLL3 = 0.36496MW

   PLL4 = 0.100317MW PLL5 = 0.079365MW

5. CONCLUSION

Continuing trend towards deregulation and unbundling of transmission services has resulted in the need to assess the impact of a particular generator or the load on the power system. In this project three different methods are compared to allocate losses among only generators. Among these three approaches, the new method of power flow tracing in power system has been proposed which allocates the transmission losses among generators. In this method the transmission losses are allocated in a fair way. Since losses in the each transmission line are equally distributed between corresponding buses, so that the contribution of generators and loads in total system losses can be evaluated. Second approach which was proposed J.W.Bialek [1] is to consider net flows when all the losses are removed from the network. Third approach [3] is to considering the sensitivity co-efficient to evaluate the loss contribution by each generator.

In this paper three more different approaches to obtain the losses among generators and loads have been proposed. In two of three methods, loads are considered as negative generation. First method is using the generation shift distribution factor (GSD) and incremental loss. This method is simple and accurate. For second method the contribution of the losses to generators are calculated from J.W.Bialek method [1] and then shared among loads and generators. Third method is dependent on the proportional sharing principle.

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