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A Method for Separation and Minimization of Generation, Loads and Transmission Losses in Restructured Electrical Power Market

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Abstract: *The transmission, generation and load loss division problem in restructured electric power systems are deliberate in this paper by new method. Formulations are based on network representing relations and no additional assumption or simplification is considered. Also in suggested method, division of losses is assigned to real power buyers and sellers as well as losses between generators and load. Numerical test is performed on a standard power system network (IEEE-14 and 30) for this method against some other famous loss allocation techniques. The proposed methodologies provide better reliability and minimum limitation of conventional real power loss division and minimization of that real power loss by using compensation. This paper gives new dynamic phenomena for calculation of real power loss caused by technical loss based on generator and load.*

Keywords *– Restructuring, Electricity Act 2003, Distinguish of Transmission loss, Load loss, Loss due to unbalance generation voltage.*

I. INTRODUCTION

In recent two decades, the electrical power systems of many countries have been subjected to restructuring or deregulation. After restructuring, competition has been introduced with respect to productions, but transmission system is still performed by regional monopoly [2, 3]. As a result of that, several new problems and challenges have arisen, one of this problem is transmission system loss separation, that means dividing losses cost of transmission network into fractions to be paid by market participants (network users, such as generation or distribution companies), to loss compensator generators through ISO (Independent System Operator). Electric power generators and users engage in power transactions which take place over the transmission system and hence create losses. Transmission losses usually represent up to 5 - 10% of the total generation [18, 19]. Consequently, the problem of "who should pay for losses" arises and therefore satisfactory sharing of the transmission system utilization costs among all market participants has become a key issue [1, 12].

Division transmission loss is not an easy task. Even a generator to supply a single load with a simple power system, the generator and the load between the loss-share loss of separation in a unique way that determines the physical measurement or mathematical method as there are no agreed upon has gone. In a real system, the cases become more complicated because of two facts. Before each load through each transmission line is a good degree of arbitrariness due to the determination of the line flows. Is a nonlinear function of the transmission line loss line flow, and therefore a unique concrete manner through a partial flow between the line cannot be separated [14, 15].

Select a loss separation method for hard work but every generation company generator load loss and loss allocation and ISO as well should submit their report to the Electricity Act 2003.You can use it to analyse loss [17].

Loss of allocation schemes in a flower market or in a bilateral contracts market to behave differently generator / load system for allocating losses is presented. Pro-rata method, incremental transmission losses (ITL) methods, proportional sharing process: Mainly there are three families of schemes based on different assumptions and approximations [4, 5, 6. 7, 8, 9, 10].

In this paper, based on networks characteristics equations, a loss separation method is proposed that can divide the power losses in pool power market to its users, in their terms of real power injections as well as losses between generators and loads. This paper is performed using IEEE-14 and 30 bus reliability test system and finally conclusion is presented in section–VI. This is the advance method for transmission loss division.

II. BASIC CONCEPT OF ELECTRICAL POWER SYSTEM

Loss separation problem with the compensation of losses is naturally different. Pool market mechanism usually about ISO bids submitted calculate an economic power dispatch. Therefore selected for each generator bus load generation supply and the economy, the deficit level will determine compensation. So dull, just like just a phase reference generator bus and the bus between the generator and the load losses of the system but also the division responsible for compensating the loss is not.

Transmission loss is disintegrating into two components. Planning is the first and the second operation because of damage suffered. In this paper, due to the load current flows from the generator and the generator load current circulation loss as to explain the operation. Two or more generator sets are operated in parallel, when a current generator can circulate between. Each is slightly different from the internal voltage generated by the generator when it will exist in the present. The current line through the parallel bus and the second generator, the generator leads will flow out. The "current roll" the load, the current does not flow in. Circulating current losses for the separation method is important to consider.

Synchronization of the generator output voltage, the voltage potential difference causes the voltage on the grid is more or less a synchronized three-phase generator for a grid, the condition of synchronization, grid frequency and voltage of the generator coincides generator and to visit the current circulating between the grid. Heating circulating currents that may arise and actually can damage the generator is useless when synchronize as ideally there should not be any voltage potential difference.

The idea applies in an AC system but with all physical parameters and quantities are complex. Consider the AC simple system of Fig. 1. The unbalance voltages between the source points 1 and 2, V_1-V_2, is a complex quantity with a magnitude of ΔV and angle δ, i.e. $V_1-V_2= \Delta V \angle\delta$

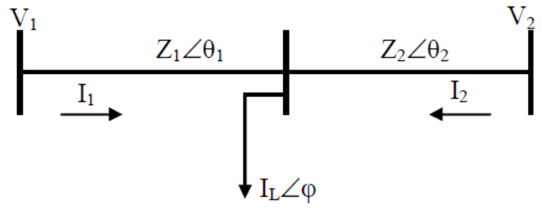

Fig.1: Simple 3 bus ac system

The total power loss in the transmission lines of the AC system can be proved to be as follows.

$$P_t^{Loss} = \frac{|I_L|^2(Z_1^2.Z_2\ .\cos(\theta_2)+Z_1\ Z_2^2.\cos(\theta_1))}{|Z_1+Z_2|^2} + \frac{|\Delta V|^2.(r_1+r_2)}{|Z_1+Z_2|^2} + \frac{2|\Delta V||I_L||z_1.z_2|}{|Z_1+Z_2|^2}. \quad \sin(\emptyset-\delta)\ .\ \sin(\theta_1-\theta_2) \qquad (1)$$

The first term of equation (1) is the load loss, and the second term is show the circulating current loss. The third term is due to the difference of X/R ratio of the two lines and can be considered as a sort of impedance mismatch loss. Also, the presence of transformers which have X/R ratio larger than that of the lines gives rise to this term, if the two lines have the same X/R ratio, i.e. $\theta_1 = \theta_2 = \theta$, the total loss in AC system becomes,

$$P_t^{Loss} = \frac{|I_L|^2|Z_1.Z_2|.\cos(\theta)}{|Z_1+Z_2|} + \frac{|V_1-V_2|^2.(r_1+r_2)}{|Z_1+Z_2|^2} \qquad (2)$$

The first term of equation (2) determines the load loss and load loss can be determined by short-circuiting the all the sources and letting the load currents alone flow through the network and the second term determines the circulating current loss. It can be calculated by simply letting the load current equal to zero.

III. MATHEMATICAL MODEL

Transmissions losses are divided in two parts are following:

1) Load Loss:

Loss due to load currents are obtained by assuming that all generators act as ideal voltage sources with no circulating currents between them. In such a case, generation nodes are short circuited and the load nodes are considered as current sources [4]. Considering the node equations of the power system, and by proper partitioning of Y_{BUS}, the power system equations can be written as:

$I=Y\ V$ (3)

$$\begin{bmatrix} I_G \\ I_L \end{bmatrix} = \begin{bmatrix} Y_{GG} & Y_{GL} \\ Y_{LG} & Y_{LL} \end{bmatrix} \begin{bmatrix} V_G \\ V_L \end{bmatrix} \qquad (4)$$

I_G, V_G, I_L and V_L are the current and voltage vectors for generation and load nodes, respectively. Y_{GG} is the self-admittance matrix of generator nodes, Y_{GL} is the mutual admittance matrix between generation and load nodes, Y_{LG} is the mutual admittance matrix between load and generation nodes, Y_{LL} and is the self-admittance matrix of load nodes.

$I_G = Y_{GG}\ V_G + Y_{GL} V_L$ (5)

$I_L = Y_{LG}\ V_G + Y_{LL}\ V_L$ (6)

To determine the current flow through branches due to loads are determined while the voltages at generation nodes are set to zero in (6). In this condition, the load node voltages will be

$V_L = Z_{LL}\ I_L$ (7)

With N_G the number of generation nodes and N_L the number of load nodes, generation node voltages can also be expressed as

$V_G = 0_{NG\times NL}\ I_L$ (8)

The branch currents I_b can be calculated as follows:

$I_b = [Y_{br}]\ [A^T]\ V_{bus}$ (9)

Where Y_b is the branch admittance matrix, which is a diagonal matrix with its main diagonal elements are the branch admittances. A^T is transpose of the branch to node incidence matrix. To decompose the branch current into its components caused by individual load currents, the current column is replaced by diag (I_L), which is a diagonal matrix having load currents as its main diagonal elements

$[I_{br}^L] = K.\ diag[I_L]$ (10)

Where, $K = [Y_{br}]\ [A^T] \begin{bmatrix} 0_{N_G \times N_{Load}} \\ Y_{LL}^{-1} \end{bmatrix}$

K is the load current distribution factors matrix, where k_{br}^L is the fraction of the current of load L that flows through branch b, that is, $I_{br}^L = k_{br}^L .\ I_j$

$[I_{br}^L]$ is $N_{br} \times N_{Load}$ matrix with its ij^{th} element equals the current flowing in the i^{th} branch due to the current injection of the j^{th} load. The summation of each row gives the total branch current due to all loads. Using this total branch current and the resistance of the line, the power loss through this line can be determined.

Using the partial currents, elements of the row, the loss due to each load through this line can be determined using the equation of loss allocation [5].

$\Delta P_{ij} = r_i\ [I_{br\,ij}^L] \bullet [I_i]$ (11)

Where,

ΔP_{ij} = the power loss in branch i due to load at node j,

$I_{br\,ij}^L$ = the current through branch i due load at node j,

I_i = the current through branch i due to all loads,

$\bullet$ = the dot product of a vector defined as follows:

$$I_{br}^L \bullet I_i = \Re(I_{br}^L)\Re(I_i) + \Im(I_{br}^L)\Im(I_i)$$

$\Re$= real part of an expression

$\Im$= imaginary part of an expression

2) Loss due to Difference in voltage at generation point:

Another loss can be obtained by voltage difference at generator node during operating condition which is known as circulating current loss. The generator circulating current is obtained by setting the load currents to zero in equation (4), and the generator voltage as obtained the from power flow solution. The generator circulating current is calculated as follows.

$[I_G^{cir}] = [[Y_{GG}]-[Y_{GL}].\ [Y_{LL}]^{-1}.\ [Y_{LG}]][V_G]$ (12)

The voltage vector of load nodes is determined as,

$[V_L] = -\ [Y_{LL}]^{-1}.\ [Y_{LG}].\ [V_G]$ (13)

The node voltage vector in this case can be written in terms of the generator circulating current as,

$\begin{bmatrix} V_G \\ V_L \end{bmatrix} = \begin{bmatrix} Z_{GG} \\ -Y_{LL}^{-1}.Y_{LG}.Z_{GG} \end{bmatrix} [I_G^{cir}]$ (14)

So,

$[Z_{GG}] = [[Y_{GG}]-[Y_{GL}]\ [Y_{LL}]^{-1}.[Y_{LG}]]^{-1}$ (15)

The branch current due to the generators' circulating current can thus be obtained as follows.

$[I_{br}^{cir}] = [Y_{br}][A^T] \begin{bmatrix} Z_{GG} \\ -Y_{LL}^{-1}.Y_{LG}.Z_{GG} \end{bmatrix} .diag[I_G^{cir}]$ (16)

$[I_{br}^{cir}]$ is $N_{br} \times N_G$ matrix with its ij^{th} element equals the current flowing in the i^{th} branch due to the circulating current of j^{th} generator. The summation of each row equals the total current flowing in the branch due to the circulating current of the generators.

The circulating current losses in each branch due to each generator can be calculated the same way as for the load losses using (11).

$\Delta P_{ij} = r_i\ [I_{br}^{cir}] \bullet [I_i]$ (17)

Where,

ΔP_{ij} = the power loss in branch i due to load at node j,

I_{br}^{cir} =the branch current due to the generator's circulating current,

I_i = the current through branch i due to all loads,

$\bullet$ = the dot product of a vector defined as follows:

$$I_{br}^{cir} \bullet I_i = \Re(I_{br}^{cir})\Re(I_i) + \Im(I_{br}^{cir})\Im(I_i)$$

$\Re$= real part of an expression
$\Im$= imaginary part of an expression

IV. ACTIVE POWER LOSS COMPENSATION

Each of the current trade regimes is taking care of its own losses or damages in Open Access requires each individual generator / load is necessary to have an approach that presents. To perform this task, a damage compensation scheme is developed in this section. The advantage of this approach to open access once an agreement has been so defined, the results obtained in the previous sections are valid. Loss allocation formula defined in the previous section, each generator / loads are used to determine the allocation of losses. After identifying the allocation of loss, basically due to the approach of the real power in the other buses designated for injection resulting in dull just compensation for damages equal to the necessary measures. ISO then either increase production or weight loss by reducing the amount of compensation determined runs.
The losses power balance equation before injection can be shown as

$$P_s + \sum_{i=1, i\neq 1}^{N} P_i = P_L \tag{18}$$

P_s = Active power injection at slack bus
P_i = Active power injection at i^{th} bus
P_L= Active power Loss of system
The total transmission loss is expressed as a function of initial power Loss P_L^0 and the change in total transmission loss as ΔP_L injection of active power at busses.

$$P_L = P_L^0 + \Delta P_L \tag{19}$$

The equal loss compensation for active power with the injection of real power, ΔP_i at i^{th} bus generally results in decreasing the injection at the slack bus with all agreements on the system continuing unaffected. i.e. with the supplementary total of power ΔP_i injected at bus i into the system to off load the loss recompense at the slack bus, the Power balance equation becomes

$$P_s - \Delta P_s + \sum_{i=1, i\neq 1}^{N} (P_i + \Delta P_i) = P_L + \Delta P_L \tag{20}$$

$$-\Delta P_s + \sum_{i=1, i\neq 1}^{N} \Delta P_i = \Delta P_L \tag{21}$$

The exact transmission loss using bus injected powers and system Parameters

$$P_L = \sum_{i=1}^{N}\sum_{j=1}^{N}\left[A_{ij}\left(P_iP_j + Q_iQ_j\right) + B_{ij}\left(Q_iP_j - P_iQ_j\right)\right] \tag{22}$$

Now the active power loss of system can be expressed as Taylor series about initial active power loss P_L^0, before injection, where the terms in Talyor series expansion are the injected power ΔP_i at each bus with only the linear terms retained.

$$P_L = P_L^0 + \sum_{i=1, i\neq s}^{n} \frac{\partial P_L}{\partial P_i}\Delta P_i \tag{23}$$

The term represents the loss sensitive factor, which is defined as an incremental change of real power loss by an incremental change of scheduled power injected into bus. This loss sensitive factor can be obtained by differentiating the equation (21) w.r.t P_i, i.e.,

$$\frac{\partial P_L}{\partial P_i} = 2A_{ii}P_i + \sum_{j=1, j\neq i}^{NB} \left[(A_{ij} + A_{ji})P_j + (B_{ij} - B_{ji})Q_j\right] \tag{24}$$

By rearranging the equations (2),(3),(4) and (6) ,

$$P_L - P_L^0 = \sum_{i=1, i\neq s}^{NB} \frac{\partial P_L}{\partial P_i}\Delta P_i = \Delta P_L = -\Delta P_s + \sum_{i=1, i\neq s}^{NB} \Delta P_i \tag{25}$$

$$\Delta P_i = \sum_{i=1, i\neq s}^{NB} [1 - \frac{\partial P_L}{\partial P_i}]\Delta P_i \tag{26}$$

Let

$$\alpha_i = [1 - \frac{\partial P_L}{\partial P_i}]$$

α_i is called as the loss compensation Index at bus i. The physical interpretation of α_i is as follows. α_i MW injected at i^{th} reducing loss compensation by 1 MW at the slack bus.

$$\Delta P_s = \sum_{i=1, i\neq s}^{NB} \alpha_i \Delta P_i$$

The equivalent loss compensation at i th bus is given by

$$\Delta P_i = \frac{\Delta P_s}{\alpha_i}$$

The proposed approach is classified into two categories:

1) All system losses are compensated by slack bus as explained in the computational procedure above (Loss Allocation Methodology).
2) Each generator uses its own generation to compensate for its allocated losses i.e. the generators are self-compensating with their specified compensation fractions. (Self-Loss compensating Scheme).

V. CASE STUDY

IEEE-14 Bus System

The IEEE 14 bus system with Bus and line data, bus-1 is consider as a slack bus, bus-2 are generator buses (Total Generation: 411MW), another buses are load buses contain with different load (Total Load: 368MW). The above proposed method explains which is converted into MATLAB programming and applies on IEEE 14 system which results shows in below table.

Table 1. IEEE – 14 Bus System line losses with and without compensation

Bus No.	Without compensation					With Compensation (Bus – 5: -24MVAR, Bus – 6: -25MVAR)		
	Voltage Profile	Line		Line Loss		Voltage Profile	Line Loss	
				Active Power	Reactive Power		Active Power	Reactive Power
		From	To					
1	1.000	1	2	0.660	-3.207	1.000	0.681	-2.514
		1	5	23.882	62.280		23.861	60.488
2	0.995	2	1	0.660	-3.207	0.995	0.681	-2.514
		2	3	3.607	-5.687		2.951	-9.835
		2	4	4.949	13.410		2.187	4.326
		2	5	2.559	9.103		0.803	0.612
3	0.863	3	2	3.607	-5.687	0.931	2.951	-9.835
		3	4	0.424	-1.407		0.503	-1.683
4	0.833	4	2	4.949	13.410	0.922	2.187	4.326
		4	3	0.424	-1.407		0.503	-1.683
		4	5	2.995	4.030		3.313	4.364
		4	7	0.858	23.427		0.498	12.065
		4	9	0.198	11.281		0.118	4.769
5	0.854	5	1	23.882	62.280	0.933	23.861	60.488
		5	2	2.559	9.103		0.803	0.612
		5	4	2.995	4.030		3.313	4.364
		5	6	1.318	36.491		0.765	21.172
6	0.745	6	5	1.318	36.491	0.959	0.765	21.172
		6	11	0.071	-0.910		0.077	-1.641
		6	12	0.326	0.108		0.176	-0.597
		6	13	0.382	0.066		0.237	-0.689
7	0.743	7	4	0.858	23.427	0.964	0.498	12.065
		7	8	0.022	3.047		0.011	0.881
		7	9	0.015	0.840		0.016	0.409
8	0.713	8	7	0.022	3.047	0.970	0.011	0.881
9	0.738	9	4	0.198	11.281	0.991	0.118	4.769
		9	7	0.015	0.840		0.016	0.409
		9	10	0.240	-0.784		0.172	-1.458
		9	14	0.415	-0.060		0.266	-0.757
10	0.729	10	9	0.240	-0.784	0.984	0.172	-1.458
		10	11	0.036	-0.814		0.048	-1.490
11	0.732	11	6	0.071	-0.910	0.969	0.077	-1.641
		11	10	0.036	-0.814		0.048	-1.490
12	0.722	12	6	0.326	0.108	0.947	0.176	-0.597
		12	13	0.052	-1.000		0.034	-1.740
13	0.730	13	6	0.382	0.066	0.956	0.237	-0.689
		13	12	0.052	-1.000		0.034	-1.740
		13	14	0.012	-0.975		0.026	-1.707

14	0.720	14	9	0.415	-0.060	0.969	0.266	-0.757
		14	13	0.012	-0.975		0.026	-1.707
Total				**43.020**	**149.240**		**36.742**	**84.974**

Table 2. IEEE-14 Bus System Generator and Load loss with and without compensation

	Without Compensation	With Compensation
Generator Loss	11.213	11.5553
Load Loss	34.856	25.2322
Total Active Power Loss	46.069	36.787

From table 1, the solution based on proposed method, it is clear that the load loss is constant and almost independent of the generator output, which approves the validity of the proposed method. The circulating power and circulating current loss are changes with generation. As shown in table 2, when P_G was 90 MW, the circulating power calculated by the proposed method was found to be 11.23 MW, which proofs the accuracy of the proposed method in determining the circulation power in addition to the load loss. The dependence of circulating current loss on the amount of circulating power is clear from the table. The small difference between the total loss calculated and loss due to circulating power because difference in voltage magnitude. This difference causes a reactive power to flow in the system causing active power loss. Reactive power is reduce with adding of compensation. Result comparison of with and without compensation given in above tables. Generator, load and transmission losses are reduced by compensation, which clearly proved in above tables: 1 & 2. Without compensation generator, load and transmission losses are 11.21MW, 34.856MW and 46.069MW, after addition of compensation generator, load and transmission losses are 11.55MW, 25.35MW and 36.78MW, which proved that the compensation through minimize the generator, load and transmission losses.

IEEE-30 Bus System

The IEEE 30 bus system with Bus and line data, bus-1 is consider as a slack bus, bus-2 are generator buses (Total Generation: 514MW), another buses are load buses contain with different load (Total Load: 460MW). The above proposed method explains which is converted into MATLAB programming and applies on IEEE 30 system which result shows in above table

From table 3, the solution based on proposed method, it is clear that the load loss is constant and almost independent of the generator output, which approves the validity of the proposed method. The circulating power and circulating current loss are changes with generation. In table 3, when P_G was 120 MW, the circulating power calculated by the proposed method was found to be 17.18 MW, which proofs the accuracy of the proposed method in determining the circulation power in addition to the load loss. The dependence of circulating current loss on the amount of circulating power is clear from the table. The small difference between the total loss calculated and loss due to circulating power because difference in voltage magnitude. This difference causes a reactive power to flow in the system causing active power loss. Reactive power is reduce with adding of compensation. Result comparison of with and without compensation given in above tables: 3 & 4. Generator, load and transmission losses are reduced by compensation, which clearly proved in tables 3 & 4. Without compensation generator, load and transmission losses are 17.18MW, 42.898MW and 60.078MW, after addition of compensation generator, load and transmission losses are 16.387MW, 31.41MW and 47.797MW, which proved that the compensation through minimize the generator, load and transmission losses.

Table 3. IEEE – 30 Bus System line losses with and without compensation

Bus No.	Without compensation					With Compensation (Bus – 5: 50 MVAR, Bus – 8: 40MVAR,Bus – 24: 45 MVAR)		
	Voltage Profile	Line		Line Loss		Voltage Profile	Line Loss	
				Active Power	Reactive Power		Active Power	Reactive Power
		From	To					
1	1.000	1	2	13.282	29.977	1.000	12.723	28.328
		1	3	9.086	29.489		8.702	27.886
2	0.990	2	1	13.282	29.977	0.990	12.723	28.328
		2	4	4.563	10.648		3.401	6.886
		2	5	8.883	33.790		7.033	25.623
		2	6	6.192	37.919		4.872	29.279
3	0.907	3	1	9.086	29.489	0.960	8.702	27.886
		3	4	2.656	3.722		2.436	2.562
4	0.889	4	2	4.563	10.648	0.954	3.401	6.886
		4	3	2.656	3.722		2.436	2.562
		4	6	2.003	1.613		1.782	-0.092
		4	12	0.156	17.896		0.126	13.965
5	0.842	5	2	8.883	33.790	0.948	7.033	25.623
		5	7	0.098	-15.587		0.078	-19.597
6	0.873	6	2	6.192	37.919	0.956	4.872	29.279

		6	4	2.003	1.613		1.782	-0.092
		6	7	0.712	0.918		0.571	0.212
		6	8	1.370	1.168		0.183	-0.642
		6	9	0.066	6.189		0.063	5.799
		6	10	0.045	5.477		0.038	4.366
		6	28	0.632	-1.731		0.461	-3.211
7	0.853	7	5	0.098 -	15.587	0.948	0.078	-19.597
		7	6	0.712	0.918		0.571	0.212
8	0.850	8	6	1.370	1.168	0.959	0.183	-0.642
		8	28	0.044	-0.135		0.029	-0.211
9	0.899	9	6	0.066	6.189	1.024	0.063	5.799
		9	11	0.000	-1.231		0.000	-1.595
		9	10	0.098	2.085		0.090	1.382
10	0.900	10	6	0.045	5.477	1.044	0.038	4.366
		10	9	0.098	2.085		0.090	1.382
		10	20	0.103	-0.400		0.042	-0.646
		10	17	0.016	-1.326		0.007	-1.811
		10	21	1.068	0.851		0.783	-0.304
		10	22	0.593	-0.115		0.559	-0.123
11	0.901	11	9	0.000	-1.231	1.026	0.000	-1.595
12	0.928	12	4	0.156	17.896	1.050	0.126	13.965
		12	13	0.019	-0.634		0.015	-1.081
		12	14	0.112	-1.048		0.095	-1.454
		12	15	0.378	-2.105		0.362	-2.983
		12	16	0.110	-4.792		0.088	-6.315
13	0.925	13	12	0.019	-0.634	1.047	0.015	-1.081
14	0.920	14	12	0.112	-1.048	1.049	0.095	-1.454
		14	15	0.019	-1.041		0.021	-1.365
15	0.913	15	12	0.378	-2.105	1.048	0.362	-2.983
		15	14	0.019	-1.041		0.021	-1.365
		15	18	0.086	-0.351		0.050	-0.599
		15	23	0.168	-0.776		0.268	-0.995
16	0.917	16	12	0.110	-4.792	1.049	0.088	-6.315
		16	17	0.059	-0.957		0.030	-1.374
17	0.903	17	16	0.059	-0.957	1.044	0.030	-1.374
		17	10	0.016	-1.326		0.007	-1.811
18	0.902	18	15	0.086	-0.351	1.043	0.050	-0.599
		18	19	0.022	-1.298		0.009	-1.785
19	0.896	19	18	0.022	-1.298	1.041	0.009	-1.785
		19	20	0.022	-1.453		0.021	-1.980
20	0.898	20	19	0.022	-1.453	1.044	0.021	-1.980
		20	10	0.103	-0.400		0.042	-0.646
21	0.873	21	10	1.068	0.851	1.036	0.783	-0.304
		21	22	0.000	-1.113		0.050	-1.472
22	0.873	22	10	0.593	-0.115	1.041	0.559	-0.123
		22	21	0.000	-1.113		0.050	-1.472
		22	24	0.265	-0.195		1.396	1.269
23	0.893	23	15	0.168	-0.776	1.043	0.268	-0.995
		23	24	0.049	-0.590		0.098	-0.692
24	0.869	24	22	0.265	-0.195	1.086	1.396	1.269
		24	23	0.049	-0.590		0.098	-0.692
		24	25	0.227	-0.364		0.212	-0.662
25	0.855	25	24	0.227	-0.364	1.062	0.212	-0.662
		25	26	0.033	-1.096		0.022	-1.742
		25	27	0.346	-0.474		0.625	-0.717
26	0.848	26	25	0.033	-1.096	1.050	0.022	-1.742
27	0.810	27	25	0.346	-0.474	1.006	0.625	-0.717
		27	28	0.001	6.283		0.001	3.542
		27	29	0.320	-0.225		0.205	-0.907
		27	30	0.393	-0.371		0.251	-1.153
28	0.858	28	27	0.001	6.283	0.956	0.001	3.542
		28	8	0.044	-0.135		0.029	-0.211
		28	6	0.632	-1.731		0.461	-3.211
29	0.786	29	27	0.320	-0.225	0.990	0.205	-0.907
		29	30	0.008	-1.138		0.005	-1.825
30	0.781	30	27	0.393	-0.371	0.986	0.251	-1.153
		30	29	0.008	-1.138		0.005	-1.825
Total				**54.300**	**147.481**		**47.808**	**93.767**

Table 4. IEEE-30 Bus System Generator and Load loss with and without compensation

	Without Compensation	With Compensation
Generator Loss	17.180	16.387
Load Loss	42.898	31.410
Total Active Power Loss	60.078	47.797

VI. CONCLUSION

This paper is states loss division technique which separate transmission, generation and load losses of the electric power market to that competitors. There is no approximation formula derived and it can decouple the loss share due to unbalanced generator voltages. The proposed method provides the possibility of self-compensation with the help of balancing generator voltage magnitude and angle. Numerical test was performed on IEEE 14&30 – bus reliability test system and the results show that this method is comprehensive and fair to separating the power losses of a restructuring power market to its participants which restructure electrical power system.

Thus, this method is reliable, least amount of limitation for loss division and which gives the system operator suggestion about economic operation and power plant operation at which rate.

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