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A New Technique for Transmission Loss Allocation in a Deregulated Electricity Market

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Abstract: ***In a present day a necessity for fair allocation of transmission loss in a deregulated electricity market. This paper presents modifiedZbus loss allocation method to calculate the allocation of transmission loss loss . The procedure depends on straightforward circuit laws and doesn't include any suppositions. results obtained for IEEE 14 Bus system are analysed with the other present methods.***

Keywords: ***Load Flow Analysis, , Transmission Pricing,*** Z_{bus} ***, Transmission Loss Allocation***

I. INTRODUCTION

Loss allocation of transmission loss plays a important role in deregulated electricity market. In a power system has generators and demands are connected to the common network, change in one individual effects the others connected in the network by complicating the calculation of cost of each individual accountability[1]. A perfect method of calculating the allocation of transmission loss is needed for all individual who participate. Each elected method is constructed on specific characteristic of its network [2]. Postage stamp method is the simplest method which compacts with the amount of power flow and its usage for particular time regardless of its supply and demands in the network located. This method suits to the electric system where all the generators and demands located with short distance without considering the usage of participant[1]. Actual Power flows are not reflected in power grid using contract path method[2]. Another method The MW-Mile explains the participation of each demand & generator in each line flow and its loss[1][2]. Proportional sharing principle method calculates the losses proportionally to the flow of power entering the bus, based on KCL. Loss allocation is done 50% loss to generation and 50% to demands from total lossi this method depends on select on of slack bus[3].

J.Bailekanticipated a method to calculate loss allocation via merit based generation power dispatch and calculating nodal pricing to allocate loss between supplies and demands [4]

Coefficients used can be positive or negative for transmission loss allocation in Incremental transmission loss(ITL) [5]. A.J.Conejoacknowledge the mathematical separation of losses in exsisting network buses, by subjugated $Z_{bus,}$, new proposed a loss allocation method [6]. J.S. Daniel *et al* modified the Y_{bus} to comprise the method of transmission loss allocation [7]. Using bus loss matrix a quadratic loss look and allocation is introduced by Qieng Ding and Ali Abur [8].Z_{bus} based technique offers commitments of bus currents to complex line flows is built up [9]. A bound together methodology for transmission loss distributionwithinbuses and different exchanges is established in[10].The framework loss is disintegrated by the whole of bus- shrewd fractional integrals, every one of which speaks to the bus wise allocation of loss in[11] Power loss in transmission line in spot pricing is not often through because of is complications like flow of power in paths, nonlinearity, ambiguous solutions in order to minimize the error of allocation to match with accurate real system loss in [12] S.M. Abdul Khaderdeintegratedtransmission loss into various sects (i) flow of current from generator to demands, circulating current within generators and theirinvolvement arrangemtand leads to rise or reduction of transmission losses[13]. AC load flow is used to calculate loss factors aimed at calculation of loss allocationfrom incremental methods [14]. Heavy transfer of power is accountablefor huge transmission losses and loss procedure, loss allocation for mixed pool and bilateral markets was anticipated in[15]. By means of bus-branch flow direction matrix determined power flow tracing loss allocation was established [16]. The paper anticipates a new model to acheive transmission loss allocation factors for [7]. The method consists of basics of Kirchhoff laws. The method obtains power loss allocation by comprising real power loss and its bus contribution factors . The results were obtain on a IEEE 14 BUS system . The results were compared with the results of other existing methods. The paper is organized as follows. converged load flow solution, conclusion of the contributions of bus currents to the complex line flow is presented in Section II. Transmission loss allocation methodology is known in section III. . Results of IEEE 14 bus system loss allocation are presented in section IV. Conclusions are given in section V.

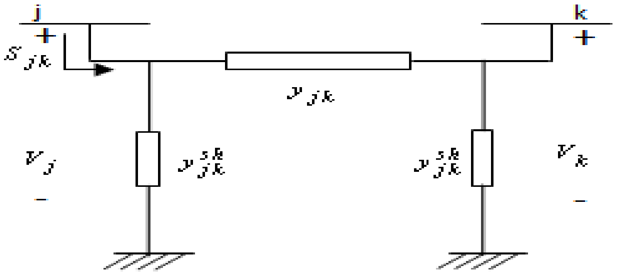

Fig 1. Π- Equivalent circuit of line

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II. CONTRIBUTIONS OF BUS CURRENTS

Using load flow analysis bus voltages, complex power flows in lines, slack bus power generation etc are obtained. Coefficients of the bus currents in the line flows are obtained by determining the coefficients and allocation of transmission loss and cost belong to discrete buses.

As shown in Fig 1.,y_{jk} is line admittanceand y_{jk}^{sh} half line charging susceptance connected between the buses jand k. $V_j$and$V_k$are the nodal voltages of buses j and k respectively. S_{jk}in terms of the node voltage V_j and the line current I_j through the lineconnected between jth and k th busesas

$S_{jk} = V_j I_{jk}^*$………. (1)

The equations from Z_{bus} based system, the potential of jth node is specified below

$V_j = \sum_{i=1}^{n} Z_{ji} I_i$ ………… (2)

The linecurrent betweenjthand kthbuses is obtained as

$I_{JK} = (V_j - V_k) y_{jk} + V_j y_{jk}^{sh}$ ………. (3)

Substituting (2) in (3) and rearranging

$I_{jk} = \sum_{i=1}^{n} [(Z_{ji} - Z_{ki}) y_{jk} + Z_{ji} y_{jk}^{sh}] I_i$ ……….. (4)

Replacing theI_{jk} from (4) in (1) & reordering

$S_{jk} = \sum_{i=1}^{n} (Factor\_1)_{jk}^{i}$ ………… (5)

Where

$Factor\_1_{jk}^{i} = V_j \left[[(Z_{ji} - Z_{ki}) y_{jk} + Z_{ji} y_{jk}^{sh}] I_i \right]^*$ ……….. (6)

So, the complex power flowS_{jk} any line j to k is denoted as a function of all bus currents; i = 1, 2, 3…..n.

$Factor\_1_{jk}^{i}$ represents contribution of ith bus to ‘j→k’ line power flow.

III. TRANSMISSION LOSS ALLOCATION

Similarly, .S_{kj}complex line flow from bus k to bus jis

$S_{kj} = \sum_{i=1}^{n} (Factor\_2)_{jk}^{i}$ ………… (7)

where

$Factor\_2_{jk}^{i} = V_k \left[[(Z_{ki} - Z_{ji}) y_{jk} + Z_{ki} y_{kj}^{sh}] I_i \right]^*$ ……….. (8)

$Factor\_2_{jk}^{i}$ says the participation of complex power flow in the line k to j due to it generator. The Complex transmission line loss is the algebraic sum of active and counter complex line flows. Hence, apparent transmission line lossis represented as

$S_{line\ loss} = S_{jk} + S_{kj} = \sum_{i=1}^{n} Factor_{jk}^{i}$ ……….. (9)

Where$Factor_{jk}^{i} = (Factor_1)_{jk}^{i} + (Factor_2)_{jk}^{i}$

The significance of $Factor_{jk}^{i}$ is that it represents the contribution of ith bus to the ‘j→k’ line loss and also the contribution of line’j→k’to the power injection at bus i.

For a given power flow solution this quantity is a constant

Thus, conventionline linked between jth and kth by generator ‘i' can be well-defineds in a way

$U_{jk}^{Gi} = |SR13_{jk}^{i}|$. …………. (10)

where $SR13_{jk}^{i} = real(S1_{jk}^{i} + S3_{jk}^{i})$ …………. (11)

henceforth the convention line’jk’ by demand ‘i' can be well-definedsin a way

$U_{jk}^{Di} = |SR24_{jk}^{i}|$ …………. (12)

where $SR24_{jk}^{i} = real(S2_{jk}^{i} + S4_{jk}^{i})$ …………. (13)

the resulting convention line by bus ‘i' is given by

$U_{jk}^{i} = U_{jk}^{Gi} + U_{jk}^{Di}$ …………. (14)

The total conventionline ‘jk’ commencing entire buses is

$U_{jk} = \sum_{i=1}^{n} U_{jk}^{i}$ …………. (15)

Transmission Cost allocation

If ‘C_{jk}’in $/his the total annualized line cost, comprisesbuilding costs, maintenance andoperation,. The cost rate for line ‘jk’ is

$r_{jk} = \frac{C_{jk}}{U_{jk}}$ $/MWh ………..(16)

line cost allocated to the generator located at ith bus is

$C_{jk}^{Gi} = r_{jk} U_{jk}^{Gi}$ …………. (17)

Similarly, line costallocated to the demand located at ith bus is

$C_{jk}^{Di} = r_{jk} U_{jk}^{Di}$ …………(18)

The total transmission cost of the network allocated to the generator located at ith bus is

$C^{Gi} = \sum_{(j,k)\in nline} C_{jk}^{Gi}$ …………. (19)

where ‘n_line’ is the total number. of lines

similarly, the total transmission cost allocated to the demand located at ith bus

$C^{Di} = \sum_{(j,k)\in nline} C_{jk}^{Di}$ …………. (20)

IV. RESULTS

ForaIEEE 14 bus system. We get

	L1	L2	L3	L4	L5	L6	L7	L4	L16	L17	L 18	L 20	P_{inj}
Bus1	0.493	0.38	0.324	0.442	0.293	0.284	0.109	0.0002	1E-04	-0	0.0001	2E-04	**2.3251**
Bus2	0.038	0.03	0.025	0.033	0.023	0.026	0.0093	0	0	0	0	0	**0.1829**
Bus 3	-0.194	-0.15	-0.13	-0.18	-0.124	-0.116	-0.045	0.0002	1E-04	0	0.0001	1E-04	**-0.942**
Bus4	-0.098	-0.08	-0.07	-0.09	-0.062	-0.064	-0.022	0.0002	1E-04	-0	0.0001	1E-04	**-0.478**
Bus5	-0.015	-0.01	-0.01	-0.01	-0.01	-0.01	-0.004	0	0	0	0	0	**-0.076**
Bus6	-0.038	-0.02	-0.02	-0.02	-0.016	-0.02	-0.008	-8E-04	-0	0.001	-3E-04	-7E-04	**-0.112**
Bus7	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Bus8	-0.009	-0	0.002	-0	-0.001	-0.003	0.001	0.0001	2E-04	-0	0	1E-04	**2E-18**
Bus9	-0.052	-0.05	-0.04	-0.05	-0.037	-0.036	-0.014	0.0012	5E-04	-0	0.0009	9E-04	**-0.295**
Bus10	-0.016	-0.01	-0.01	-0.02	-0.011	-0.011	-0.004	0.0005	1E-04	0	0.0004	2E-04	**-0.09**
Bus11	-0.006	-0.01	-0	-0.01	-0.004	-0.004	-0.002	0.0004	0	0	-3E-04	0	**-0.035**
Bus12	-0.011	-0.01	-0.01	-0.01	-0.008	-0.008	-0.003	-3E-04	3E-04	1E-04	-2E-04	-3E-04	**-0.061**
Bus13	-0.024	-0.02	-0.02	-0.02	-0.017	-0.017	-0.006	-5E-04	0.001	1E-04	-3E-04	-8E-04	**-0.135**
Bus14	-0.028	-0.02	-0.02	-0.03	-0.019	-0.019	-0.007	0.0001	8E-04	2E-04	0.0001	0.001	**-0.149**
Ploss	**0.042**	**0.02**	**0.017**	**0.028**	**0.009**	**0.004**	**0.0046**	**0.0013**	**0.003**	**0.001**	**0.0006**	**0.001**	

Table 3 Represents the Power Injection Line Flow Distribution Matrix[B] matrix

Table 4 loss aloccation of IEEE 14 bus system

Bus	**Zbus**	**PR**	**PS**	**ITL**	**Proposed method**
1	7.64	5.5	6.48	6.14	6.45
2	0.16	0.64	0.3	0.96	0.48
3	2.78	2.34	2.88	2.92	2.58
4	0.84	1.16	1.26	1.26	1.31
5	0.08	0.18	0.16	0.18	0.21
6	0.48	1.02	0.26	0.32	0.33
7	0	0	0	0	0
8	0.02	0.66	0	0	0.07
9	0.52	0.82	0.78	0.68	0.8
10	0.18	0.26	0.28	0.2	0.24
11	0.06	0.1	0.1	0.08	0.1
12	0.1	0.14	0.16	0.18	0.18
13	0.26	0.34	0.38	0.32	0.38
14	0.44	0.4	0.52	0.32	0.43
Total	13.56	13.56	13.56	13.56	13.56

The results obtained using proposed method are compared with other methods. Allocation using Zbus modified method is considered with other methodologies.

V. CONCLUSIONS

The paper presents from load flow solution, and observing the contributing causes of complex power injection at a node and obtaining the transmission line loss connected between the buses and allocation is done as per the usage of power and it is satisfied . Alternative noteworthy element of this method is that, impact of reactive power supply and demand can effectively improved.This method can be extended to calculation of LMP 's in a deregulated electricity market.

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