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Methodology for congestion management

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ABSTRACT: *Now a days all our basic needs are relates with electricity. The demand for electricity is tremendously increasing day by day. Due to insufficient transmission capacity, one or more transmission line may operate beyond their limits thereby causing transmission congestion and voltage instability problems. Due to the congestion in the network, it is not possible to transmit all the contracted power. Thus increased power demand has forced the power system to operate very closer to its stability limits. So transmission congestion problems are arise in the power system. In this paper the generator participation factor is used to determine the ATC of network, designed in Power Word Simulator17. The participation factor is a measure of how the real power output of the generator changes in response to load demand. In this paper, ATC of the network is calculated, by considering different generator participation factors. By changing the participation factors of generators maximum allowable load at a bus can be changed without causing insecurity to the power system network and hence can be used as a tool for congestion management.*

Keywords - *Available Transfer Capability (ATC), Congestion, Participation Factors,Power transfer distribution factor, Transmission Management*

I. INTRODUCTION

Now a days all our basic needs are relates with electricity. The demand for electricity is tremendously increasing day by day. Every link in the transmission system has a limit on the amount of power it can transfer at a given time. Several phenomena can impose these transfer limits, including thermal limits, voltage limits, and stability limits. The increased power demand has forced the power system to operate very closer to its stability limits. So transmission congestion problems are arise in the power system. Thus Congestion management is major challenges to power system researchers.

1.1 Congestion management

When the producers and consumers of electric energy desire to produce and consume in amounts that would cause the transmission system to operate at or beyond one or more transfer limits, the system is said to be congested. Congestion management that is, operating the transmission system so that transfer limits are observed is perhaps the fundamental transmission management problem. Congestion can be detected by evaluation of ATC of the network for various applied power transactions.

There are different method available for congestion management such as Out-aging of congested lines, using transformer taps/phase shifters, using FACTs devices, by changing generator participation factor, Curtailment of loads.

II. METHOD FOR CONGESTION MANAGEMENT

2.1 Congestion Management By Changing Generator Participation Factor

2.1.1 ATC

When electric power is transferred from one location (or area) to another, the entire transmission network responds to the transaction. Power flows on transacting elements and interfaces changes depending on many factors such as network topology, generation dispatches, customer demand levels and other transactions in the network. The ATC of the transmission network would therefore, become a function of all these variables. ATC can have a huge impact on market outcomes and system reliability, so the results of ATC are of great interest importance.

"ATC is a measure of the transfer capability remaining in the physical transmission network for further commercial activity over and above already committed uses". Mathematically, ATC is defined as the Total Transfer Capability (TTC) less the Transmission Reliability Margin (TRM), less the sum of existing transmission commitments (which includes retail customer service) and the Capacity Benefit Margin (CBM). ATC can be expressed as

$$ATC = TTC - TRM - \{ETC + CBM\}.$$

III. GENERATOR PARTICIPATION FACTOR

The participation factor is used to determine how the real power output of the generator changes in response to demand when the generator is available for Automatic Generation Control (AGC) and the area is on participation factor control .Participation factor of a generator is the ratio of change in generator power of that generator to the change in load. It is given as,

$$x_i = \frac{\Delta T_{ik}}{\Delta P_k}$$

Where, x_i Generator participation factor,

ΔT_{ik} change in generator power at i^{th} bus due to change in load at k^{th} bus,

ΔP_k change in load at k^{th} bus

For the purpose of calculating ATC, buyer and seller transactors are to be specified. This can be slack, a single bus, injection groups, areas etc. When multiple generators exist in the transaction, such as the case of areas or injection groups, participation factors are needed to be assigned. So as to know the participation of generators or loads, the load flow solution must be known .When x_i are specified, change in generator powers will be,

$$\Delta T_{ik} = x_i \Delta P_k$$

It is assumed that the losses are to be contributed by slack bus generator which gives,

$$\Delta T_i = \Delta T_{ik} + \Delta Loss$$

where,

$\Delta Loss$ is the change in losses due to ΔP_k

IV SIMULATION RESULTS FOR IEEE 9 BUS SYSTEM

The effect on ATC of the network by changing generator participation factors and by varying the load has been carried on below modified IEEE 9 bus system. In this modified IEEE 9 bus system, the bus1 is a slack bus, bus 2 and bus3 are generator buses. The bus5, bus7, bus9 are load buses.

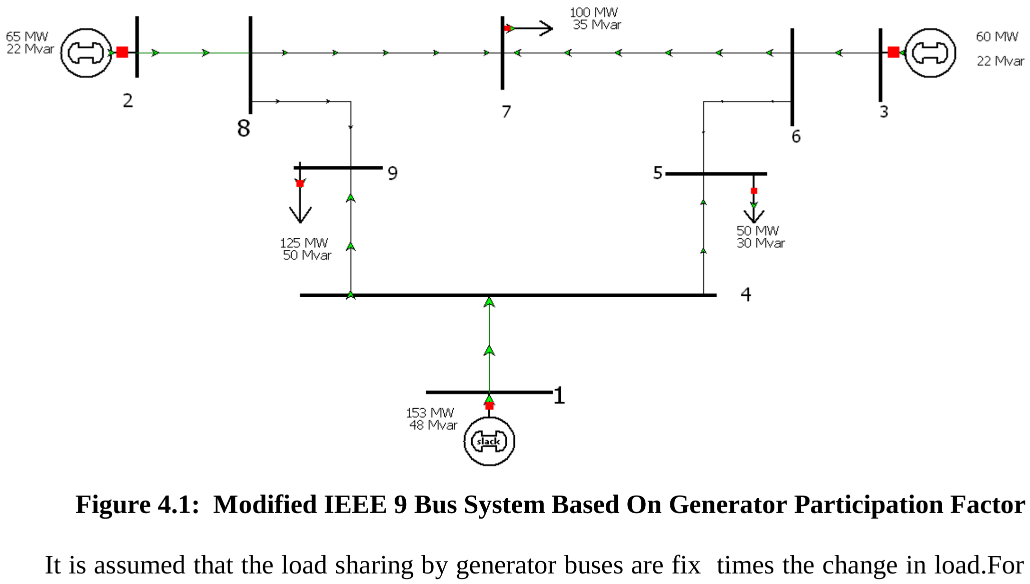

Figure 4.1: Modified IEEE 9 Bus System Based On Generator Participation Factor

It is assumed that the load sharing by generator buses are fix times the change in load.For example, if 0.2, 0.2, 0.6 are the participation factors for the generators 1, 2, 3 respectively. For a change in load 10 M.W, then generator 1 additionally supplies 2 M.W, generator 2 additionally supplies 2 M.W and generator 3 additionally supplies 6 MW. The ATC contributions with changing generator participation factors and increment of load at particular bus is shown as follows :

Table 1: ATC of IEEE 9-bus system for x_1=0.3x_2=0.5,x_3=0.2 & initial load at bus 5=50 MW

Comp-uting Hour	Applied Change in Load at bus 5 (MW)	Generator and Load Bus Pair	Transacting power MW x_1=0.3 x_2=0.5 x_3=0.2	N/W ATC when Individual Transactions are of concern (MW)	N/W ATC (MW) for Simultaneous Power Transaction from all Generators to Bus 5
1	5	1---5	1.5	201.52	63.92
		2---5	2.5	31.96	
		3---5	1	64.37	
2	5	1---5	1.5	199.69	59.28
		2---5	2.5	29.64	
		3---5	1	59.70	
3	5	1---5	1.5	197.85	54.66
		2---5	2.5	27.33	
		3---5	1	55.04	
4	10	1---5	3	194.34	44.74
		2---5	5	22.37	
		3---5	2	45.25	
5	10	1---5	3	190.59	35.7
		2---5	5	17.85	
		3---5	2	35.96	
6	5	1---5	1.5	188.70	31.1
		2---5	2.5	15.55	
		3---5	1	31.31	
7	5	1---5	1.5	186.80	26.48
		2---5	2.5	13.24	
		3---5	1	26.68	
8	10	1---5	3	182.98	17.28
		2---5	5	8.64	
		3---5	2	17.41	
9	-5	1---5	-1.5	184.89	21.9
		2---5	-2.5	10.95	
		3---5	-1	22.05	
10	-7	1---5	-2.1	187.55	28.36
		2---5	-3.5	14.18	
		3---5	-1.4	28.56	
11	-5	1---5	-1.5	189.44	32.98
		2---5	-2.5	16.49	
		3---5	-1	33.21	
12	-5	1---5	-1.5	191.32	37.6
		2---5	-2.5	18.80	
		3---5	-1	37.86	

Fig 4.2 shows the variation in Available Transfer Capability of network corresponding to change in load at bus-5 for set of participation factors as x_1=0.3x_2=0.5,x_3=0.2.

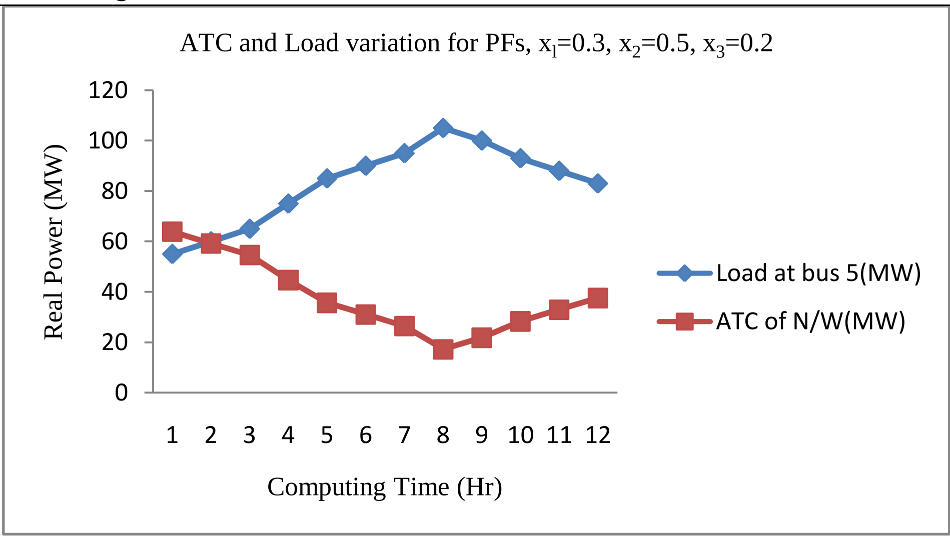

Figure 4.2: ATC And Load Variation For Pfs, X_1=0.3x_2=0.5,X_3=0.2

Fig 4.3 shows the congestion in network corresponding to change in load at bus-5 for set of participation factors as x1=0.3, x2=0.5, x3=0.2.

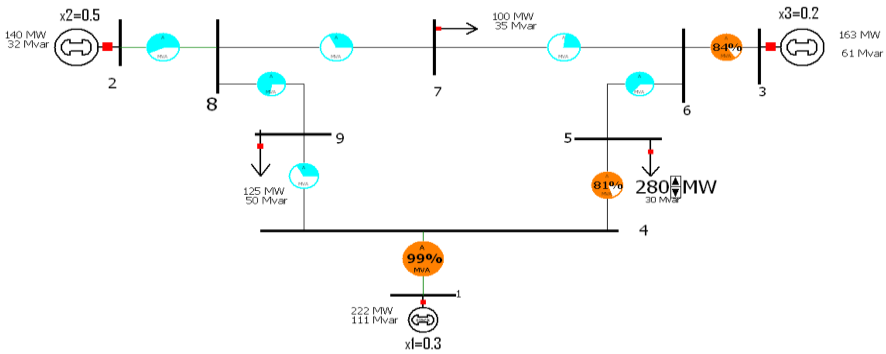

Figure 4.3: Congestion In Network For Participation Factors X1=0.3, X2=0.5, X3=0.2

Fig 4.4 shows the congestion in network corresponding to change in load at bus-5 for set of participation factors as x1=0.3, x2=0.3, x3=0.4.

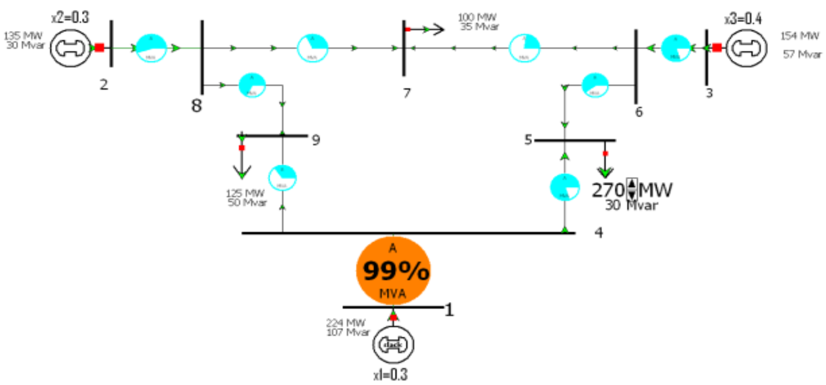

Figure 4.4: Congestion In Network For Participation Factors X1=0.3, X2=0.3, X3=0.4

TABLE 2: ATC with consideration of changes in load at bus 5 and different participation factor

Compu t-ing Hour	Applied Change in Load at bus 5 (MW)	ATC of N/W(MW) x1= 0.6 x2=0.2 x3=0.2	ATC of N/W (MW) x1= 0.4 x2=0.3 x3=0.3	ATC of N/W (MW)x1= 0.5 x2=0.2 x3=0.3
1	55	112	101.9	138
2	60	110	96.8	133.3
3	65	107.2	91.7	128.55
4	75	101.55	81.5	119.1
5	85	95.95	71.3	109.65
6	90	93.15	66.2	104.9
7	95	90.3	61.13	100.5
8	105	84.15	50.4	90.7
9	100	87	55.5	95.45
10	93	90.95	62.66667	102.1
11	88	93.8	67.76667	106.85
12	83	96.6	72.9	111.6

4.1 Observations

It is observed that when load at bus-5 is increased from 1st computing hour, the ATC of network decreases upto 8th hour and again increases from 9th computing hour when load at bus 5 is decreased. It is observed that ATC of network changes when the generator participation factor is changed. The below graphical representation shows the ATC and load variations for corresponding generator participation factors.

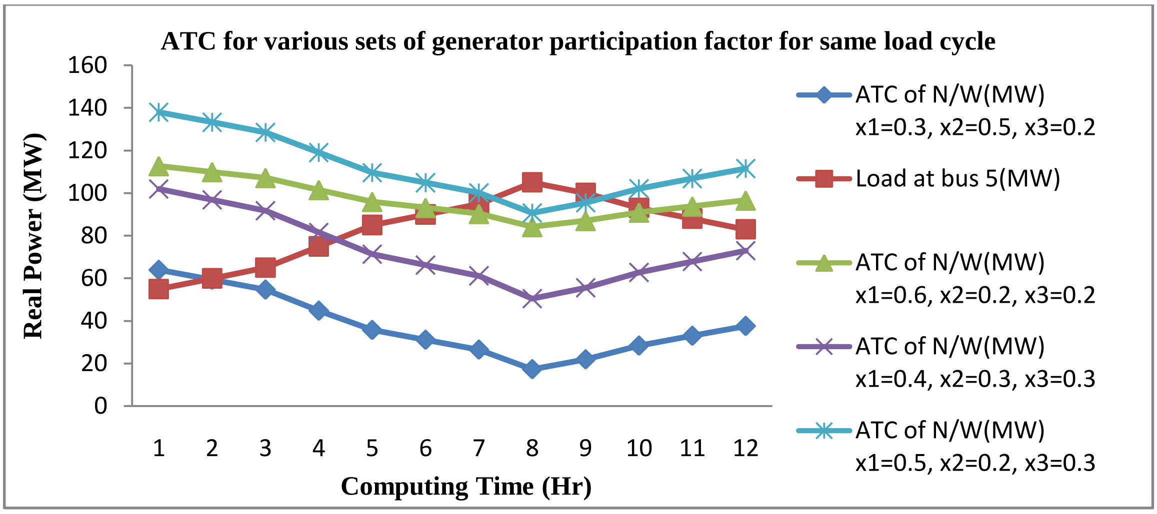

Figure 4.5: Graphical Representation Of Network ATC For Various Sets Of Generator Participation Factor For Same Load Cycle

From fig.4.4 & fig.4.3 it is observed that the total maximum load applied at load bus 5 for are 140 M.W for participation factors x1=0.3, x2=0.5, x3=0.2 is280 MW and 270 M.W for participation factors x1=0.3, x2=0.3, x3=0.4. Thus by changing generator participation factor congestion can be relieve and loadability of the network can be increased.

V CONCLUSION

Congestion management is one of the challenging and toughest tasks. Whenever the loading on the network continuously increases, then ATC of the network will goes on decreases. From the results as obtained, it can be concluded that, the maximum load that can be applied to a bus without causing network congestion can be changed by changing generator participation factor. Generator participation factor can be used as a tool for congestion management.

REFERENCES

[1]. Ghawghawe N.D and Thakre, K.L 'ATC evaluation with consideration of load changes and participation factors-A sensitivity analysis approach' Power Engineering Conference, 2007. IPEC 2007.
[2]. Shahidehpour M and Almoush M "Restructured Electric Power System" Marcel- Deccer Publishers pp.158-159.
[3]. Bhattacharya K, Operation of Restructured Power Systems, Kluwer Academic Publishers, USA, 2001 pp 15-21[4] Hugh Rudnick,
[4]. "Planning in a deregulated environment in developing countries : Bolivia, Chile, Peru", IEEE Power Engineering Review 16(7) (1996) 18-19.
[5]. Christie R and Wangestin I, 'Transmission Management in Deregulated Environment' IEEE Proceedings 88(2000) 170-195.
[6]. North American Electric Reliability Council (NERC), 'Available Transfer Capability Definitions and Determination', NERC Report, June 1996.
[7]. ETSO-'Definitions of Transfer Capabilities in Liberalised Electricity Markets' final report April 2001.
[8]. Sauer P.W , 'Technical Challenges of Computing Available Transfer Capability (ATC) in Electric Power Systems" Proceedings, 3tf[h]
[9]. Annual Hawai International Conference on System Sciences Jan 7-10, 1997 pp. 1-5
[10]. Prabha Kundur, Power System Stability and Control, EPRI, Power system Engineering Series, Tata McGraw-Hill, 3[rd] Reprint 2007
[11]. Hadi Saadat Power System Analysis Tata McGraw-Hill Edition 2002s