ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 10, October 2015

Evaluation of Available Transfer Capability in a Restructured Electricity Market Using UPFC Transformer Model

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ABSTRACT: In a competitive electricity markets, calculation of Available Transfer Capability (ATC) is significant indicator for a commercial use of transmission networks. In this approach, all the market participants try to utilize the transmission system to the possible extent. This paper presents the determination of ATC for a bi-lateral transactions based on AC Power Transfer Distribution Factors (ACPTDF), using Unified Power Flow Controller (UPFC) in a power system network. In order to study the capability of UPFC, in determining the ATC values, a transformer model of UPFC is used. The proposed method is tested on New England 10 machine 39-bus system.

KEYWORDS: ATC, Bi-lateral Transaction, ACPTDF, Transformer model of UPFC

I. INTRODUCTION

In a deregulated power system networks, it is required for the Independent System Operator (ISO) to provide a fair and non-discriminatory access to transmission network for all power producers and distributors. In view of maintaining security and stability of the transmission system, the accurate quantification of ATC has become one of the major responsibilities of the ISO and to update ATC in real time for its optimal and economical way of operation for maintaining security and stability of the power system operations. According to NERC report [1], ‘‘Available Transfer Capability Definitions and Determination”, ATC is mathematically defined as the Total Transfer Capability (TTC) less the Transmission Reliability Margin (TRM), less the sum of the Existing Transmission Commitments (ETC) and the Capacity Benefit Margin (CBM) .Some techniques and methodologies have been proposed to compute these components before calculating ATC. In fact, if the CBM, TRM, and ETC values are assumed to be constant, then ATC is directly expressed by TTC. Thus, TTC is usually addressed as the basis for ATC determination [2].

There are three different restrictions to the power transmission network. They are Thermal, voltage and stability limits. With capability and flexibility of power system networks, FACTS technology addresses most of the system constraints. FACTS devices can regulate voltage profiles, by maintaining voltage magnitude and phase angle of the system within the limits. These devices will provide the solutions for power flows both steady state and dynamic conditions [3].

Many authors have been proposed for determination of ATC using power flow sensitivity. These methods are based on power transfer distribution factors/outage factors (PTDFs), (LODFs) using DC load flow [4], AC load approach using sensitivity factors including maximum area concept, sensitivity analysis of system uncertainties [5–13]. The DC load flow based approaches are fast however are based on DC load flow assumptions.

Sen Transformer has emerged as one of the powerflow control devices. An analysis of comparison of UPFC and Sen Transformer is presented recently in [14]. However, the authors have utilized optimal power flow based methods for ATC enhancement with FACTS devices. The PTDFs with FACTS devices for ATC determination in multi-transaction market environment can be obtained for ATC determination as sensitivity based methods are proven faster.

II. ACPTDF DETERMINATION WITH UPFC

From the power transfer point of view, a transaction is a specific amount of power that is injected into the system at one bus by a generator and drawn at another bus by a load. The coefficient of linear relationship between the amount of a transaction and flow on a line is represented by PTDF. It is also called sensitivity because it relates the amount of one change - transaction amount - to another change - line power flow.
PTDF is the fraction of amount of a transaction from one bus to another that flows over a transmission line $PTDF_{lm,ji}$ is the fraction of a transaction from bus i to bus j that flows over a transmission line connecting buses l and m.

$$PTDF_{lm,ji} = \frac{\Delta P_{lm}}{P_{ji}}$$

ATC calculation
ATC is determined by recognizing the new flow on the line from node I to node m, due to a transaction from node I to node j. The new flow on the line is the sum of original flow P_{lm}^0

$$P_{lm} = P_{lm}^0 + PTDF_{lm,ij} P_{ij}$$

Where, P_{lm}^0 is the base case flow on the line and P_{ji} is the magnitude of proposed transfer. If the limit on line Im, the maximum power that can be transferred without overloading lineIm, is $P_{lm}^{\max}$, then,

$$P_{ij,lm}^{\max} = \frac{P_{lm}^{\max} - P_{lm}^0}{PTDF_{lm,ij}}$$

$P_{ij,lm}^{\max}$ is the maximum allowable transaction from node I to node j constrained by the line from node I to node m. ATC is the minimum of the maximum allowable transactions over all lines.Using the above equation, any proposed transaction for a specific hour may be checked by calculating ATC. If it is greater than the amount of the proposed transaction, the transaction is allowed. If not, the transaction must be rejected or limited to the ATC.

$$ATC_{ij} = \min\left(P_{ij,lm}^{\max}\right)$$

Using the above equation, any proposed transaction for a specific hour may be checked by calculating ATC. If it is greater than the amount of the proposed transaction, the transaction is allowed. If not, the transaction must be rejected or limited to the ATC.The detailed analysis regarding the calculations of ATC values for any power system network has been given in [15].

III. UPFC TRANSFORMER MODEL

Here this modeling is performed by using Transformer and a shunt branch shown in Fig.1.

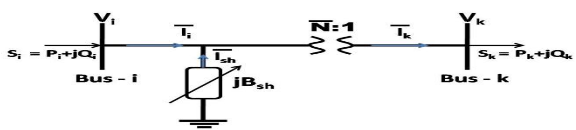

Fig.1. UPFC Transformer Model

The main improvement in this model is that, device control parameters are related to the transformer not related to the device currents and voltages. Hence the independent control variables are transformer turns ratio (N), phase shifting angle (ϕ) and susceptance of the shunt branch (B_{sh}). The turn's ratio of the transformer can be expressed as

$\overline{N} = Ne^{j\phi} --(1)$

The modeling of the UPFC can be done by including UPFC in a transmission line by converting the system into two ports including device, namely input and output. The final two port representation of the model is

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

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$$\begin{bmatrix}\bar{V}_i\\ \bar{I}_i\end{bmatrix} = ABCD_U \begin{bmatrix}\bar{V}_k\\ \bar{I}_k\end{bmatrix} \quad -(2)$$

where, input and output voltages of UPFC can be represented as

$$\bar{V}_i = \bar{V}_k N\underline{/\phi} \quad -(3)$$

$$\bar{I}_i = j\bar{N}B_{sh}\bar{V}_k + \frac{1}{\bar{N}^*}\bar{I}_k \quad -(4)$$

The complex power injections at buses 'i' and 'k' are expressed as

$$\bar{S}_i = \bar{V}_i\bar{I}_i^*$$

$$\bar{S}_i = T\bar{V}_k\left(\bar{N}B_{sh}\bar{V}_k + \frac{1}{\bar{N}^*}\bar{I}_k\right)^*$$

$$\bar{S}_i = \bar{S}_k - j|\bar{N}|^2.\bar{V}_k^2B_{sh} \quad -(5)$$

From this it is clear that there is no real power transaction in the line by UPFC (P_i=P_k) and the reactive power is

$$Q_k = Q_i + \bar{N}^2\bar{V}_k^2B_{sh}$$

can be generated/absorbed by the device as there is a shunt branch. The expressions for UPFC input voltage and current are (from Eqs (3), (4))

$$\bar{V}_i = \bar{V}_k - \bar{V}_N = \bar{V}_k\left(1 - \frac{\bar{V}_N}{\bar{V}_k}\right) = \bar{V}_k N\underline{/\phi}$$

Similarly,

$$\bar{I}_i = \bar{I}_k + \bar{I}_N = \bar{I}_k + \left(\frac{1}{N}\underline{/\phi} - 1\right)\bar{I}_k + jB_{sh}\bar{V}_i$$

The injected voltage and device current into the system are

$$\bar{V}_N = \bar{V}_k\left(1 - N\underline{/\phi}\right) \quad -(6)$$

$$\bar{I}_N = \left(\frac{1}{N}\underline{/\phi} - 1\right)\bar{I}_k + jB_{sh}\bar{V}_i \quad -(7)$$

The power handled by the UPFC converters is

$$\bar{S}_1 = \bar{V}_i\bar{I}_N^* = \left(1 - N\underline{/\phi}\right)\bar{S}_k - jB_{sh}|\bar{N}|^2.\bar{V}_k^2$$

$$\bar{S}_2 = -\bar{V}_N\bar{I}_k^* = (N\underline{/\phi} - 1)\bar{S}_k$$

Thus

$$\bar{S}_2 + \bar{S}_1 = -jB_{sh}|\bar{N}|^2.\bar{V}_k^2$$

This clearly shows that, UPFC Transformer model does not depend on the voltage and current parameters of the device. The main dependent variables are related to the transformer parameters listed above. The resultant UPFC transformer model is shown in Fig.2.

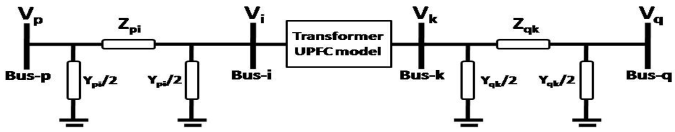

Fig.2. UPFC included in a transmission line

Incorporation UPFC in Load Flow

Let us consider two system buses (p and q) to install UPFC. From Fig.2, the transmission line is divided into three sections, input and output sections represents 'Π' networked transmission lines, the middle section consist UPFC.

The ABCD matrices for input and output sections are given as

$$ABCD_p = \begin{bmatrix}A_p & B_p\\ C_p & D_p\end{bmatrix} \quad and \quad ABCD_q = \begin{bmatrix}A_q & B_q\\ C_q & D_q\end{bmatrix}$$

Where,

$$A_p = D_p = 1 + \frac{Y_pZ_p}{2}, \qquad B_p = Z_p, \qquad C_p = Y_p\left(1 + \frac{Y_pZ_p}{4}\right)$$

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

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Vol. 4, Issue 10, October 2015

$$A_q = D_q = 1 + \frac{Y_q Z_q}{2}\ ,\ B_q = Z_q\ ,\quad C_q = Y_q\left(1 + \frac{Y_q Z_q}{4}\right)$$

The propagation constant ('γ') and characteristic impedance (Z_C) are computed as

$$\gamma = \frac{1}{l}\cosh^{-1}\left(1 + \frac{yz}{2}\right) \qquad -(8)$$

$$z_c = \frac{z}{\sinh(\gamma l)} \qquad -(9)$$

where, 'l' is the length of the transmission line in km.

In Fig.2, the equivalent transmission line parameters can be expressed as

$$Z_p = Z_c \sinh(\gamma l.x)\ ,\quad Y_p = \frac{2(\cosh(\gamma l.x) - 1)}{Z_p}$$

$$Z_q = Z_c \sinh(\gamma l.(1-x))\ , Y_q = \frac{2(\cosh(\gamma l.(1-x)) - 1)}{Z_q}$$

The resultant two port network equation is represented as

$$\begin{bmatrix}\bar{V}_p \\ \bar{I}_q\end{bmatrix} = ABCD_p ABCD_U ABCD_q \begin{bmatrix}\bar{V}_q \\ -\bar{I}_q\end{bmatrix} = \begin{bmatrix}A_{pq} & B_{pq} \\ C_{pq} & D_{pq}\end{bmatrix}\begin{bmatrix}\bar{V}_q \\ -\bar{I}_q\end{bmatrix} \qquad -(10)$$

where,

$$A_{pq} = \bar{N}A_p A_q + j\bar{N}B_p A_q B_{sh} + \frac{1}{\bar{N}^*}B_p C_q$$

$$B_{pq} = \bar{N}A_p B_q + j\bar{N}B_p B_q B_{sh} + \frac{1}{\bar{N}^*}B_p D_q$$

$$C_{pq} = \bar{N}C_p A_q + j\bar{N}D_p A_q B_{sh} + \frac{1}{\bar{N}^*}D_p C_q$$

$$D_{pq} = \bar{N}C_p B_q + j\bar{N}D_p B_q B_{sh} + \frac{1}{\bar{N}^*}D_p D_q$$

The currents at buses 'p' and 'q' are given as

$$\begin{bmatrix}\bar{I}_p \\ \bar{I}_q\end{bmatrix} = Y_{bus,pq}\begin{bmatrix}\bar{V}_p \\ \bar{V}_q\end{bmatrix} \qquad -(11)$$

The resultant Y-bus including UPFC can be expressed as

$$Y_{bus,pq} = \begin{bmatrix}\frac{D_{pq}}{B_{pq}} & C_{pq} - \frac{A_{pq}D_{pq}}{B_{pq}} \\ -\frac{1}{B_{pq}} & \frac{A_{pq}}{B_{pq}}\end{bmatrix} \qquad -(12)$$

By deriving Y-bus using the above procedure, there is no concept of forming fictitious buses for UPFC. This model can be directly incorporated into the system by modifying Y-bus as per the Eq. (12).

ACPTDF determination with UPFC

If a change in the transmission line quantity is ΔP_{ij} for a transaction of P_{mn}among the seller and buyer bus with UPFC, the ACPTDF can be calculated as

$$ACPTDF_{mn,UPFC}^{ij} = \frac{\Delta P_{ij}^{UPFC}}{P_{mn}}$$

For PTDF calculations with UPFC, the power flow sensitivity and N-R load flow Jacobian matrix can be calculated. The change in power flow at any bus i can be formulated in terms of Jacobian as:

$$\begin{bmatrix}\Delta P \\ \Delta Q\end{bmatrix} = \begin{bmatrix}J_{1,UPFC} & J_{2,UPFC} \\ J_{3,UPFC} & J_{4,UPFC}\end{bmatrix}\begin{bmatrix}\Delta \delta \\ \Delta V\end{bmatrix}$$

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

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Where$J_{1,UPFC} = \frac{\partial P}{\partial \delta}$, $J_{2,UPFC} = \frac{\partial P}{\partial V}$,$J_{3,UPFC} = \frac{\partial Q}{\partial \delta}$,$J_{4,UPFC} = \frac{\partial Q}{\partial V}$

Based on these equations the change in the angle and voltage magnitudes can be determined. Based on the ACPTDF values, the best probable location of UPFC has been obtained to get the enhanced ATC for possible transactions.

IV. RESULT AND DISCUSSION

The proposed ATC evaluation procedure is implemented for New England 39 Bus System. This test system is having ten generators and forty six transmission lines. However out of thirty nine buses, the loads are connected to nineteen buses only. Since out of these one bus is taken as a slack bus (bus - 1),therefore the possible bi-lateral transactions for both the cases (i.e. without UPFC & with UPFC) with generator at bus -30 are listed in Table 1. and also variation of ATC values for possible bi-lateral transactions with generator at bus-30 is shown in Fig.3.
Similarly ATC values for possible bi-lateral transactions with generator at bus-32,33,34,35,36,37,38,39 are shown in Table.2,3,4,5,6,7,8 &9 respectively. The corresponding variations of ATC without and with UPFC are represented in Fig.4,5,6,7,8,9,10,11. It is observed that, the ATC values are enhanced in all the transactions.

Table 1. ATC evaluation for possible bi-lateral transactions with generator at bus-30

S. No.	Transaction Details		ATC	
	Generator bus number	Load bus number	Without UPFC	With UPFC
1	30	3	1247.145	1248.342
2		4	1246.696	1247.714
3		7	1246.658	1246.719
4		8	1246.669	1247.145
5		12	1246.504	1247.023
6		15	1245.815	1245.987
7		16	1079.212	1080.236
8		18	1246.343	1246.845
9		20	465.7926	465.8102
10		21	783.6068	783.8203
11		23	700.5496	700.6535
12		24	1021.292	1022.132
13		25	1149.625	1149.921
14		26	1245.451	1246.173
15		27	1245.545	1245.762
16		28	1245.507	1245.982
17		29	1206.378	1207.425
18		39	1246.741	1247.172

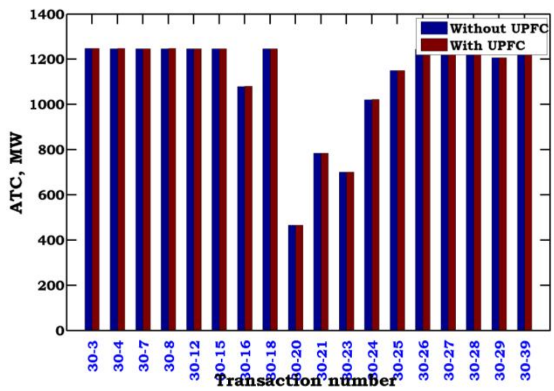

Fig.3. Variation of ATC values for possible bi-lateral transactions with generator at bus-30

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ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

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Table2. ATC evaluation for possible bi-lateral transactions with generator at bus-32

S.No.	Transaction Details		ATC	
	Generator bus number	Load bus number	Without UPFC	With UPFC
1	32	3	1473.693	1474.231
2		4	1627.513	1628.412
3		7	1626.944	1627.012
4		8	1625.958	1626.152
5		12	1635.682	1636.734
6		15	1475.004	1476.183
7		16	1289.606	1290.423
8		18	1626.035	1627.162
9		20	474.9212	475.1926
10		21	810.1108	810.9355
11		23	724.3332	724.7821
12		24	1090.333	1090.923
13		25	1174.422	1175.498
14		26	1226.503	1227.927
15		27	1444.907	1446.231
16		28	1231.301	1232.782
17		29	1210.744	1211.824
18		39	1623.552	1625.372

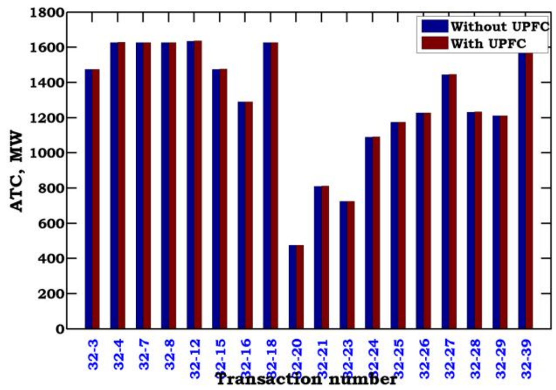

Fig.4. Variation of ATC values for possible bi-lateral transactions with generator at bus-32

Table 3. ATC evaluation for possible bi-lateral transactions with generator at bus-33

S. No.	Transaction Details		ATC	
	Generator bus number	Load bus number	Without UPFC	With UPFC
1	33	3	1466.544	1467.637
2		4	1466.548	1467.983
3		7	1468.084	1469.735
4		8	1463.152	1464.352
5		12	1149.483	1150.734
6		15	1473.091	1474.352
7		16	1478.936	1479.352
8		18	1468.931	1469.537
9		20	1122.117	1123.732
10		21	795.5755	795.9822
11		23	715.7088	715.9822
12		24	1043.555	1044.783
13		25	1182.501	1183.782
14		26	1032.086	1032.867
15		27	1243.201	1243.674
16		28	1035.481	1035.849
17		29	1035.526	1035.948
18		39	1454.323	1454.947

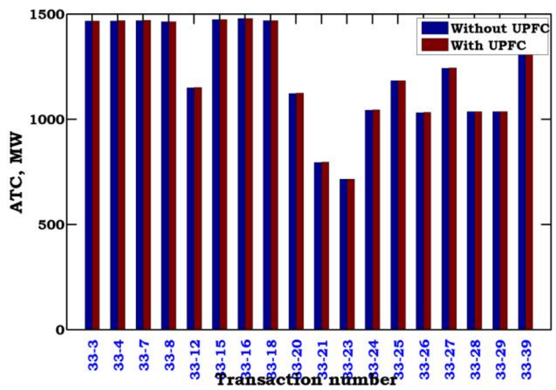

Fig.5. Variation of ATC values for possible bi-lateral transactions with generator at bus-33

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

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Table 4. ATC evaluation for possible bi-lateral transactions with generator at bus-34

S.No.	Transaction Details		ATC	
	Generator bus number	Load bus number	Without UPFC	With UPFC
1	34	3	874.2833	874.8459
2		4	875.1762	875.4738
3		7	873.8592	873.9972
4		8	871.9829	872.1243
5		12	890.0488	890.8732
6		15	877.0034	877.7382
7		16	876.7421	876.9321
8		18	874.4647	874.9467
9		20	1493.005	1495.001
10		21	793.7892	793.9343
11		23	713.5124	713.8923
12		24	876.7385	877.1239
13		25	872.5464	872.9635
14		26	873.9837	874.1324
15		27	873.8818	874.1251
16		28	874.8425	875.2341
17		29	875.3283	876.1962
18		39	867.5549	867.9350

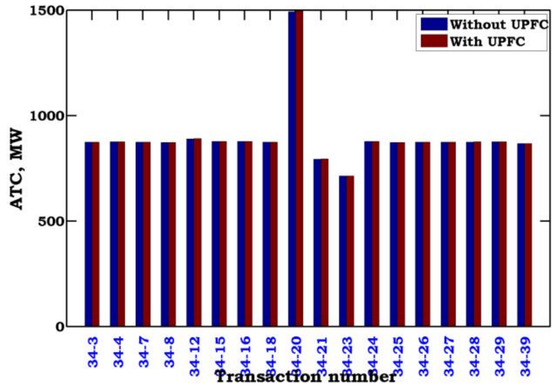

Fig.6. Variation of ATC values for possible bi-lateral transactions with generator at bus-34

Table 5. ATC evaluation for possible bi-lateral transactions with generator at bus-35

S.No.	Transaction Details		ATC	
	Generator bus number	Load bus number	Without UPFC	With UPFC
1	35	3	1639.787	1640.347
2		4	1639.785	1640.324
3		7	1640.879	2641.283
4		8	1642.123	1642.783
5		12	1164.201	1165.152
6		15	1479.699	1480.152
7		16	1637.527	1638.142
8		18	1542.370	1543.193
9		20	474.8762	474.976
10		21	1638.883	1639.254
11		23	1196.266	1197.132
12		24	1638.022	1639.152
13		25	1194.509	1195.362
14		26	1021.002	1021.952
15		27	1251.717	1251.927
16		28	1024.324	1025.152
17		29	1024.368	1025.172
18		39	1645.774	1646.142

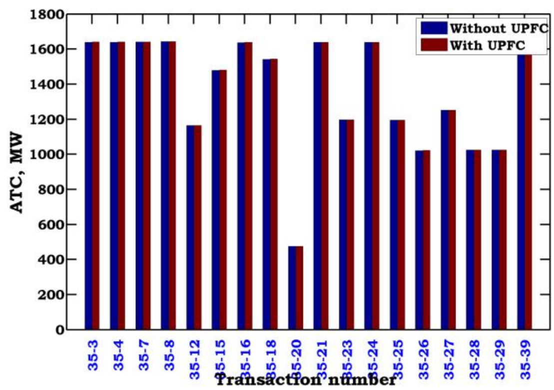

Fig.7. Variation of ATC values for possible bi-lateral transactions with generator at bus-35

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

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Table 6. ATC evaluation for possible bi-lateral transactions with generator at bus-36

S.No.	Transaction Details		ATC	
	Generator bus number	Load bus number	Without UPFC	With UPFC
1	36	3	1538.621	1539.723
2		4	1538.884	1539.142
3		7	1539.744	1540.152
4		8	1540.311	1540.914
5		12	1165.644	1166.152
6		15	1474.024	1475.172
7		16	1537.079	1537.927
8		18	1537.557	1538.256
9		20	475.4804	476.5622
10		21	1373.402	1374.564
11		23	1546.043	1547.352
12		24	1537.301	1538.563
13		25	1190.919	1191.523
14		26	1016.304	1017.245
15		27	1251.588	1252.724
16		28	1019.597	1020.257
17		29	1019.640	1020.526
18		39	1541.901	1542.156

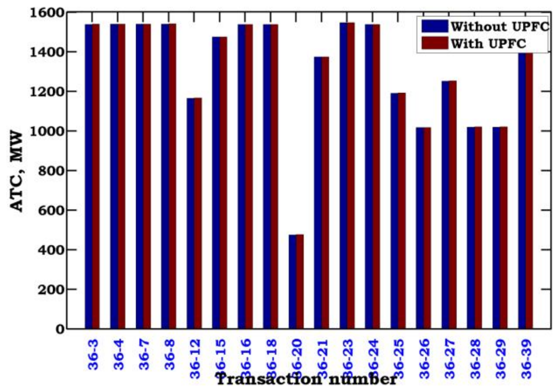

Fig.8. Variation of ATC values for possible bi-lateral transactions with generator at bus-36

Table 7. ATC evaluation for possible bi-lateral transactions with generator at bus-37

S.No.	Transaction Details		ATC	
	Generator bus number	Load bus number	Without UPFC	With UPFC
1	37	3	1501.869	1502.342
2		4	1501.918	1502.143
3		7	1501.605	1502.167
4		8	1501.520	1502.829
5		12	1283.277	1284.145
6		15	1241.741	1242.156
7		16	1044.326	1045.452
8		18	1503.424	1504.142
9		20	465.7284	465.9831
10		21	782.8722	782.9912
11		23	700.6631	700.9845
12		24	1018.401	1019.572
13		25	1527.065	1528.167
14		26	1510.813	1511.985
15		27	1508.139	1509.231
16		28	1335.590	1336.152
17		29	1221.873	1222.935
18		39	1499.474	1450.562

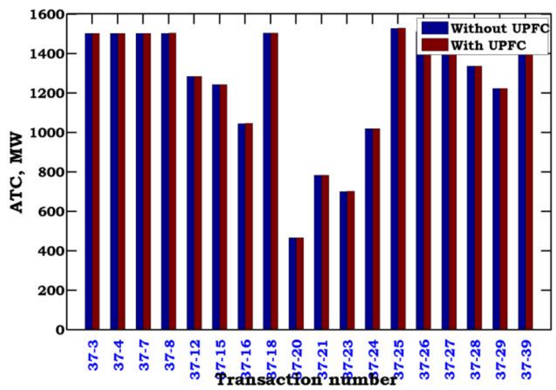

Fig.9. Variation of ATC values for possible bi-lateral transactions with generator at bus-37

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

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Table 8. ATC evaluation for possible bi-lateral transactions with generator at bus-38

S.No.	Transaction Details		ATC	
	Generator bus number	Load bus number	Without UPFC	With UPFC
1		3	1754.613	1755.721
2		4	1666.172	1667.542
3		7	1631.792	1632.238
4		8	1629.911	1630.278
5		12	1232.501	1233.738
6		15	1083.281	1084.367
7		16	929.9243	930.1521
8		18	1513.171	1514.782
9	38	20	467.7438	467.8922
10		21	786.8606	786.9822
11		23	705.0631	705.7821
12		24	929.8096	930.2671
13		25	1372.617	1373.672
14		26	1777.081	1778.563
15		27	1488.043	1489.562
16		28	1523.141	1524.673
17		29	1804.895	1805.156
18		39	1766.846	1767.341

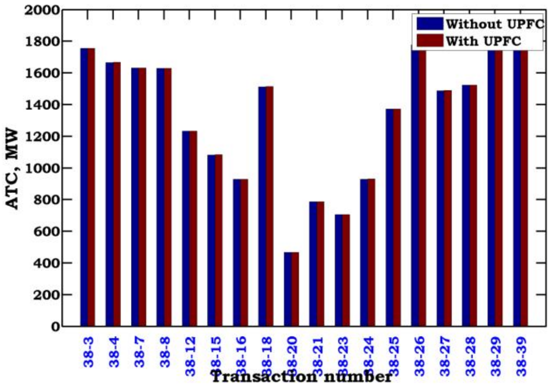

Fig.10. Variation of ATC values for possible bi-lateral transactions with generator at bus-38

Table 9. ATC evaluation for possible bi-lateral transactions with generator at bus-39

S.No.	Transaction Details		ATC	
	Generator bus number	Load bus number	Without UPFC	With UPFC
1		3	1610.277	1612.372
2		4	1701.013	1701.783
3		7	1172.283	1173.453
4		8	1495.569	1496.674
5		12	990.9369	991.5633
6		15	1747.544	1748.673
7		16	1397.064	1398.235
8		18	1494.579	1495.378
9	39	20	461.1892	461.9835
10		21	772.6186	772.9782
11		23	692.2993	692.6732
12		24	994.3644	994.8219
13		25	1175.825	1176.735
14		26	1502.064	1503.637
15		27	1546.151	1546.673
16		28	1313.936	1314.256
17		29	1196.192	1197.563
18		39	1292.504	1292.504

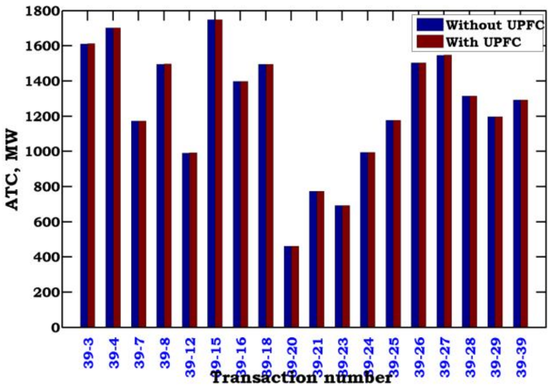

Fig.11. Variation of ATC values for possible bi-lateral transactions with generator at bus-39

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 10, October 2015

V. CONCLUSION

In this paper, the ACPTDF have been obtained for bi-lateral transactions with UPFC, using N-R load flow approach. In point of view of operational planning, the paper evaluated the impact of UPFC on ATC enhancement. The transformer model of UPFC is presented to accomplish the maximum possible ATC value with UPFC control.. The results demonstrated that the use of UPFC device, which enables the balance of line flow and regulate node voltage simultaneously, can enhance the ATC significantly. There is a considerable increase in ATC is observed in almost all the transactions with the usage of UPFC.It is evident that, FACTS technology can offer an effective and promising solution to boost the usable power-transfer capability, thereby improving transmission services of the deregulated power system market.

REFERENCES

[1] Available transfer capability definitions and determination. North American electric reliability council report; June 1996.
[2] Mohamed Shaaban, Yixin Ni, Felix Wu. Available transfer capability evaluation by decomposition. In: IEEE summer meeting proceeding; June 2001.
[3] T. Jain, S.N. Singh, S.C. Srivastava, Dynamic available transfer capability computation using a hybrid approach, IET Proc. Gener.Transm.Distrib. 2 (6) (2008) 775–788.
[4] Christie RD, Wollenberg BF, Wangstien I. Transmission management in the deregulated environment. Proc IEEE 2000;88(2):170–95.
[5] Gravener MH, Nwankpa C. Available transfer capability and first order sensitivity. IEEE Trans Power Syst 1999;14(2):512–8.
[6] Ejebe GC, Waight JG, Santos-Nieto M, Tinney WF. Fast calculation of linear available transfer capability. IEEE Trans Power Syst 2000;15(3):1112–6.
[7] Greene S, Dobson I, Alvarado FL. Sensitivity of transfer capability margin with a fast formula. IEEE Trans Power Syst 2002;17(1).
[8] Grijalva S, Sauer PW. Reactive power considerations in linear ATC computation. In: Proc of the 32nd annual Hawaii int. conf. on system sciences, HICSS-32, vol. 3; 5–8 January 1999, p. 11.
[9] Grijalva S, Sauer PW, Weber JD. Enhancement of linear ATC calculations by the incorporation of reactive power flows. IEEE Trans Power Syst 2003;18(2): 619–24.
[10] Ejebe GC, Waight JG, Santos-Nieto M, Tinney WF. Fast calculation of linear available transfer capability. In: Proc of the 21st IEEE intconf on power industry computer applications, PICA, 16–21 May 1999. p. 255–60.
[11] Gravener MH, Nwankpa C. Available transfer capability and first order sensitivity. IEEE Trans Power Syst. 1999;14(2):512–8.
[12] Li C-Y, Liu CW. A new algorithm for available transfer capability calculation.Int. J Electr. Power Energy Syst. 2002;24:159–66.
[13] Kumar A, Srivastava SC, Singh SN. Available transfer capability (ATC) determination in competitive electricity market using AC distribution factors.Electr Power Components Syst 2004;32:927–39.
[14] Kumar Ashwani, Kumar Jitendra. Comparison of UPFC and SEN transformer forATC enhancement in restructured electricity markets.Int J Electric Power Energy Syst 2012;41:96–104.
[15]Ghawghawe ND, Thakre KL. Computation of TCSC reactance and suggesting criterion of its location for ATC enhancement.Int J Electric Power Energy Syst2009;31:86–93.