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Investigation and Analysis of Grid Disturbances in view of Unscheduled Interchange Mechanism

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Abstract

This paper has touched the important issues and present regulatory reforms in form of Unscheduled Interchange held responsible to grid disturbance. Unscheduled Interchange is an important instrument to tackle the grid frequency and deviation from schedule leads to penalty for generators for under-injection and same for over-drawal by distribution utilities. It also provide incentive for over-generation by generator and under-drawal by distribution utilities. As this regulatory frame work has been investigated and analysed with recent grid disturbances in context to country India..

Keywords: Unscheduled Interchange(UI),Over-Drawal(OD),Under-Drawal(UD),Grid-Disturbance,Over-injection,Under-injection,Availablity Based Tariff(ABT)

1. Introduction:

As we know electricity is non –storable and very expensive to store. This makes electricity a unique thing in its own .It requires to be consumed at same time when generated i.e balance to be maintained between demand and supply to maintain the grid security.

In developing countries like India to maintain the grid discipline is the taunting task for the grid operators i.e maintaining of grid frequency .Higher demand than supply reduces the grid frequency, which is 50 Hz in India in opposite if supply is more than frequency will increase .Both the scenario are dangerous for grid security. India power system is divided into 5 regional grids.1. Northern Grid(NR) 2.Eastern Grid(ER) 3.Northern-Eastern Grid(NER) 4.Western Grid(WR) 5.Southern Grid(SR).

In order to maintain grid discipline a commercial mechanism was introduced in form of Availability based Tariff(ABT)[1]. It was introduced in India on 1st July 2002 in Western region and its main aims were (a) to maintain grid discipline (b) promote trade in energy and capacity (c) encourage higher generation availability (d) economic load dispatch. This tariff is three part tariff and it consists of (a)Fixed Charges (b)Variable Charges and (c)UI (Unscheduled Interchange's).Prior to Availability Basic Tariff on 2nd January, 2001 grid disturbance[2] was occurred in Northern Region and system frequency was 51.0Hz.Thermal station including NTPC stations at Singrauli and Rihand were instruction to back-down generation. But Singrauli STPS continued inject power and do not backing down station .But to this non compliance and cumulative tripping of 400Kv lines. This leads to black out in Northern Region except that of Rajasthan. During crises the NTPC stations at Singrauli and Rihand had been generating in excess of the schedule given to them by NRLDC.Here case studies has been done prior to ABT and after ABT.

2. Availability Based Tariff (ABT) Mechanism

To deal with the problems arises due to grid frequency. A new tariff scheme: Availability Based Tariff (ABT) was introduced in July 2002. ABT comprises of three components: (a) Capacity Charge (b) Energy Charge (c) Unscheduled Inter-change (UI) Charge.

2.1 Capacity Charge:

This component represents the fixed cost and is linked to the declared capacity/availability of the plant, i.e., its capability to deliver MWs on a day-by-day basis. The total amount payable to the generating company over a year towards the fixed cost would depend on the average availability of the plant over the year. In case the average actually achieved over the year is higher than the specified norm for plant availability, the generating company would get a higher payment and also get incentive. In case the average availability achieved is lower, the payment will be lower and given in the form of pro-rata basis. Hence, the scheme is named Availability Based Tariff.

2.2 Energy Charge:

This component of ABT comprises of the variable cost, i.e. the fuel cost(in case of thermal power plant Coal as the primary fuel and oil (HFO + LDO)as secondary fuel of the power plant for generating energy as per given schedule for the day. Therefore, this energy charge is not according

to the actual generation but only for scheduled generation. i.e if scheduled generation of the plant is 300 MW and plant generates 310 MW the energy charges would still be paid for 300 MW of energy generation and the remaining 10 MW will be paid as per prevailing UI rate according to system frequency. This component also consists of Fuel price adjustment (FPA) charges.

2.3 Unscheduled Interchange Charge:

In case there are deviations from schedule, this third component of ABT comes into picture. Deviations from schedule are determined in 15-minute time blocks through special metering. They are priced according to the system condition prevailing at that time. If the frequency is above 50 Hz (nominal frequency in Indian System), UI rate will be small and if it is below 50 Hz, it will be high. As long as the actual generation/withdrawal is according to the given schedule, the third component of ABT is zero. In case of over-drawl, beneficiary has to pay UI charge according to the frequency dependent rate specified. Beside promoting competition, efficiency and economy and leading to more economically viable power scenario, ABT has been able to pave way for high quality power with more reliability and availability through enhanced grid discipline. This UI component is having more relevance.

3. Investigation and Analysis of Grid Disturbances in view of UI mechanism

When Availability Base tariff was introduced in India it has been thought this commercial mechanism will help maintaining grid discipline .By imposing penalty from deviation from schedule. But after ten years of implementation of this tariff it has creates havoc for grid security. Case has been studied to understand what gone wrong in implementation while analysis of important events in grid in power system as under

3.1 Prior to Availability based Tariff:

3.1.1 Grid Disturbance 2nd January 2001[2].

As on 2nd January 2001, a major grid disturbance was occurred prior to ABT.

Table -3.1Pre-Disturbance Condition on 2nd January 2001

S.No.	Genarating Stations	Time	Scheduled generation	Actual generation
1	Singrauli STPS	1200 hrs.	1840 MW	1952 MW
		0030 hrs.	1620 MW	1742 MW
		0130 hrs	1540 MW	1631 MW
		0400 hrs	1320 MW	1520 MW
2	Rihand STPS	Time	Scheduled generation	Actual generation
		1200 hrs.	910 MW	984 MW
		0030 hrs.	810 MW	908 MW
		0130 hrs	730 MW	800 MW
		0400 hrs	730 MW	730-770MW

It is evident from Table-3.1 that during the period of crisis, Singrauli and Rihand STPS of NTPC had been generating in excess of the schedule given to them by RLDC.Before implementation of ABT, generating stations were govern by the two part tariff system, Capacity charges are payable against the 62.79%(deemed) PLF (Plant Load Factor) of the station.50% full charges are payable for 0% deemed PLF and full fixed charges(100%) are payable at achieving a PLF of 68.49% and above 68.49% PLF incentive is payable at 1paise/kwh for each 1% increase in PLF. In order to avail full fixed charges they use to inject more energy to earn more when grid system are having high frequency situation. This tariff structure did not provide any incentive for either backing down generation during off peak hours or for reducing consumer load /enhancing operation during peak-load hours. In other way round this tariff creating indiscipline in grid. An investigating the complete case of grid disturbance two major things comes out that without enforcing free governor operations and commercial mechanism, it was not possible to enforce grid discipline.

Therefore UI mechanism was developed to improve grid efficiency, grid discipline, accountability and responsibility by imposing charges on those who defer from scheduled generation or drawal.

3.2 Grid Disturbance after implementation of Availability Based Tariff:

3.2.1 Grid Disturbance 30 July-2012[3].

On 30th July, 2012 there was a grid disturbance in the NEW grid at 02:33:11 hrs that lead to the separation of the NR grid from the rest of the NEW grid and eventually NR system collapsed. Before black out regional generation, demand and import were as per Table 3.2.1

Table-3.2.1 Pre-Disturbance Condition on 30th July 2012.

S.No.	Region	Generation(MW)	Demand(MW)	Import(MW)	Remarks
1	NR	32636	38322	5686	
2	ER	12452	12213	(-)239	Bhutan import 1127 MW
3	WR	33024	28053	(-)4971	
4	NER	1367	1314	(-)53	
	Total	79479	79902		

3.2.2 Grid Disturbance 31 July-2012[3].

Another grid disturbance took place on 31st July 2012 in the NEW grid at 13:00:13 hrs that led to the separation of the NR, NER and ER from the WR and eventually led to the collapse of the NR, ER and NER grids as shown in Figure 3.2.1 and Figure 3.2.2. Before black out regional generation, demand and import were as Table 3.2.2

Table-3.2.2 Pre-Disturbance Condition on 31st July 2012.

Sl. No	Region	Generation(MW)	Demand (MW)	Import (MW)	Remarks
1	NR	29884	33945	4061	
2	ER	13524	13179	(-)345	Import from Bhutan 1114 MW.
3	WR	32612	28053	(-)4559	
4	NER	1014	1226	212	
Total	NEW Grid	76934	76403		

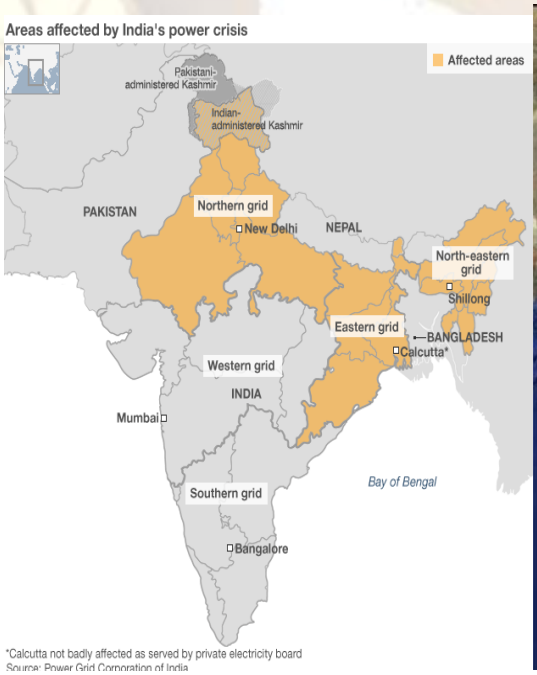

Fig 3.2.1Overview of five operating grid system with shaded portion indicating area affected during power crisis

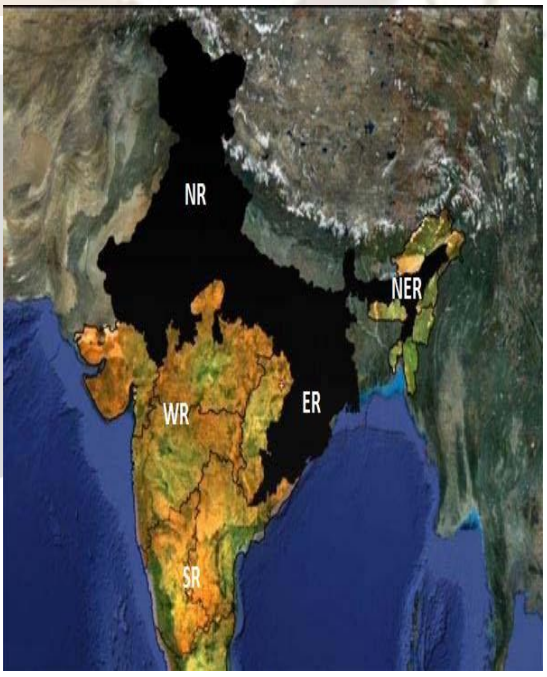

Fig.3.2.2 Overview of affected regional grids

3.3.3Analysis:

It is evident from Table -3.3.3 Northern Region (NR) is having less installed capacity than that of Western Region and from the Table-3.2.1 and Table -3.2.2, states distribution utilities in the NR region were overdrawing power from grid and at the same time Western Region (WR) generating stations were over injecting power. This was due to fact frequency during disturbance was recorded 49.68HZ & 49.84 HZ .Non compliance of order issued by load dispatch centre to the distribution utilities and generating station in view of over drawal and over injection leads to the black out.

Table-3.3.3 All India region wise generating installed capacity (mw) of power utilities including allocated shares in joint and central sector utilities (as on 31-12-2012)

SL.	REGION		THERMAL			Nuclear	HYDRO	R.E.S.@	TOATL
NO.		COAL	GAS	DSL	TOTAL		(Renewable)	(MNRE)	
1	Northern	31323.5	4671.26	12.99	36007.75	1620	15456.75	4623.24	57707.74
2	Western	43099.5	8254.81	17.48	51371.79	1840	7447.5	8450.04	69109.33
3	Southern	23782.5	4962.78	939.32	29684.6	1320	11353.03	12096.78	54454.41
4	Eastern	22607.88	190	17.2	22815.08	0	3882.12	436.71	27133.91
5	N. Eastern	60	824.2	142.74	1026.94	0	1200	243.28	2470.22
6	Islands	0	0	70.02	70.02	0	0	6.1	76.12
7	All India	120873.4	18903.05	1199.75	140976.2	4780	39339.4	25856.14	210951.7

Captive Generation Capacity in Industries having demand of 1 MW or above, Grid interactive(as on 31-03-2011)=34444.12 MW

In view of such circumstances distribution utilities will not have to pay additional UI. It has already been investigated that before implementation of ABT, it was two part tariff. Charges were charged as per Plant Load Factor. Due to which generator use to inject more power to earn more, it was evident from Table-1.As during 51.0 HZ generators are injecting more under wealthy frequency regime. It might be possible that grids were already under crises and these adverse grid conditions were not arises in a single day but it was prevailing since long time ,due to which notices may also been served to utilities for non compliance for non-performing as per Unscheduled Interchange charges regulations and to curb overdrawal.It was the duty of Northern Load Dispatch Centre and states utilities to maintain proper load management in Northern Region constituents and curbing overdrawal in terms of the Indian Electricity Grid Code and Unscheduled Interchange charges regulations. In order to maintain grid discipline UI mechanism was introduced while incorporating commercial mechanism. But after ten years of implementation of UI mechanism, it is high time to relook the present mechanism .

In real sense frequency and rupee has no direct correlation in maintain power system frequency. To maintain frequency in power system only system parameter must be used i.e ancillary services.

Conclusion

Unscheduled Interchange mechanism in present scenario must be relook again. Because commercial implication may never be helpful in maintaining power system frequency. It` is also evident that only UI is not responsible for present grid disturbances other many factors which correlated the cascade tripping of many lines during grid disturbances. The cooperative causes of grid failure was that the grid was initially operating in insecure condition because of number of lines were not available due to either forced outages, planned outages or kept out to control high voltages. The main aim of the de-regulation as under Electricity Act 2003 was to distant government and encourage private participant in the power sector, but aim was not fulfil. Every private player wish to become power generator as it is profitable as comparison to transmission and distribution segment.

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