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Energy Efficiency of Thermal Power Station Auxiliary Power Consumption and Cost Savings in Carbon Footprint in India

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Abstract: This study discusses about the energy conservation and carbon credits in Thermal Power Stations in India. Indian power scenario, accounts for 66.4% (1,36,436 MW) of Thermal Power Generation. The Thermal Power Stations have the problem of consuming 8.5% of power it produces. Also it has the drawback of emission factors which leaves the carbon footprint, which has to be controlled as per the Clean Development Mechanism (CDM). The United Nations Framework watches climate change (UNFCC). Hence by conserving auxiliary power consumption, the problem in Indian Power sector of consuming more auxiliary power consumption is reduced. This is having tremendous opportunity, to earn revenue, as per UNFCC norms, of carbon credentials. The Power Plant power factor is improved with VSC HVDC and the results obtained are simulated in MATLAB software and results are obtained.

Key words: Auxiliary power consumption in power plants, VSC HVDC, carbon footprint

INTRODUCTION

In India the Electricity Demand is exceeding the Power generation in the order of 12%. The installed total capacity in India is 205340.26 MW (CEA, 2012) out of which the Thermal power stations accounts for (66.4%) 136436.18 MW. The deficit on the peak load is of the order of 128,687 MW. in the order of -8.6%. (CEA, 2012). The Indian scenario of cost effective generation has forced to go in for the Demand side energy efficiency methods. Also on the carbon credential rate India suffers the most by since the major chunk of the power is (66.4%) based on thermal power stations. So, under this scenario it's imperative to go in for the energy efficient methods of power generation. One of untapped area of energy saving area lies in the Thermal power stations itself.

PROBLEM IDENTIFICATION

The thermal power stations are having its own power system to cater the need of its auxiliary equipments in power generation process. The auxiliary power consumed in the Thermal power station is in the order of 8.34 to 9% (CEA, 2012) in India. The Thermal power stations, has the drawback of inductive loads with, the MV Pumps and Fans. The operating auxiliary power factor is at the range of 0.85 (Data collected from MTPS 4×210 MW). The auxiliary power consumed is in India for the total installed capacity of the order of 11406.06 MW (8.36% of 1, 36,436 MW). The power stations having the other problem of emission in the form of CO_2 by burning the fossil fuels which leaves the carbon footprint. Where the power savings and Emission reduction is need of the hour and energy savings methods by the modernization of the Thermal power station power system needs an attention.

PROBLEM SOLUTION

The typical model power system in thermal power station and the data collected in Mettur Thermal Power station, Salem District in Tamilnadu, is analyzed for the modernization and energy savings. The results of savings are calculated and by energy conservation the CO_2 emission reduced is found out.

UNIT AUXILIARY SYSTEM DETAILS FOR FOUR UNITS

The unit auxiliary arrangement (Fig. 1) has two unit buses A and B which feeds the auxiliaries and the in case of unit shutdown auxiliaries are fed by the (ST) Station Transformers. The AVR loop is fed from the Generator Terminal Voltage V g Through Excitation Transformer.

The operating power factor and load of the thermal power station (Fig. 2) auxiliaries has the typical values is given. This is in reference to 210 MW unit of thermal power station in Mettur dam (4×210 MW) (Table 1).

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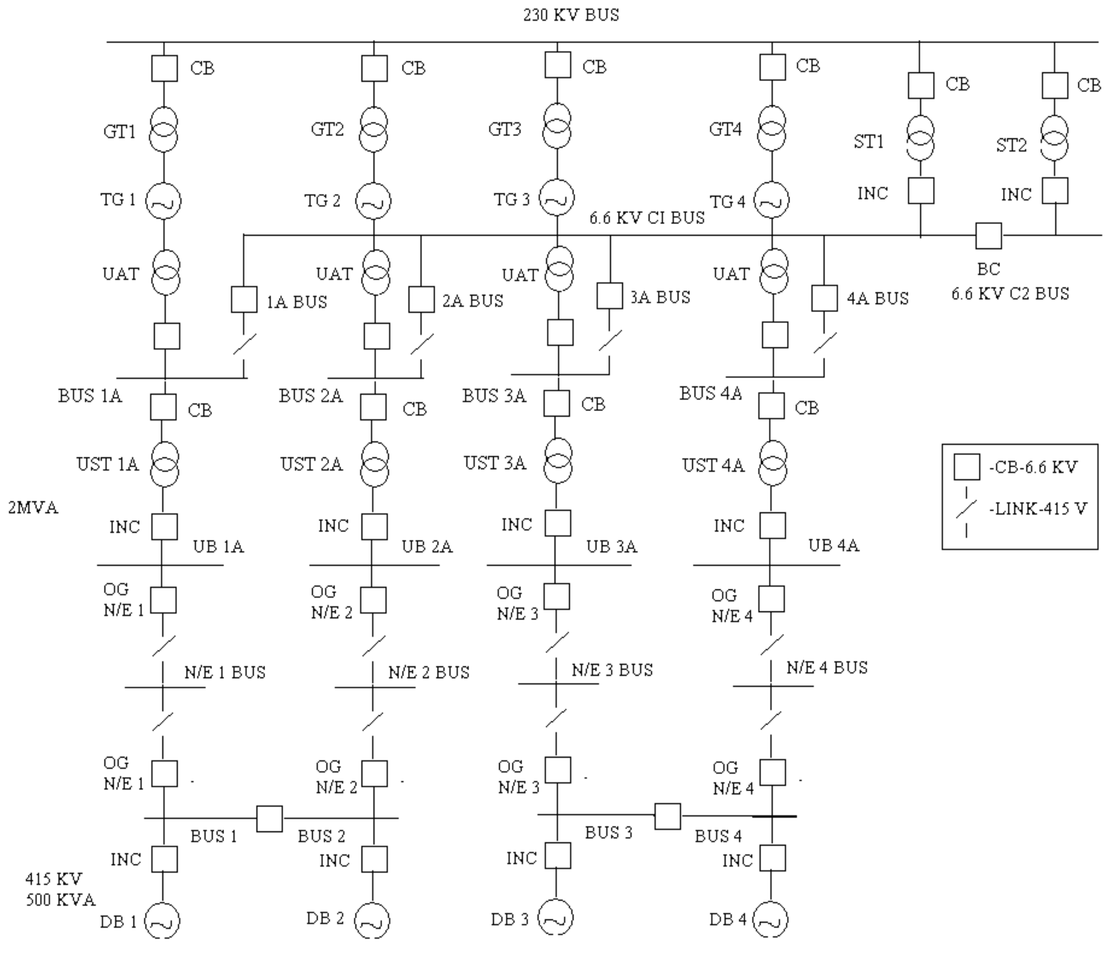

Fig. 1: Auxiliary power system SLD of thermal power station

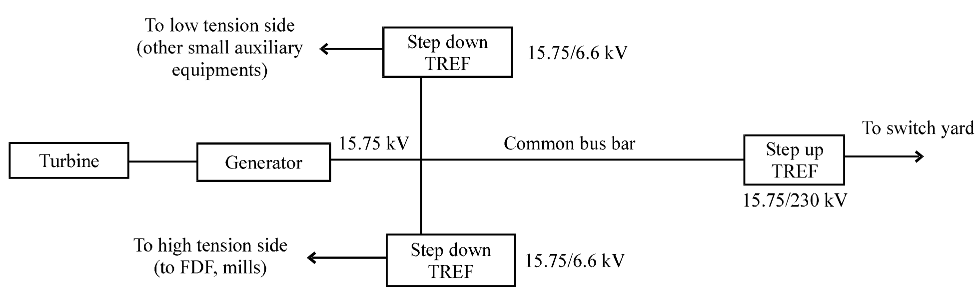

Fig. 2: Block diagram of thermal power sation power system

Table 1: Thermal unit auxiliary details of a 210 MW

	Voltage (kV)		Current (A)		P.F		Load (MW)	
Units	Av	Bv	Ai	Bi	Aφ	Bφ	Ap	Bp
Unit 1	6.75	6.75	950	725	0.87	0.85	9.5	6.7
Unit 2	6.60	6.70	750	820	0.86	0.86	8.1	7.5
Unit 3	6.65	6.60	685	800	0.89	0.87	6.5	7.9
Unit 4	6.70	6.70	840	830	0.85	0.86	8.3	8.4

Table 2: KVAR for various power factor

Power factor calculations	Q1	Q2	KVAR	Cost consumption h^{-1} in Rs. for various power factors	Cost savings due to PF improvement
0.85 to 0.95	31.78	18.19	5220.00	54000.00	6351.600
0.86 to 0.95	30.68	18.19	5237.10	54634.34	5717.545
0.87 to 0.95	29.54	18.19	4285.80	55269.62	5082.265
0.88 to 0.95	28.35	18.19	3797.65	55904.90	4446.985
0.89 to 0.95	27.12	18.19	3304.37	56540.19	3811.695
0.90 to 0.95	25.84	18.19	2802.43	57175.47	3176.415
0.91 to 0.95	24.49	18.19	2284.66	57810.75	2541.135

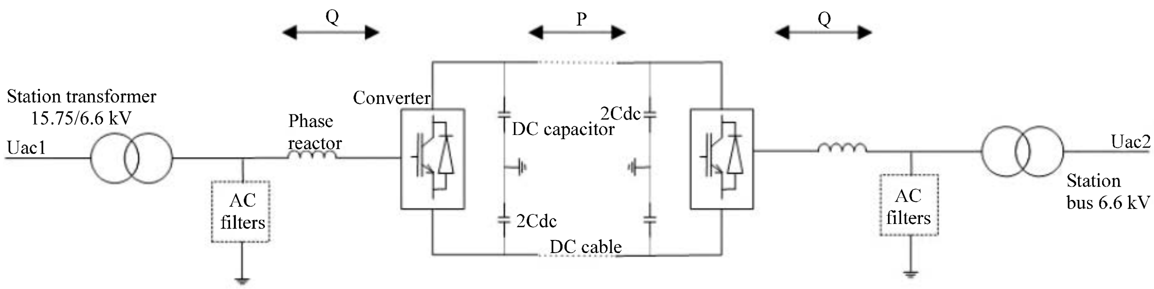

Fig. 3: VSC HVDC SLD

RE-DESIGN OF POWER SYSTEM IN THERMAL POWER STATIONS

Use of Thyristor technology in the modernising the power system in power plant (Flourentzou *et al*., 2009) yields the control over bulk power, with low p.f in the order of 0.85 in the power plant auxiliaries and achieving the VAR compensation (Table 2) (Johansson *et al*., 2004). A design of DC link solves the p.f correction and power quality in this Power system (Alves and Barbi, 2009). where a frequent operation MV Motors of auxiliaries and varying loads due to modulation various controls of feedback loops (Bhel, 2001) occurs in real time. The VSC HVDC is based on the voltage source converter and the valves are built by IGBT. The VSC HVDC Can produce reactive power instantly and can control Active and Reactive power independently (Du, 2003). To create the desired Voltage wave form PWM is used it also can produce any phase angle and magnitude instantly with changing PWM pattern. The VSC HVDC acts as synchronous machine without mass that can control active and reactive power instantaneously. The main components of VSC HVDC (Fig. 3) are Transformer, AC filter, converters, phase reactors, DC capacitors and DC Cables.

VSC HVDC APPLIED TO POWER SYSTEM IN POWER STATION

For the concentrated load in the thermal power station power system which operates with the PF of 0.85 the VAR compensation is done with VSC HVDC and the auxiliary p.f can be maintained in the optimum range of 0.95. For this power factor improvement in the case study of Mettur Thermal power station the economic results in this front of p.f improvement can be calculated and this can be applied to the Thermal Power stations in India (Fig. 4 and 5).

ECONOMIC RESULTS

$$\frac{\text{Savings in cost}}{\text{Unit by improving p.f. from 0.85 to 0.95}} = \frac{\text{Rs. 54, 877,824}}{\text{Year}} \tag{1}$$

$$\text{Savings For all 4 units} = \frac{\text{Rs. 21,911,296}}{\text{Year for 840 MW}} \tag{2}$$

Applied to all the power Plants in India:

- Total Thermal Power station capacity (CEA, 2012) = 1, 36,436 MW
- Power savings = 10, 086.135 MW h

The cost savings by improving the p.f. from:

$$85 \text{ to } 0.95 = \text{Rs. 302, 58,406/year} \tag{3}$$

CO_2 CREDITS

The Energy efficient method of power generation, with newer technologies and renovation and modernisation old Thermal power stations results in the energy savings. This is eligible for Clean Development Mechanism. Since these endeavours results reduced CO_2 emissions.

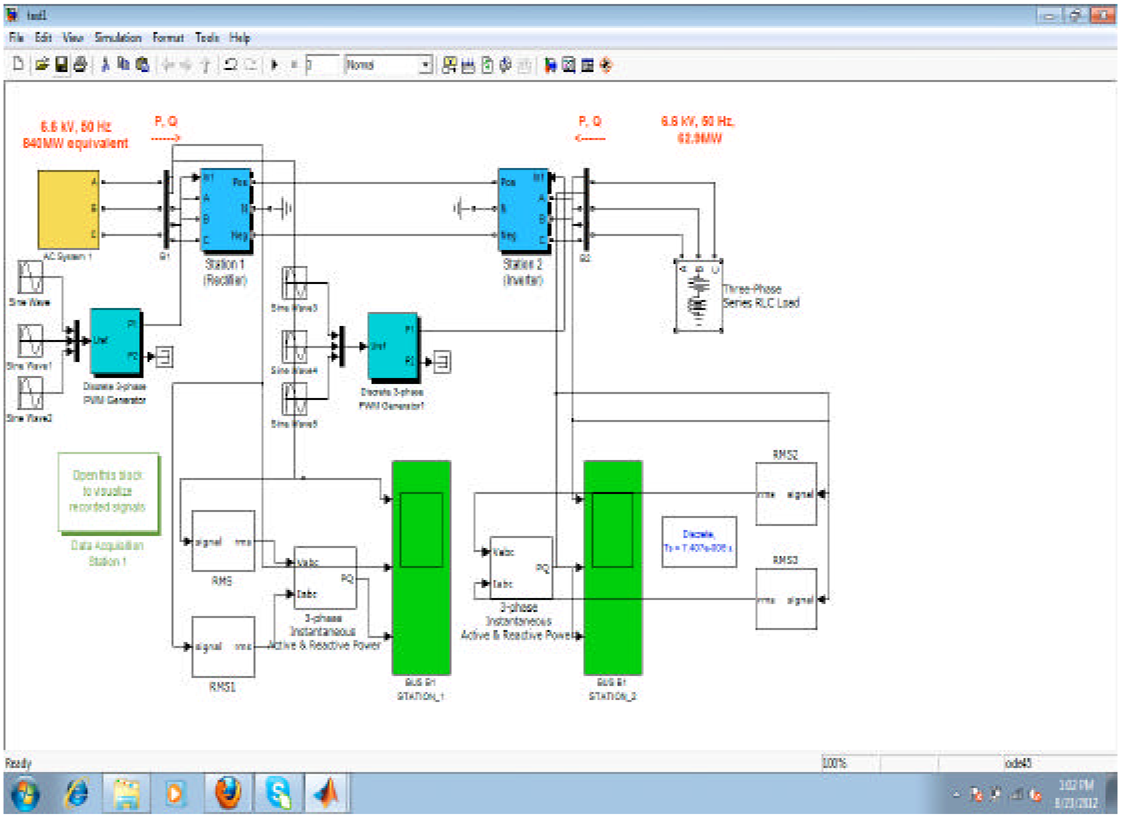

Fig. 4: MATLAB system simulation for the design of new system

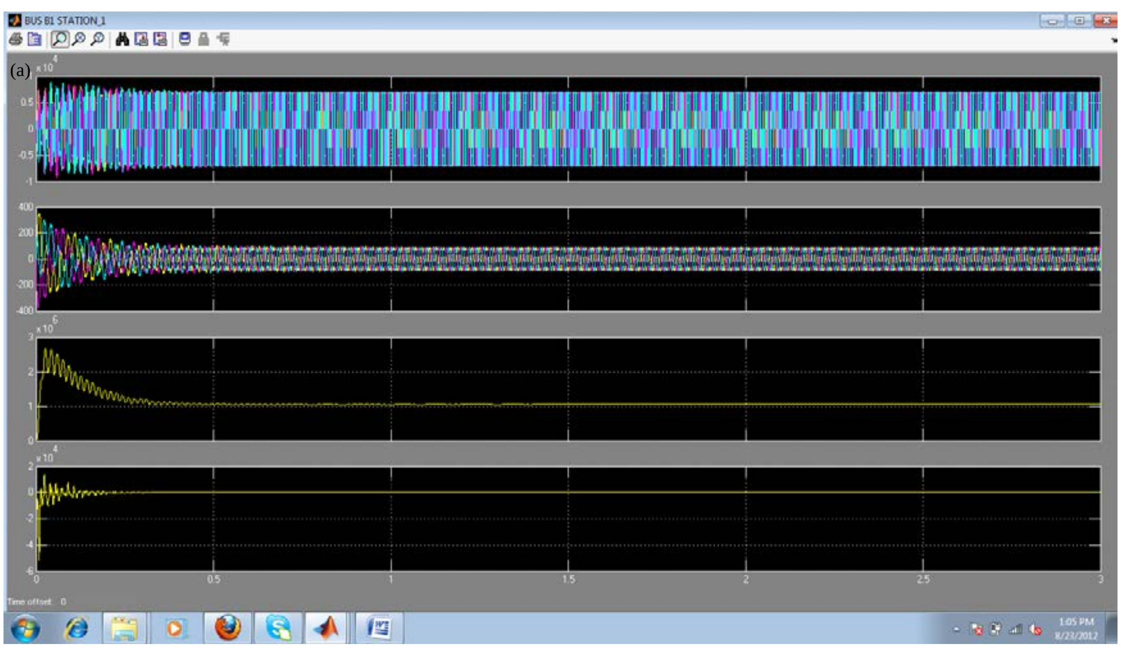

Fig. 5(a-b): Continue

Fig. 5(a-b): (a) Simulation results for converter and (b) Simulation results for inverter

The Clean Development Mechanism (CDM), as per UNFCC (EPA, 2008) (Investopedia Inc, 2010) provides an opportunity for Indian power sector, to reduce of Green House Gas emission (GHG) and CO_2 emission control (UNFCCC, 2010a). Hence by efficiency improvement of reducing the auxiliary consumption the carbon foot print is reduced (Carr and Kishan, 2006). The extent to which emitting less carbon (UNFCCC, 2007) which get credited in a country is carbon credit (UNFCCC, 2010b).

CO_2 CREDITS CALCULATION

- Auxiliary power consumption before the P.F. Improvement = 18000 kW
- CO_2 t MW^{-1} before Improvement = 0.928 ton MW^{-1}
- Auxiliary power consumption After P.F Improvement = 15882 kW
- CO_2 t MW^{-1} after Improvement = 0.915 ton MW^{-1}
- Carbon foot print for/year for 840 MW (MTPS) = 95659 CO_2 t $year^{-1}$

CONCULSION

In this study the energy efficiency method for, Thermal Power plants auxiliaries is shown. The power plants which are concentrated inductive loads which consumes 8.5% of the power it produces has been got reduced by improving the power factor from 0.85 to 0.95 is calculated. The results are simulated in the MATLAB program. The energy efficiency out of the proposed methodology is converted as the carbon credits which also have the financial earnings and has been calculated.

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