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ENERGY PERFORMANCE IMPROVEMENT OF COAL FIRED THERMAL POWER PLANT – CASE STUDY APPROACH

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Abstract: *As on September 2014 the power generation installed capacity of India is 253390 MW. India is the fifth largest consumer of electricity in the world. Coal fired power plants are account for about 65% of the installed capacity catering the need of power demand in the country. Still we are facing shortage of power to the tune of 6% in the peak demand and installed capacity. In order to enhance the availability and reliability of power now days it is essential to conserve the energy by way of energy efficiency through energy management practices in thermal power plants. Various thermal power plants have implemented the techniques/ approaches of energy management to improve energy efficiency of equipments in the power plant are discussed in this paper. Based on these case studies which energy management factors are suitable to improve the performance indicators can be considered in this research paper to improve the performance indicators of the plant. The case study focuses on Energy Management practices followed in thermal power plants and to identify the areas for improvement of energy efficiency of the plant. With implementation of Periodic Energy Audits, Energy Conservation Measures, Process Optimization and Diagnostic Studies. The consumption of coal, oil and electricity can be reduced substantially in the Plant for cost competitiveness and increase in Profitability through energy management approaches.*

Keywords: *Energy management practices, Performance evaluation, Energy Audit*

I. INTRODUCTION

Energy efficiency solutions have proven and well documented ability to improve energy efficiency of the power plants. It can improve the power output to the grid up to 10% without increasing the fuel consumption. It can be achieved by the following energy management practices in brief.

- Raise the plant electrical output by correcting process efficiencies.
- Generate more energy from less fuel by lowering fuel consumption of the plant.
- Increase plant revenue by selling more energy and reducing fuel wastage.
- Extending the operating life of the plant by optimizing the auxiliaries and main equipments performance.
- Improve the operational flexibility by maximizing process efficiency.
- Reduce the green house gas emissions by judicious management of all sorts of energy used it the thermal power plant.

India needs total investment of over $ 250 billion for the development of power sector during 12th five year plan. During 12th five year plan period (2012-17) India plans to add 88537 MW in the existing capacity of power generation out of which 69280 MW will come from coal based power plants [1]. It is said that the country is likely to suffer a coal shortfall of 200 million tons (MT) by the end of 12th plan period. Similarly the oil is becoming costly due oil imports and the balance of payment is increasing day by day. Since pulverized coal fired thermal power plant is using huge quantity of coal, oil and 10% of electricity as auxiliary power consumption to run the plant, it is imperative to save energy by way of implementing energy management approaches. This will improve the performance parameters of the thermal power plant and minimize the cost of power generation. The case studies of energy improvement from different plant in the country will provide the information and data to the plants to improve their performance indicators like plant load factor (PLF), operational availability factor (OAF), planned maintenance PM), forced outage (FO), auxiliary power consumption (APC), specific coal consumption (SCC), specific oil consumption (SOC) and heat rate (HR). Energy Management is an important management means by which organizations establish the systems and procedures necessary to achieve operational control and continual improvement of energy performance. It has been applied in many economies and areas, such as Australia, China, USA and India.

Energy performance evaluation means applying scientific criteria, methods and procedures to make correct evaluation as much as possible on energy performance achieved by individual plants or organizations.

This paper elicits the case studies of energy improvement in various thermal power plants and the approaches can be used as guidelines to improve the performance parameters.

II. DR. SHYAMA PRASAD MUKHARJEE THERMAL POWER STATION, CSPGCL, KORBA-EAST (CHHATTISGARH)

Chhattisgarh State Power Generation Co. Ltd. is a fully integrated utility engaged in generation of electricity. 2X250MW DSPM TPS KORBA (EAST) is one of the company's best generating facilities at Korba. Power generated from DSPM is transmitted through State Load Dispatch Center. DSPM units are the 2X250MW sets supplied by BHEL INDIA and are in operation since March-2008. Since commissioning DSPM TPS is performing well and presenting example of best operation and maintenance practices. DSPM units are maintaining very high level of Plant Load factor (PLF) when compared to national average. Unit I came into operation on dated 21/10/2007 where as Unit II put into operation dated 20/03/2008. Taking minimum period of stabilization both units have started performing well and during 2008-2009 the PLF of DSPM reached up to 84.8% and during the year 2009-2010 the PLF of DSPM increased up to 87.65% At Present the DSPM TPS is performing best with a PLF of 94.93% up to Oct. 2010.

2.1 Energy conservation & saving details

After commissioning during 2008-09, DSPM units with a minimum period of stabilization achieved annual PLF of 84.8% with overall generation of 3714.07 MUs. The gross heat rate was 2577 kCal/kWh. By the time 2009-10 by best operation and maintenance practices, as mentioned
above our PLF improved from 84.8% to 87.65%with a generation of 3838.93MU. By reducing unnecessary tripping by best operation and maintenance activities station reduced its specific oil consumption from 1.358 to .756 ml/kWh. By operating the unit at optimum parameters and minimum deviation from designed parameters, station improved its heat rate from 2577 KCal/KWh to 2481.43 KCal/KWh. The following energy management approaches are implemented.

2.2 Activities implemented by the station to achieve Energy Saving

- By operating unit at designed parameter overall efficiency of plant is improved.
- Reduction in partial loading results in higher PLF hence improvement and electrical energy saving.
- Reducing partial losses.
- Avoiding idle running hours of CHP.
- Utilizing max capacity of conveyor Belts of CHP.
- Proper switching control of lighting load.
- Reduction in specific oil/coal cons results in saving in aux power cons.
- Utilizing max capacity of existing aux by operating at full load.
- Proper up keeping of running aux reduces outage of aux and consequently unwanted outages of units.
- Reducing various steam, water, coal and air leakages.

2.3 Future Energy management Targets

- Secondary fuel consumption below 0.70 Ml/KWh.
- Specific coal consumption below 0.70 Kg/KWh.
- Auxiliary power consumption below 7.7%.
- DM water make up below 1.0 %.

2.4 Result

The following improvement have been achieved due to implementation of energy management practices over the year 2008-09 during the year 2009-10

1) Plant load factor - 84.8% to 87.65%
2) Specific oil consumption - 1.358 to .756 ml/kWh.
3) Plant Heat rate - 2577 KCal/KWh to 2481.43 KCal/KWh.

The above data implies that the plant load factor, plant heat rate and specific oil consumption have improved after implementation of energy management approaches.

III. ENERGY MANAGEMENT PRACTICES IN 2 X 250 MW DAHANU THERMAL POWER STATION

The commercial operation of this plant started in 1995-96 catering needs of the power to commercial capital Mumbai and best Environmentally Performing Power Plant. Dahanu is Operating in Eco Sensitive Zone and following Stringent Environmental Norms. Winner of more than 100 National & International Awards. 1st Company in the World to Achieve Certification of ISO 50001:2011 for Energy Management. The statistical data for the various performance indicators is given below from 2007-08 to 2011-12.

3.1Plant Performance

The performance of the plant as compared to norms of design/ CERC is shown below

Performance	2007-08	2008-09	2009-10	2010-11	2011-12

Indicator					
Availability% Dahanu TPS National	96.7 87.12	96.31 86.00	97.18 85.05	96.48 85.05	97.48 84.76
Heat rate Kcal/Kwh CERC Norms DTPS HR	2450 2279	2450 2300	2450 2288	2450 2282	2450 2282
DM makeup% Design DTPS	3.00 0.22	3.00 0.24	3.00 0.32	3.00 0.42	3.00 0.294
Auxiliary power consumption % Design DTPS	9.75 7.67	9.75 7.71	9.75 7.60	9.75 7.38	9.75 7.42

Table 1 Plant performance indicators for the years 2007 to 2012

Plant load factor %

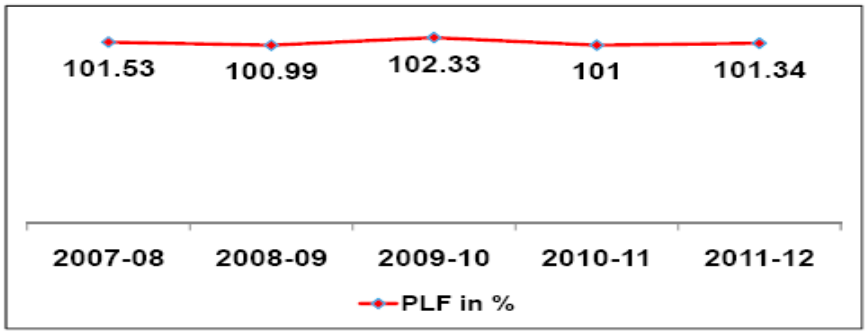

Figure 1 Plant Load factor%

Specific oil consumption ml/kwh

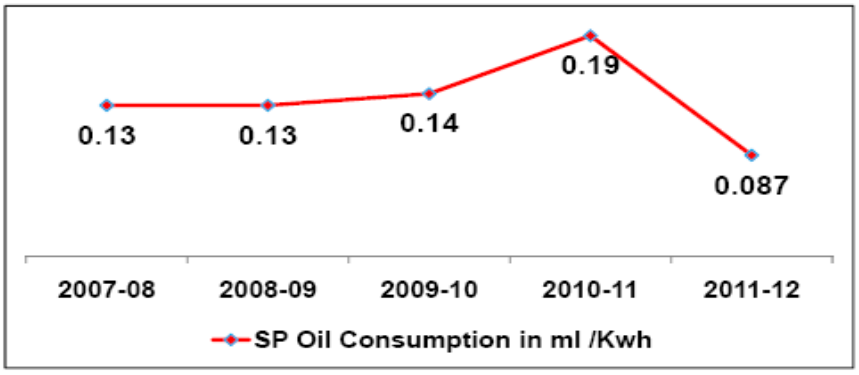

Figure 2 Specific oil consumption ml/Kwh

The comparison of various performance parameters of DTPS with NTPC ltd. thermal power plants is shown below

Station	PLF %	Availability Factor %	Aux power consumption %	Sp. oil consumption Ml/kwh	Heat rate Kcal/Kwh
DTPS	**100.99**	**96.31**	**7.71**	**0.13**	**2300**

Dadri	99.36	96.35	7.36	0.14	2389
Simhadri	97.41	94.54	5.28	0.10	2351
Rihand	97.23	95.61	6.37	0.16	2347
Korba	96.21	93.47	5.86	0.08	2369

Table 2 National benchmarking parameters

3.2 Energy management system

- Energy policy established
- Structured Energy management Cell
- Identify, Evaluate and Analyze Energy use & Consumption (Coal, Oil, electricity , Water)
- Periodic Energy Audit as per Central Electricity Authority (CEA) Guidelines
- Daily energy deviation reporting
- Total 25 Energy auditors
- E- LAN System for Energy Consumption Monitoring.
- Adopting new energy efficient and new technology.
- Managing energy by adopting best practices.
- Carrying out regular energy audits
- Complying with all relevant regulatory and statutory requirementsw

3.4 Establishment of Energy Management Cell in Dahanu Thermal Power Plant & Strategies

Under the Energy conservation Act 2001, all thermal power plants falling under Designated Consumers category is to nominate or appoint certified energy manager apart from setting up an energy management cell. Detailed survey was carried out by Ministry of Power, Govt. of India circulating the questionnaire to all designated consumers of thermal power plants to obtain the status on the following:

- Establishment of energy efficiency cells
- Engaging of certified energy managers and Auditors
- Roles and responsibilities
- Organizational structure pertaining to energy management cell
- Present status of procedures to measure energy efficiency

Under the Energy conservation Act, all thermal power plants falling under Designated Consumers category needs to take up specified activities. One important activity for Designated Consumer is to nominate or appoint energy manager possessing certified energy manager certification from Bureau of Energy Efficiency (BEE) apart from setting up an energy management cell. The energy manager and energy cell occupies an important position in the organization.

Energy manager will be the focal point of all the activities pertaining to energy management in the organization. Energy manager will have certain mandatory duties & responsibilities to fulfill the EC act requirements by the designated consumer.

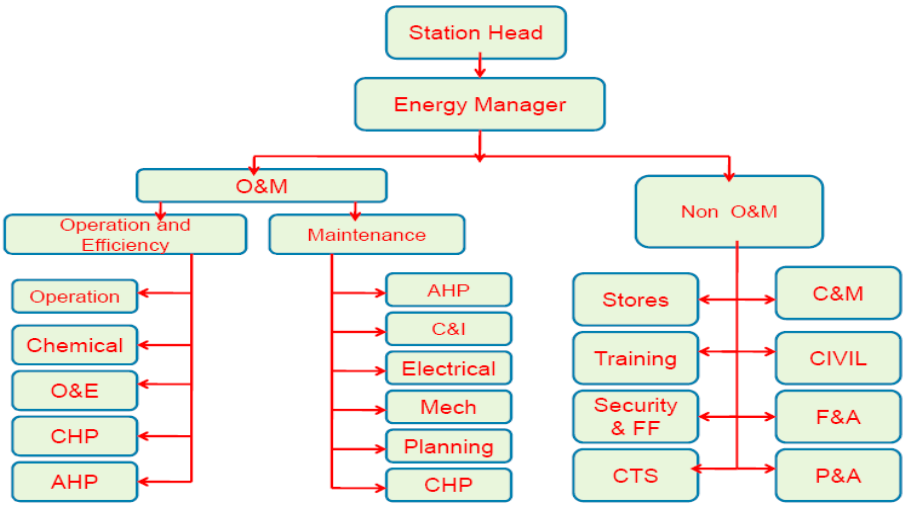

Figure 3 Energy management cell of Reliance Energy ltd. Dahanu TPS

3.3 The objectives of Energy Management Cell (EMC)

To operate the power station at highest energy efficiency & optimum cost and to create awareness about energy conservation amongst all stakeholders. EMC achieves objective of "**highest energy efficiency and at optimum cost "through following steps [2].**

- Regular internal Energy Audits
- Documentation for energy management activity
- Regular energy audits through accredited energy audit firms
- Regular filling of energy returns to state level designated agency
- Enhancement of employees' knowledge through internal training programme
- Energy conservation projects – Identification, Evaluation & Implementation
- Application of energy conservation techniques in the entire gamut of activities of DTPS including purchase, Training ,O&M, Inspection & Testing etc.
- Establishing the efficiency test procedures & schedules for all equipments & systems
- MIS

EMC achieves objective of **"Awareness drive"** through following initiatives.

- Display of posters and slogans in plant area
- Ongoing sensitization campaign for all employees
- Create awareness among local school children about energy conservation
- Employees suggestion scheme
- Celebration of Energy Conservation week
- Competition of posters & slogans
- Film show
- Display of energy conservation projects
- Technical training sessions from internal & external faculty
- Energy conservation walk involving all employees

3.4 Energy monitoring & targeting

Objectives & targets are set for departmental level as well as individual level. All objectives & targets are in line with corporate strategy & objectives. Everybody is responsible for energy productivity through KRI & KPI. KRA & KPI dashboards are reviewed on plant level as well as corporate level. Plant Level Review consist review of Plant performance, Maintenance, Condition monitoring, Generation cost, Heat rate losses and analysis reports. on Shift basis / Daily / Weekly / Monthly / Half Yearly Calendar year / Financial year basis Corporate review macro level in nature & consist of Plant performance, Profitability, Environmental reports aspects. Not meeting the target is noncompliance product & it is resolved by CA/PA actions.

3.5 Energy Management Policy

Reliance Energy Limited DTPS is committed to be the most efficient integrated energy utility in the world. Our mission is to use all energy resources most efficiently and thereby minimizing the impact of our operations on environment and conserving the scarce natural resources.

This we plan to achieve by,

Adopting appropriate energy efficient and clean technologies in process design, procurement, implementation and also continually upgrade our performance, managing efficient use of all forms of energy by adopting industry wide best practices, continually benchmarking our energy performance against the best in the world, improving our competitiveness by training and knowledge sharing, creating awareness about efficient use of energy and conservation methods amongst all our stakeholders, carrying out regular energy audits to identify areas for improvement and complying with all relevant state regulatory and statutory requirements on energy management.

3.6 Energy management initiatives

- Installation of Magna Drive Coupling for coal conveyor 6A
- Installation of 2HP Solar water Pump
- Improving heat rate by replacement of Unit-2 APH baskets, gratings and seals.
- Installation of Turbo wind ventilators
- Installation of IFC for service air system
- Installation of 900 Liters Per Day Solar water heater at colony stage-2
- Replacement of fluorescent lamp fixtures by fluorescent lamps (CFL) compact
- Replacing existing GT cooling pumps by energy efficient pumps.

Energy management achievements (Table 3 below)

year	Annual electrical saving achieved		Actual thermal savings		Total annual savings	Investment made
	Units Millions	Rs Millions	Tons of coal	Rs Millions	Rs Millions	Rs Millions
2.11-12	2.48	8.70	3055	12.46	14.94	11.80
2010-11	27.52	96.37	31952	89.75	96.37	18.50
2009-10	49.39	169.42	27790	83.36	169.42	286.91
Total	**78.4**	**274.5**	**62798**	**185.58**	**280.73**	**371.22**

Table 3 Annual savings and investment for energy management

Energy Saving Projects Implemented during 2011- 2012 (Table 4 below)

Energy saving project	Savings Rs lakhs	Investment Rs lakhs
Improvement in heat rate by reducing un burnt loss	5.51	Nil
Reduction in LDO oil consumption (23.64 KL)	2.46	Nil
Reduction in building energy consumption	1.66	Nil
Improvement in Heat rate by improving reheat temperature	0.16	Nil
Installation of magna drive coupling for coal conveyer	0.01	3.50

Table 4 Projects of energy savings in 2011-12

Energy Saving Projects Implemented during 2010- 2011(Table 5 below)

Energy saving project	Savings in Rs. Lacs	Investment in Rs. Lacs
Heat rate improvement by replacing HP turbine module	**81**	**51**
Auxiliary power reduction by replacement of BFP- 1B cartridge by repaired one	**70**	**35**
Auxiliary power reduction by installing Hi chrome liners instead of Mn liners in coal mill 1 AB	**57**	**60**
Installation of turbo wind ventilators stage- 4	**4.4**	**3.0**
Auxiliary power reduction by installation of fabric expansion bellows in flue gas duct passes A & B after APH outlet in both units	**3.8**	**1.6**
Revamping of electrolyses cell	**1.8**	**7.0**

Table 5 Energy saving projects

Energy Saving Projects Implemented during 2009- 2010 (Table 6 below)

Energy saving projects	Savings in Rs lakhs	Investments in Rs lakhs
Improving Heat rate by replacement of Unit 2 Air Pre Heater baskets, gratings and seals	**267**	**315**
Heat Rate improvement by replacing HP Turbine module	**122**	**220**
Installation of vapor absorption machine	**65**	**156**
Auxiliary power reduction by replacement of BFP 2 cartridge with repaired one	**48**	**100**

Installation of turbo wind ventilators 8 no	**9**	**6**
Installation of solar street lights	**0.15**	**11.52**
Installation of eco gen set for conference hall	**0.01**	**1.15**

Table 6 Energy saving projects implemented

Energy management planning for ENCON project for next 3 years (Table 7 below)

Sr. no	DPR details	Cost of project in Cr	Year wise details			
			2012-13	2013-14	2014-15	2015-16
1	Renovation of dry conveying compressors to improve reliability & energy conservation	3.0	1.0	1.0	1.0	0.0
2	Renovation of LP & IP module	8.0	0.0	0.00	4.0	4.0
3	Renovation of HP turbine module	6.5	6.5	0.00	0.00	0.0
4	Procurement of new BFP cartridge	5.0	0.0	0.00	5.00	0.0
5	Procurement of modified new design debris filter	8.0	2.0	2.0	2.0	2.0
6	Renovation and modernization of fluid coupling in CHP & AHP equipments	1.5	0.56	0.44	0.25	0.25
7	Installation of VFD in ID fan	5.5	2.75	0.00	2.75	0.0
8	Installation of VFD in LT drives	0.25	0.10	0.10	0.05	0.0

Table 7 Energy management planning

3.7 Reliance Energy Limited, Suggestions for effective implementation of Energy management in power plant

Thermal power sector has challenge of meeting growing demand by increasing generation. Bridging of supply & demand gap is difficult since generation is not increasing with same ratio as demand increases. Generation is lagging behind supply because thermal power plant is capital intensive & need long lead time for plant construction & modification. As it is known fact that thermal power plant utilizing only 30% of energy value of primary fuel, there is 70% loss mostly in the form of heat, all generation utilities should be made more responsible for energy productivity. To increase energy productivity, most essential step is to upgrade generation efficiency. As we know that saving of one electrical unit is equivalent to two units generated, energy conservation plays vital role to bridge the gap between supply & demand. Suggestions for effective implementation of Energy Management in power plant is given below.

Top management support: - Energy management programme needs total support of top management for success. Top management should give energy efficiency equal importance in their corporate objective as in case of manpower, raw materials, production & sales.

Training: - Human capital plays important role in implementation of EC act 2001, training & awareness is necessary to all employees. A well trained employee can increase energy productivity.

Formation of Energy Management cell (EMC):- It will execute energy management activities across different parts of organization.

Management by objective (MBO):- While setting Key performance indicator (KPI) & Key result area (KRA) energy efficiency aspect must be considered. All plant personnel must be involved in energy management programme. Due to KRA & KPI everybody is responsible for energy productivity and cost effectiveness.

Monitoring & control: - Regular evaluation of energy programme is necessary. Regular monitoring of KPI dashboard will give idea of deviation if any. Necessary corrective, preventive action plant is prepared to achieve target.

Adoption of best practices: - Best practice is a process, technique or innovative use of resources & has a proven record of success in providing significant improvement in performance.
Awards & Recognition: - It will motivate the people & increase participation in energy conservation.

3.8 Result

Thermal power plants contribute 70% of India's power generation installed capacity. Thermal power plant is designated sector as per EC ACT-2001. It is not possible to meet the growing demand due to long gestation period of power plant. Only solution is to reduce auxiliary power consumption by energy conservation & energy efficiency practices. There is tremendous scope in power sector for reducing auxiliary power consumption (APC). In India, It is estimated that; reduction in APC by 1%, which is equivalent of generation of 5000 MUs of energy per annum. Saved energy can be sold out to minimize the gap between supply & demand. Energy audit & analysis help us to identify number of energy conservation options. EC Act-2001 & Electricity Act-2003 has changed the scenario of power sector & made it more accountable. This changed scenario impacted the bottom line of power generation utilities. Hence the ways to retain one's competitive edge in the fiercely competitive industry are: - Increase in Plant load factor (PLF), Improvement in Heat rate, Improvement in APC, Reduction in O & M expenditure, Reduction in distribution losses, Better cost management.

IV. ENERGY MANAGEMENT OF 210MW KORADI TPS

The Energy Audit study of Koradi thermal power station Unit No. – 6 was conducted in September 2006. The objective of the study is to optimize the performance of various auxiliaries thereby **reducing the auxiliary power consumption** of the unit. Performance of Boiler, Turbine, LP/HP heaters etc. is also evaluated during energy audit study. The detailed scope of the study is given below.

1) Harmonic Analysis
2) Transformer load management
3) Lighting load analysis
4) Air conditioning system
5) Service and Instrument air compressors
6) Coal Mills
7) ID. FD, PA and Seal air fans
8) ESP and Ash slurry pumps
9) HP/LP heaters
10) Condenser performance
11) CW System (CW pumps & CT fans)
12) Ejectors
13) Condensate extraction pumps
14) Boiler feed pumps
15) Water balance

4.1 Outcome of Energy Audit:

The energy audit study at Unit- 6 of Koradi TPS has resulted in a saving potential of **Rs. 248.36 lakhs.** Considering the investment required, the overall payback period is computed as **6.9 months.**

The plant performance data of unit – 6 of Koradi TPS for last four years is tabulated in table 8

Sl. No.	Particulars	Unit	2002-03	2003-04	2004-05	2005-06
1	Gross Unit Heat rate	Kcal/Kwh	2756	2844	2913	**2751**
2	Actual Generation	MUs	1315.77	1247.49	1430.22	**1402.97**
3	Plant load factor (PLF)	%	78.99	68.12	78.69	**79.83**
4	Availability factor	%	90.03	81.77	92.31	**94.60**
5	Auxiliary consumption	MUs	96.25	99.90	109.11	**94.14**
6	Auxiliary consumption	%	7.31	8.01	7.63	**7.23**
7	Oil consumption	KL	1191	5043	2808	**2560**
8	Sp. oil consumption	%	0.91	4.04	1.96	**1.93**
9	Coal consumption	MT	965389	901603	1088685	**984732**
10	DM water consumption	M3	8903	139220	127403	**107170**

Table 8 Plant Performance data

From the above table it is observed that the maximum generation of 1402.97 MUs was in the year 2005–06. During the same year, PLF was 79.83%, which was highest. The availability factor for this year was 94.60%, which is also highest among all the years.

4.2 Energy conservation measures

The following energy conservation and management measures have been implemented in the plant.

Sl. No.	Energy conservation measures	Anticipated saving /year (RS. Lakh)	Approximate Investment (Rs. Lakh)	Payback period (Months)
1	Reduction of lighting voltage to 230V by changing tap setting of lighting transformer	7.38	Nil	Not applicable
2	Switching off one station transformer after rationalization	5.78		
3	Switching off 2 station transformers after rationalization	0.90		
4	Replacement of old chilled water pumps with new 2.2 KW pumps	1.56	0.15	1.2
5	Performance improvement of reciprocating air compressors	4.1	1.0	3.0
6	Performance improvement of Instrument air compressors by overhauling	5.23	1.6	3.7
7	Operating single AC compressor and overhauling of other AC compressor	4.73	1.5	3.8
8	Performance improvement of PA fans	60.0	20.0	4.0
9	Performance improvement of ash slurry pumps by overhauling & removal hindrances to rotation	9.11	3.0	4.0
10	Performance improvement of Boiler feed water pumps(BFP)	130.0	45.0	4.2
11	Overhauling of spray water pumps to improve efficiency close to design value	0.57	0.20	4.2
12	Installation of VFD for one FD fan	19.0	70.0	44.0

Table 9 Energy conservation measures

4.3 Summary of outcome of Energy Audit in Electrical field (Auxiliary power consumption)

1) **Electrical energy saving potential per year = Rs. 248.36 Lakhs**
2) **No cost saving potential per year (NCSP) = Rs. 14.06 Lakhs**
3) **Percentage of no cost saving = 6%**
4) **Total Investment required = 142.45 Lakhs**
5) **Overall payback period = 6.9 Months**

4.4 Energy Audit recommendations

a) Immediate measures

1) Reduction of lighting voltage to 230 V by changing the tap setting of lighting transformer.
2) Switching of one Station transformer after rationalization.
3) Switching of two station transformers after rationalization.

b) Short term measures

1) Replacement of existing chiller water pumps with new 2.2 KW pumps.
2) Performance improvement of pulse air compressors
3) Performance improvement of Instrument air compressors by overhauling.
4) Operating single chiller compressor for feeding complete air conditioning load and overhauling other chiller compressors.

5) Performance improvement of PA fans.
6) Performance improvement of Ash slurry sumps by overhauling.
7) Performance improvement of Boiler feed pumps.
8) Overhauling of spray water pumps to improve the efficiency close to design value.

c) Long term measures

1) Installation of VFD for one FD fan.

4.5 Thermal Energy Audit

a) Boiler efficiency estimation

The boiler of Koradi unit 6 is supplied by BHEL which is pulverized coal tangentially fired, natural circulation type. During the performance test no soot blowers were operated and no drains and vents were operated. The design efficiency of the boiler was estimated to 86.23% and losses 13.77%. The boiler efficiency was calculated on loss method [3].

4.6 Results

The design values and calculated values of losses are shown in the table 10 below.

Sl. No.	Losses%	Design value	Present value	Present value (corrected)
1	Dry flue gas loss	4.27	7.30	7.37
2	Wet flue gas loss	7.36	9.47	7.47
3	Moisture in combustion air loss	0.093	0.19	0.16
4	Un burnt gas loss	0.015	0.017	0.017
5	Combustible loss	0.51	1.43	1.34
6	Radiation loss	0.20	0.20	0.20
7	Manufacturer margin and unaccounted losses	1.33	1.33	1.33
8	Total losses	13.77	19.93	**12.89**
9	Gross efficiency of boiler	86.23	80.07	**87.11**

Table 10 Various Boiler losses

Saving potential

Steam flow rate = 630 TPH
Boiler efficiency = 87.11%
Steam to coal Ratio = 6.5: 1
Calculated coal flow rate = 121 TPH
Percentage increase in boiler efficiency = 1.02%

Considering a minimum 2% improvement in boiler efficiency by bringing down the stack temperature and maintaining the optimum level of excess air the saving in coal per year is given below.

Fuel saved @ 2% efficiency = 2.42 TPH
Total fuel saved per year = 17,424 MT
Amount saved per year considering cost of coal of Rs 1300/ton = Rs. 226 lakhs
Total Investment required = Rs. 20 lakhs
Payback period = 1.1 months

V. 220 MW SAMALKOT POWER STATION RELIANCE INFRASTRUCTURE LIMITED SAMALKOT (ANDHRA PRADESH)

220 MW Samalkot power station is commissioned in year 2002. As a responsible and foreseeing the energy demand, station has taken initiative for implementation of several energy conservation and management activities in the plant. During the year 2009-10 various energy management activities have been undertaken by the plant management for annual saving in the cost and power saving in the plant.

5.1 Station Energy Consumption Performance Report

Power Plant for its own operation has many equipment, station in day to day activities calculate own energy consumption as follows,

Aux Power Consumption in MU's= energy meter reading – Export Energy meter reading
Aux Power Consumption in % = (Aux Power Consumption in MU's x 100)/ (Station Generation in MU's).

	Station capacity MW	Auxiliary Power		% Reduction in MUs %
		Million Units MUs	In % KWhr/ KWhr	
2008-09	220	33.1859	**3.2780**	Base year
2009-10	220	30.7755	**1.9749**	**7.21**

Table 11 Auxiliary power consumption reduction

Above data revels that, due to several energy conservation measures & efficient operation of the station, station could achieve reduction from 3.278 to 1.9749 KWhr/KWhr to 7.21 % reduction in auxiliary power consumption in the period of 2009-10.

5. 2 Energy Conservation Commitment, Policy and Set-Up

Samalkot Power Station (SPS) considers energy conservation as its major objective to achieve cost effective power generation. Monthly review meeting on Energy management projects is being conducted in the presence of Unit Head. Reward & Recognition scheme are at place at corporate level to motivate Employees in view of Energy Conservation. During the period several best practices initiatives were undertaken for overall improvement in all round performance.

1. Improve the Heat Rate.
2. Reduce the Auxiliary power consumption
3. Reduction in consumption of Resources (i.e. Water, process chemicals)

5. 3 Energy Management Cell

Energy management cell has been established in the plant for energy efficiency improvement and shown below.

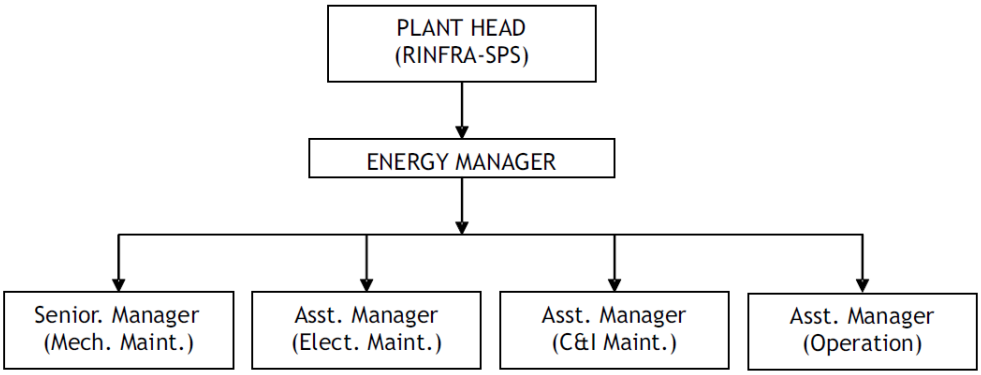

Figure 4 Energy management cell of SPS power plant

5. 4 Energy Conservation & Efficiency Improvement

At SPS there are state-of-art maintenance techniques and strategies to conserve energy.

The Energy Management cell of SPS consists of qualified energy managers and auditors who ensure adherence to constantly evolving energy efficiency standards [4].

The various energy management measures that have been put into practice are:

- Installation of VFD in HPBFP, LPBFP, Raw Water Pumps
- Modification In DD Hydraulic Oil System
- Wind Turbo Ventilators
- Normal FL lamps & ballast are replaced by High Lumen Lamps & HF Ballast.
- Corrosion coating of CW / ACW Pumps
- Installation of Energy Efficient Epoxy Coated Cooling Tower Fan Blades.
- Modification of motor driven Cooling Tower Makeup system to Gravity System.
- Draining of Abnormal sump Water by gravity to common monitoring basin.
- Plant Compressor Air System pressure set point reduced from 8.5 Bar to 7.5 Bar
- Steam & Water Analysis System (SWAS) drain water recovery to reserve feed water tank.
- During Summer Bypassing of Pretreatment plant.
- Dosing Of Alum in Pretreatment plant by gravity
- Dosing Of H_2SO_4 in Circulating water System by gravity
- Dosing Of H_2 SO_4 in Effluent Treatment Plant by gravity

- Illumination System of Building
- Replacement of FL lamps (40W) with CFL (20W) lamps at non essential areas
- Illumination System for Street Lights
- Replacement of HPSV lamps (270W) with CFL (75W) lamps
- Steam Turbine Condenser Bullet Cleaning is practiced during opportunity.
- For improving steam turbine & HRSG performance, Evaporator section chemical cleaning is practiced.

As a proactive, after implementation of much energy saving programs, Station has conducted third party plant energy audit in Sep'09. Station has implemented SAP package in 2004 for preventive maintenance activity and corrective maintenance activity. After implementation of SAP package historical data of the plant is maintained in the server and is readily available for any analysis. For efficient operation of the station, predictive maintenance is done on plant assets, as transformer dissolve gas analysis, plant equipment thermograph, vibration analysis of all critical equipments, current signature analysis on electrical equipments, Tan delta test on electrical system.

Plant Performance (PLF/AVL) up to 2009-10 financial years

Year	Station PLF %	Station availability %
2003-04	66.19	94.33
2004-05	61.00	98.30
2005-06	45.28	89.39**
2006-07	50.46	97.40
2007-08	60.67	97.41
2008-09	52.50	97.08
2009-10	80.86	90.25**

Note: ** Station was under Major Overhaul.

Table 12 Plant performance data

5. 5 Results

The annual cost and energy saving due to energy management approaches has been summarized in the table 13 below.

Sr. No	Energy conservation Activities	Power saving (KW)	Annual energy saving KWh	Annual saving in Rs lakhs	Implementation cost in lakhs	Annual energy saving KWh
1	Replacement of Cooling Tower GRP solid cell fan blade with Epoxy Coated Hollow Energy Efficient Fan Blade.	128.95	1129602	**25.42**	20.005	11.2960
2	Modifying Cooling Tower makeup system from Motor driven pumping to Gravity system.	22.80	199728	**4.49**	2.844	1.9973
3	HPBFP VFD Pressure Optimization	30	262800	**5.91**	0.00	2.6280
4	LPBFP VFD Pressure Optimization	3	25404	**0.57**	0.00	0.2540
5	Standby Closed cooling water PHE(Plate type heat exchanger) isolated from ACW(Auxiliary cooling water) as well as CCW(Closed cooling water) side.	4.6	40296	**0.91**	0.00	0.4030
6	Wind Ventilators	4.3	224431	**5.05**	3.206	2.2443
7	Illumination replacement of FL lamps with CFL	1.33	11651	**0.26**	0.189	0.1165

Table 13 Energy conservation activities of power plant of RIL

5. 6 Energy Management Policy

Reliance Energy Limited is committed to be the most efficient integrated energy utility in the world. Our mission is to use all energy resources most efficiently and thereby minimizing the impact of our operations on environment and conserving the scarce natural resources.

The plan for achievement is given below [5]

- Adopting appropriate energy efficient and clean technologies in process design, procurement, implementation and also continually upgrade our performance.
- Managing efficient use of all forms of energy by adopting industry wide best practices.
- Continually benchmarking our energy performance against the best in the world and improving our competitiveness by training and knowledge sharing.
- Creating awareness about efficient use of energy and conservation methods
- Carrying out regular energy audits to identify areas for improvement.
- Complying with all relevant state regulatory and statutory requirements on energy management.

5. 7 Results

After implementing energy management practices the station PLF have increased to 80.86 % in 2009-10 and annual saving as per table 5.3 of energy and cost saving of Rs. 42.5 Lakhs. I have taken up this research work of the Energy management factors which have positive impact on the power plant performance indicators to improve productivity indicators and financial measures thereby evolving a model which suits the modern Thermal Power plants in the country. The research work aims to explore the concept and philosophy of energy management approaches to improve the performance indicators thereby achieving the energy savings and minimize the cost of power generation, process improvement, financial performance, customer satisfaction and employee satisfaction. We feel important to address this issue through an academic and business research.

The questionnaire as given below is framed to assess the impact of Energy management practices on several performance measures of esteemed organizations in power sector. The questionnaire will provide a self assessment of Energy Management practices and performance measures. The questionnaire can be administered to the operating Engineers to collect necessary information from thermal power plants needed for this research study. The data can be collected by sending the questionnaire to collect the case study from experts of power plant, Energy Auditors, Energy managers and expert power plant trainers.

VI. QUESTIONNAIRE FOR ORGANIZATIONAL INFORMATION FOR CASE STUDY OF THERMAL POWER PLANT

1) Name of the Organization: –
2) Name of the Respondent: -
3) Designation:-
4) E-mail of respondent: -
5) When the Energy cell was formed details:-
6) Is the organization certified for ISO 50001 for Energy management systems:-
7) Energy Policy:-
8) Energy objectives:-
9) Program plan for energy management:-
10) List of measure energy consuming auxiliaries:-
11) Details of energy performance indicators:-
12) Details of Energy Audit conducted in your plant:-
13) Corrective actions taken on Energy Audit findings:-
14) Details of causes of energy reductions in the plant:-
15) Resources provided for Energy management Cell:-
16) No of Energy Auditors in the plant:-
17) Infrastructural / technical changes made for energy savings:-
18) Training programs conducted for awareness of Energy Management in the plant:-
19) Constraints/ problems in implementing Energy management system:-
19) Results and future plans:-

VII. CONCLUSION

It is evident from the above case studies of various thermal power plants the energy management approaches are implemented in Indian thermal power plants to improve performance indicators and financial measures. At present the coal based generation capacity is 176118 MW which is main stake of power supply in the country. During 12^{th} five year plan it is envisaged that about 118000 MW would be added to meet the demand of power in India. Huge amount of fuel and electricity would be required for generation of power. Implementing energy performance improvement plan based on the case studies of thermal power plants would definitely help to improve the performance parameters of the power plant. I think that the case study approach of energy management would be helpful to enhance energy efficiency of thermal power plant and economize cost of power generation so as to compete the companies in the power business.

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