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Energy Audit for Improving System Efficiency In Industrial Sector

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ABSTRACT: This paper presents the characteristics of energyconsumption in industrial sector, the methodology and results of energy audits (EA) performed in industrial sites and potentials for energy efficiency (EE) improvements. Presently industrial energy in India is characterized by significant technological low energy efficiency and low level of environmental protection.If we analyze the results of energy audits in selected industrial companies in previous period has shown the significant potentials for energy efficiency improvements in industrial sector (upgrading of equipment in the industrial energy sources and processes, introduction of energy management,the waste heat utilization, introduction of energy efficiency technology, improvement of energy efficiency in electrical equipment, usage of waste materials etc).

Keywords: EnergyAudit,Industrial sector, Energy Efficiency.

I. INTRODUCTION

Energy conservation means using energy more efficiently and effectively by reducing wastages of energy. Every year, the demand of electricity is increasing by 6-8 per cent, while production is not increasing in the same ratio. Due to this reason, the gap between demand and supply is constantly increasing. To reduce this gap, there are two alternative ways: one is to generate more electricity, which requires huge investment and second is to conserve the electricity. For making energy conservation effective, Energy audit is basic tool. Auditing is the process to identify the wastages of energy without in any way affecting productivity and growth rate. In conservation process usually new investment are required such as replacement of old inefficient equipments to new one. It can be made successful by planning maximum energy efficiency and maximum cost effectives. All activities in the field of energy efficiency have been deeply influenced by the following: a) the lack of understanding of the importance of energy efficiency by the management in the companies, b) the lack of stimulant economic measures and financial sources for the investments in energy efficiency projects and c) the lack of properly prepared energy efficiency project proposals.

1.1 The Energy Scenario in India:

With the growth of economy since independence, the country's power requirement has grown substantially. India today faces a peak shortage of about 11-18% and an energy shortage of about 7-11%. India has a rapidly growing economy and projected economic growth (@6.4%) will necessitate corresponding growth in energy requirements. In India, electric energy consumption for different sectors is as follows–

1) Industrial: 26.64%
2) Domestic and commercial: 30.78%
3) Agriculture: 1.66%
4) Transport: 29.35% 5)Others: 11.57%

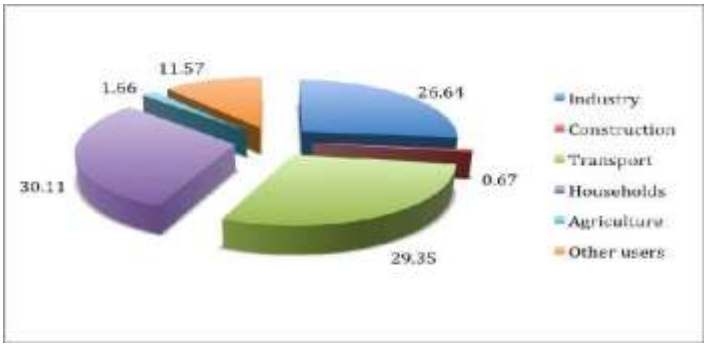


Fig 1. Share of final energy consumption per sector

1.2 Objectives of Energy Management:

Energy management is the judicious and effective use of energy to maximize profits and enhance competitive positions. Some desirable objectives of energy management programs include -Conserving energy, thereby reducing costs. Cultivating good communications on energy matters. Developing and maintaining effective monitoring, reporting and management strategies for wise energy usage. Finding new and better ways to increase returns from energy management program from all employees.

II. ENERGY AUDIT

Energy audit is an inspection, survey and analysis of energy flows for energy conservation in a building, process or system to reduce the amount of energy input into the system without affecting the output.

An energy audit is defined as a systematic procedure that

- Obtains an adequate knowledge of existing energy consumption profile of the site.
- Identifies the factors that have an effect on the energy consumption.
- Identifies and scales the cost effective energy saving opportunities.

The essential step to the energy efficiency improvements is the performance of an energy audit. Energy audit is a procedure that helps to analyze the use of energy in an enterprise or building. The energy audit serves to identify how a plant facility uses energy and to determine the energy conservation opportunities. The energy audit can assist in: evaluating energy efficiency, identifying energy saving opportunities and establishing a plan to implement energy saving projects.

An energy audit consists of comprehensive collection of data on energy use. It is a procedure that requires the use of auditing equipment and experienced personnel (energy auditors) . Through the energy audit the administration of the site can: assess the energy cost and its effect to the total production cost; identify financially and technically viable options for reducing energy usage; identify possible ways to improve productivity through interventions in areas not directly linked to energy consumption, i.e. better manpower utilization, reduction of the usage of raw material in production, improved product quality.

There are several "levels" of energy audits, which can include simple or detailed data surveys, often followed by detailed examinations of existing data and/or special plant test runs. The time taken to conduct any audit depends on the size and type of facilities, but priority should be given to the departments or sections of the plant of highest energy consumption.

A. The type of audits

Short audits: This type of audits aims to assess presentenergy consumption levels and relative costs based on existing documentation and a short visit at the site. Eventually good housekeeping measures and low cost/short payback measures for energy efficiency are proposed. A list of medium to high cost measures is also indicated without major justifications as well as the specific points, which must be tackled within a detailed energy audit. Short energy audits belong to the scanning audit models, and according to the Energy Efficiency BREF (published in March 2008), there are two main examples of short energy audits: walk-through energy audits and preliminary energy audits. A walk-through energy audit is suitable for small and medium sized industrial sites and preliminary energy audit is suitable for larger sites.

Detailed energy audit: This type of audits requires acomprehensive recording and analysis of energy consumption data, split into various sectors within the site (steam/hot water production, compressed air, electricity, HVAC etc.). In this frame, different parameters that determine each type of energy use are presented and analyzed (e.g. production capacity, climate conditions, raw materials etc.). Eventually, a list with potential energy saving measures requiring investment capital is presented together with a cost-benefit analysis for each proposed measure.

B. The methodology

The methodology is based on the standard methodology for short energy audits and it includes the following: (1) Preparation of questionnaires on energy consumption, company production rate, the list of energy systems and energy consumers, etc.; (2) Determination of energy indicators for the company; (3) Visit of the selected sites (an initial audit normally requires a few days for a small to medium-sized location; for large industrial facilities, such as refineries or steel plants, it may take more than one week and up to two weeks to complete); (4) Determination of energy losses and calculation of energy balance and energy flows; (5) Evaluation of energy efficiency and conservation potentials; (6) Identification of energy efficiency measures and applicable Energy Efficiency and Conservation (EE&C) technology and evaluation of EE&C potentials in the sector;

(7) Evaluation of implementing capacities of the sites for EMS introduction; (8) Reporting on results of energy audits.

III. OVERVIEW OF COLLECTED DATA AND ANALYSIS

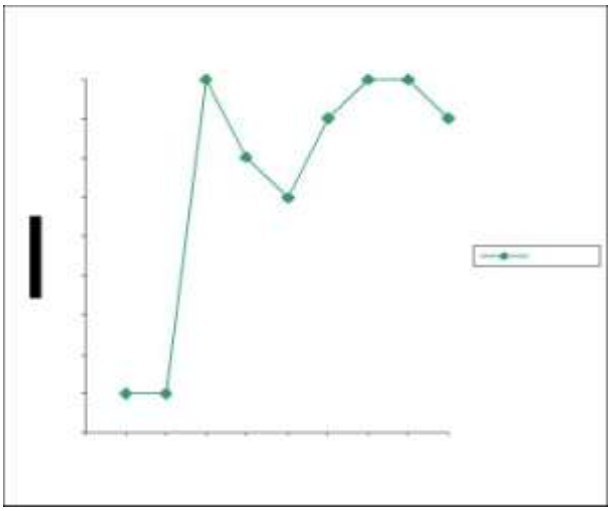


Fig.2: Monthly variation of average PF

The energy audit has been done in the automobile company and the pharmaceutical industry in the industrial area of Jeedimetla located in Hyderabad.

- Low power factor company details:

Nature of work: Automobile work shop
Contract demand: 120KVA
Average kWH consumption: 17727
Average power factor: 0.77
Average electricity bill: Rs 1,80,027

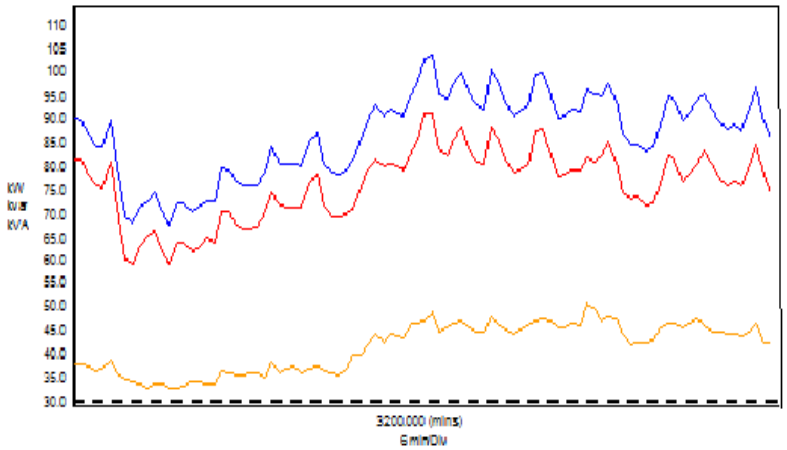
- Good power factor company details:

Nature of work: Pharmaceutical industry
Contract demand: 1900KVA
Average kWH consumption: 2,28,640
Average power factor: 0.97

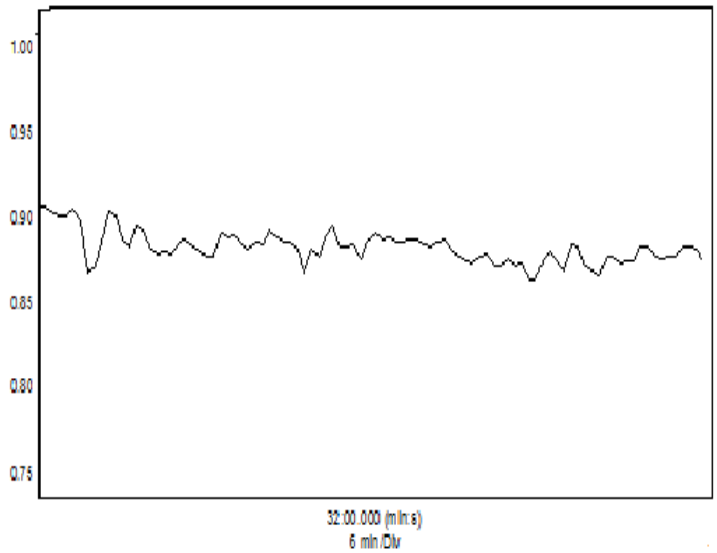
TRASFORMER								
Sl No	**PARAMETER**		**RMS**			**THD%**		
			MIN	**AVG**	**MAX**	**MIN**	**AVG**	**MAX**
1.	**VOLTAGE**	R	322.8	379.3	390.2	2.1	2.2	2.6
		Y	346.2	378.6	390.3	2.2	2.4	2.9
		B	348.4	376.2	387.1	2.1	2.3	2.6
2.	**CURRENT**	R	76.73	131.3	213.6	4.4	5.3	5.9
		Y	81.4	162.2	240.2	4.9	6.2	7.4
		B	62.12	113..9	189.5	5.0	5.9	6.5
			MIN		**AVG**		**MAX**	
3.	**POWER (KW)**		59		76.18		90.96	
4.	**POWER (KVAR)**		32.53		41.52		50.60	
5.	**POWER (KVA)**		67.62		86.87		103.3	
6.	**POWER FACTOR**		0.8490		0.8770		0.9060	

Table 1 Collected Data in the industry with low power factor.

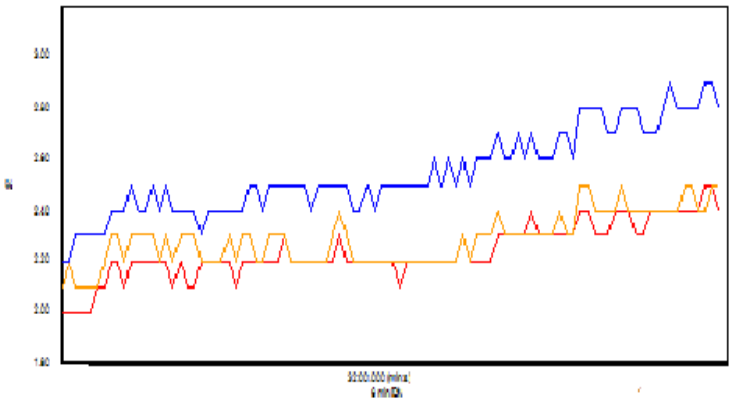
Power curves:



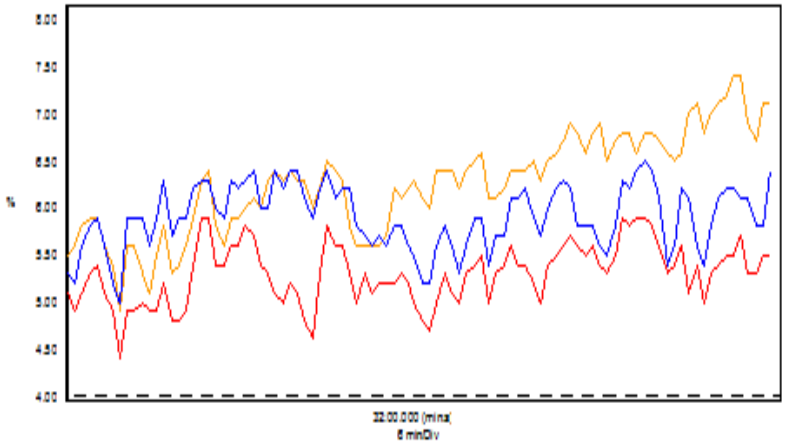
Power factor curve:



Voltage thd:



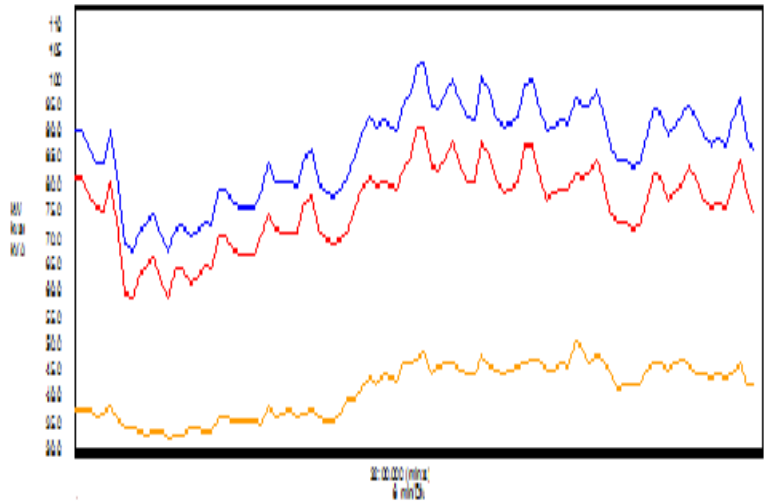
Current thd:



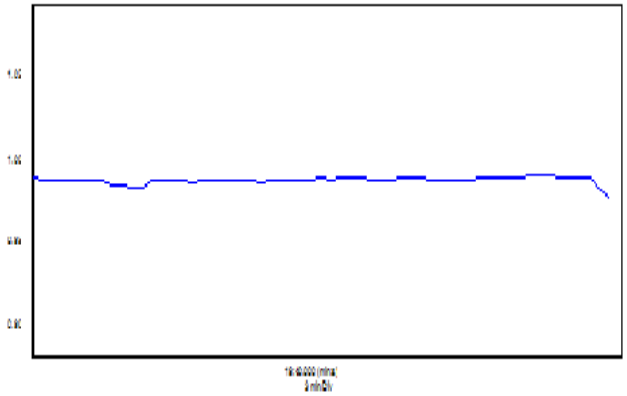
TRANSFORMER								
Sl No	**PARAMETER**		**RMS**			**THD %**		
			MIN	**AVG**	**MAX**	**MIN**	**AVG**	**MAX**
1.	**VOLTAGE**	R	420.88	434.05	440.63	1.9	2.193	2.4
		Y	419.51	432.49	439.59	2.5	2.681	3.0
		B	422.27	435.44	442.02	2.1	2.33	2.6
2.	**CURRENT**	R	827	954.2	1293	11.9	13.05	15.2
		Y	885	1015	1376	11.4	13.12	15.3
		B	807	943.9	1306	11.2	12.85	14.8
3.	**POWER (KW)**		**MIN**		**AVG**		**MAX**	
			661.4		722.8		773.3	
4.	**POWER (KVAR)**		29.98		80.6		138.2	
5.	**POWER (KVA)**		669.2		730		784.2	
6.	**POWER FACTOR**		0.9820		0.9897		0.9920	

Table 2 Collected Data in the industry with good power factor.

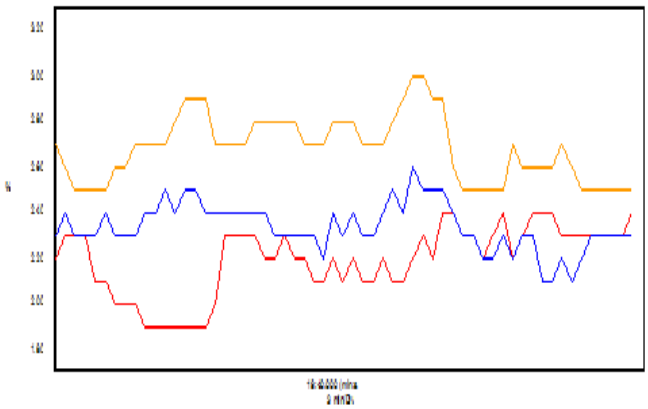
Power curves:



Power factor curve:



VOLTAGE THD:



IV. RESULTS OF ENERGY AUDITING

Energy consumption in industry is deeply dependant on the change of the structure of industrial production. The rise of the share of industrial subsectors with low energy intensity is very important, but that depends on the strategic decisions of the Government based on the overall strategy of the economic development of the country. Generally, energy efficiency improvement measures for industry can be divided in two main groups: (1) Energy efficiencyimprovements of energy sources in industry (heatproduction and electricity in heat and power plants in industry) and (2) Energy efficiency improvements ofindustrial production processes.In EE improvements of energy sources in industry, two groups of measures arerecognized: **(a)** Programs and measures of modernization, revitalization and reconstruction of existing objects, equipment or energy technologies of energy sources in industry and **(b)** Programs and projects of building of new plants or units, or replacement of old units with new energy efficient units. The effects of measures and programs of EE improvements of energy sources inindustry are estimated approximately to 20% ofreduction of total energy consumption in industry.

4.1 Lighting System:

From the survey done at the automobile company, it has been observed that the average lighting load was around 15KW and the total energy consumed per annum is 5400KWh. The industry spends an amount of Rs.37,260 on the lighting. By using a power saver 20% of the amount per month can be reduced i.e., Rs. 7,452. In order to save the lighting cost a power saver of 20KVA is required.

4.2 Powerfactor Improvement:

By studying the electricity consumption pattern it is seen that the power factor is maintained at 0.87. But, this PF is not sufficient to get the power factor incentive from MSEB. To get power factor incentive, the power factor must be maintained above 0.95. In order to maintain the power factor above 0.95 improvement in capacitor bank is recommended.The capacitors required for power factor improvement in order to get power factor incentive can be calculated from the general formula. 50 KVAR capacitor bank is required for the power factor improvement. As the demand is high, an APFC panel of 75 KVAR is required.

4.3savings In Electrical Motors:

The over sized standard motors which are in the compressor and pump sections are replaced by the new energy efficient motors to save the electricity. The existing compressor motor of 15hp is replaced by a 10hp energy efficient motor so that a total savings of Rs. 9253.752 is obtained. The payback period is around 3years.

The existing pump motor of 5hp is replaced by a 3hp energy efficient motor to obtain a total savings of Rs.3997.695. the payback is around 2.5 years.

V. CONCLUSION

As the countries develop the electricity, demand percapita increases and hence the need to save electrical energy becomes significant. Most factories face the problem of higher cost of production. They cannot reduce the cost of raw material and labour but they can reduce the cost of energy consumption by implementing energy management and conservation measures. The energy audit serves the purpose of identifying how a plant facility uses energy and of analyzing the energy conservation opportunities. In conclusion, the potential saving in energy management program for industries are based on the transformer analysis, power factor management, load management and electrical appliances analysis.

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