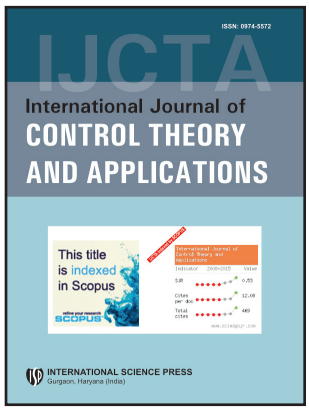

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Case Study of Electrical Energy Audit in Heat Treatment Industry

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Abstract: India is the sixth largest power generation country in the world, but it does not match the generation and demand. Presently, more initiative is taken on the generation part, rather than conservation of energy. In connection to that we started the initiative to save energy through MGR Vision 10MW. India is a country where 70% of the energy is used in the seven major sectors, namely Fertilizers, aluminium, textiles, cement, iron, steel and paper. In these sectors 5 to 10% of energy savings is possible by keeping good housekeeping and another 10 to 15% is possible with small investments like energy efficient devices, retrofits and suitable control systems, etc. This paper presents the electrical energy audit of Heat Treatment Industry in Chennai with the suitable recommendation for implementation. ETAP is used for the testing of proposed recommendation to reduce the power consumption. The financial cost analysis also presented in the paper.

Keywords: Energy Saving; Energy Audit and Renewable Energy.

1. INTRODUCTION

Energy conservation is an objective to all citizens of the country and everybody's duty is to contribute to conserve energy for his own benefit as well as for the nation. The Government of India has introduced Energy Conservation Act 2003 [1] with an aim of reducing the energy intensity in an effective manner .This act empowers the central government to insist the state governments to implement the act for the promotion of energy efficiency. The Government of India has implemented different schemes to promote the Energy conservation and energy efficiency like Standards and Labeling, Energy conservation building code, Demand Side Management and agricultural DSM. The major percentage of energy utilized in the industries where the need of energy conservation is essential. The overall objective of the assignment is energy savings in the existing system and to achieve a reduction in energy consumption pattern of the industry [2]. This has to be achieved through effective Energy Audit [3]. An energy

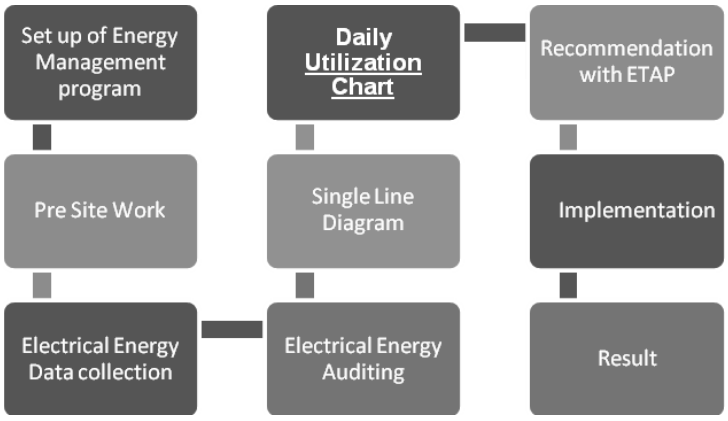
audit is a process of checking how energy is used and identifying the areas where wastage can be minimized if not totally eradicated. Since India is a developing country, it is not possible to achieve the full requirement of power in a short span, but can be achieved only on step by step process. The industrial energy audit is carried out by different authors are presented below.

Ali Hasan beigi, Lynn price in the handbook of Industrial Energy Audit has concluded How concluded effective energy audit in an industry and the recommendation for the implementation is coated and also a cash flow formula is derived to obtain the outcome in an beneficial manner [3]. C. Palanichamy conducted an energy audit in textile industry and in this audit conducted 18.23% of electrical energy is saved and also there is reduction in 777.97 tons in the outcome is obtained in the post audit[4]. P. Loganthurai explained about the importance of energy audit in one institution and concluded that in tamil nadu if all the institution undergoes energy audit 20% reduction in total demand in tamil nadu is easily obtained in an beneficial manner. [5] Wayne C. Turner and Steve Doty in the handbook of Energy management handbook has given the menthodolgy to conduct energy management in industy to reduce the consumption by optimizing methods. [6]

This work is carried out under the banner of MGR Vision 10MW. With the initiative of Prof. L. Ramesh, MGR-VISION 10MW was envisaged in Dr. MGR Educational and Research Institute (University) in the year 2014 with an objective to save 10MW of energy within a period of 10 years. The work carried out in the heat treatment industry in Chennai with an annual average consumption 50,000 unit. The analysis of auditing is done with the help of an ETAP [7] software package. The recommendations are submitted to the client for implementation with the payback period.

2. PROCEDURE

The energy audit is conducted in order to study the performance of the industrial appliances. This is to check whether all appliances are efficient and intact, initially pre site study is taken where in pre site study is done by checking the entire industry set up and types of appliances or machines used by respective industry. After the pre site audit, observation, study is done so that all equipment is checked and the entire layout of the industry is verified and survived by starting with the baseline of energy consumption, evaluating the performance of the equipment, to find out the energy saving opportunities, to quantify the total energy savings, and to find out the ways for achieving high energy efficiency.



The industry located at Chennai has taken up energy auditing and data monitoring with respect to the bills. The industry basically heat treats the products to strengthen/harden the automobile spare material parts like brake shoes, brake linings, roller, two wheeler brackets, bushes, etc., It is 24 hours operated industry, thus the entire energy utilizing equipment is studied. Where there are three units of LT CT service connections obtained

from TNEB. In industries, each unit is simulated using the ETAP. The company uses various types of furnaces namely Gas Carburizing Furnace (GCF), Vertical Force Circulation Furnace (VCF) and short Blasting Furnaces The products are heated up to 950 degree Centigrade in the furnaces for about 2 to 3 Hours depending upon the requirement and then taken out. The heated products then force cooled or naturally cooled to bring back to normal temperature.

3. DATA MONITORING

The data monitoring is the process of collecting information about the place or area where electrical energy audit is to be conducted and also to find out the maximum amount of wastage in this process can be done by the following

- Single Line Diagram
- Age of Equipments
- Tariff Details
- Wattages of the equipment's and daily utilization of wattage consumed by the industry.

In this a single line diagram is drawn using the ETAP simulation software and proper simulation is done in the layout of the industry.

3.1. ETAP Single Line Diagram

The layout of the industry is drawn using the ETAP simulation software for all the three service connections in this the recommendation for the implementation is done to ensure a beneficial outcome. Single Line diagram of Service no: 1, the diagram, i.e. drawn indicates the buses in which the load is connected. After the implementation of the recommendations, load analysis is done to get the effective outcome of the concerned recommendation.

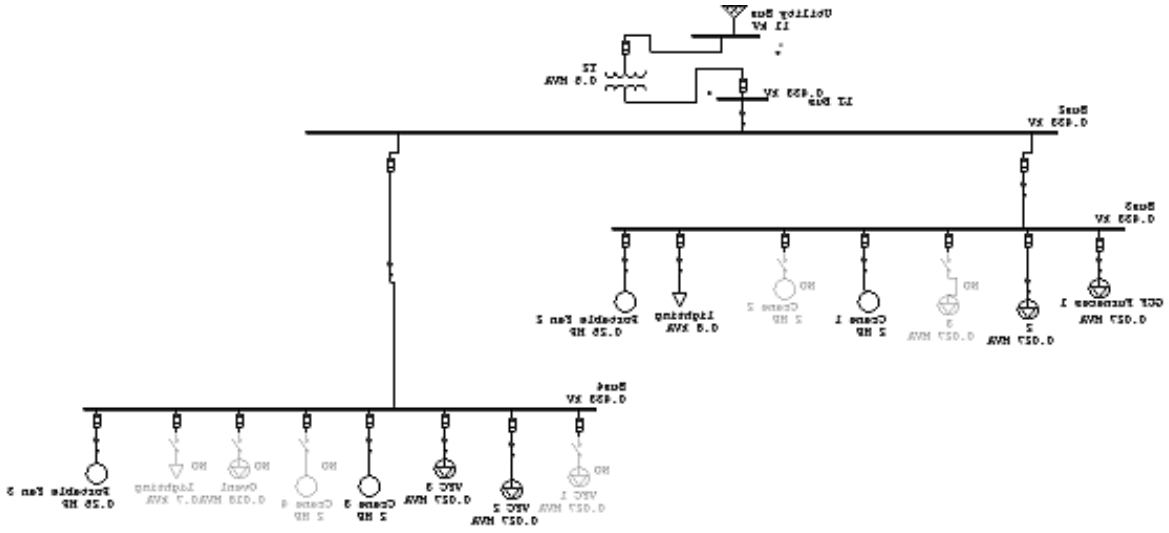


Figure 1: Service 1 Single Line Diagram

The Table 1 clearly explains about the total number of electrical appliances which are connected to the service 1 and the calculation is calculated manually and it is simulated as single line diagram using Electrical Transient and Analysis Program (ETAP).

Table 1
Service No: 1 Equipments

Bus 1	GCF Furnace-27 kW, Crane-2 HP, Lighting-800 W, Portable Fan-0.25 HP
Bus 2	VFC-27 KW, Crane 2 HP, Oven 18 KW, Portable Fan 0.25 HP, Lighting 700 W

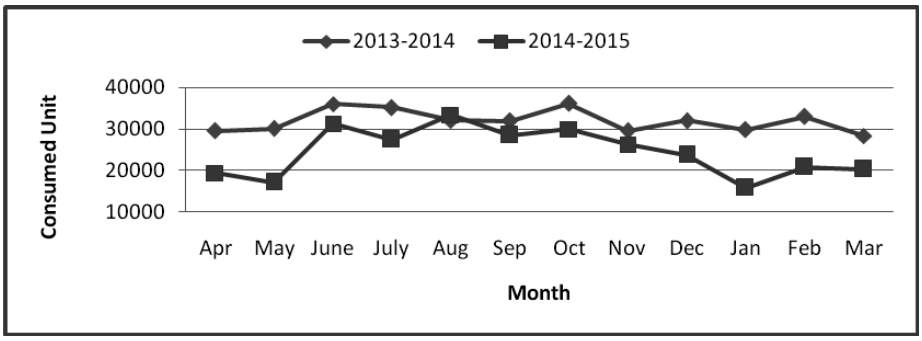


Figure 2: Service 2 Tariff details

Figure 2 explains about the monthly tariff bills in the particular industrial unit on the basis of monthly utilization of the unit consumed and the amount fixed by TNEB.

Single Line diagram of Service no: 2, the diagram, i.e. drawn indicates the buses in which the load is connected. After the implementation of the recommendations, load analysis is done to get the effective outcome of the concerned recommendation.

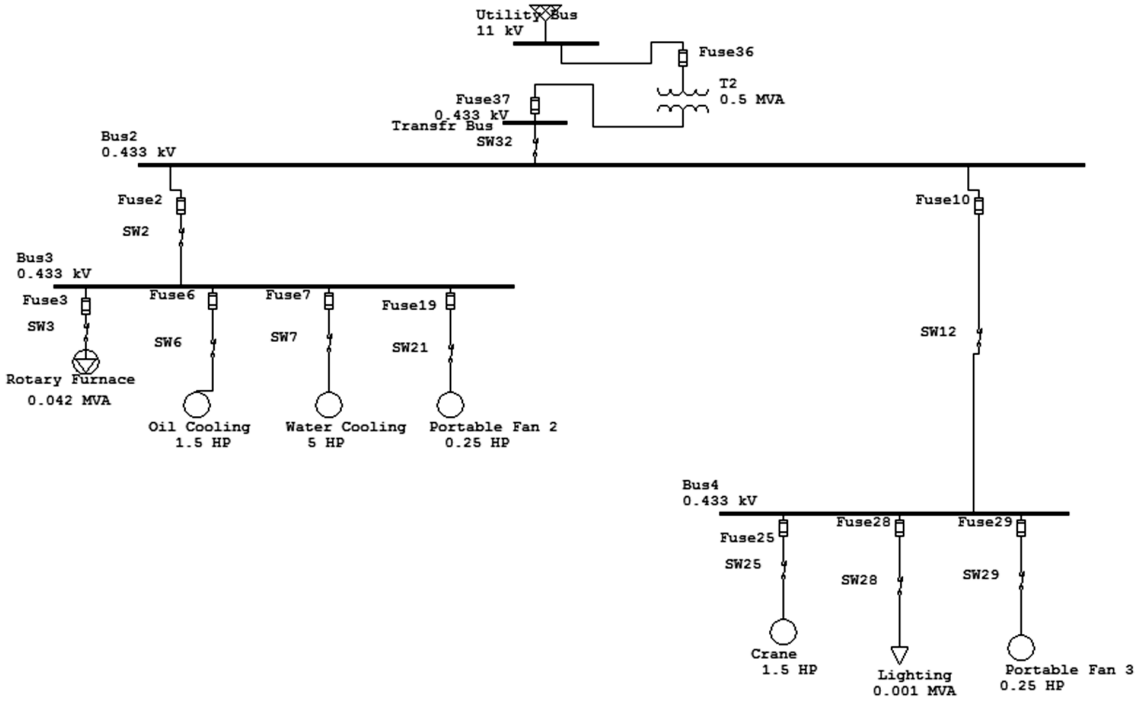


Figure 3: Service 2 Single Line Diagram

The Table 2 clearly explains about the total number of electrical appliances which are connected to the service 2 and the calculation is calculated manually and it is simulated as single line diagram using Electrical Transient and Analysis Program (ETAP).

Table 2
Service No: 2 Equipments

Bus 1	Short Blasting Furnace-10 kW, Wall mounted fan-1 HP, Air conditioner-2.3 KWA
Bus 2	Air compressor-50 HP, Lighting 100 W, Portable Fans-0.75 HP, Compressor-10 HP

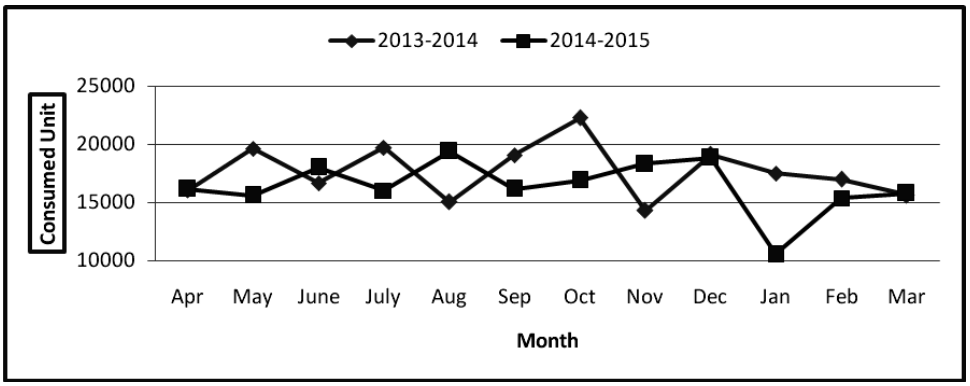


Figure 4: Service 2 Tariff details

Figure 4 explains about the monthly tariff bills in the particular industrial unit on the basis of monthly utilization of the unit consumed and the amount fixed by TNEB.

Single Line diagram of Service no: 3, the diagram, i.e. drawn indicates the buses in which the load is connected. After the implementation of the recommendations, load analysis is done to get the effective outcome of the concerned recommendation.

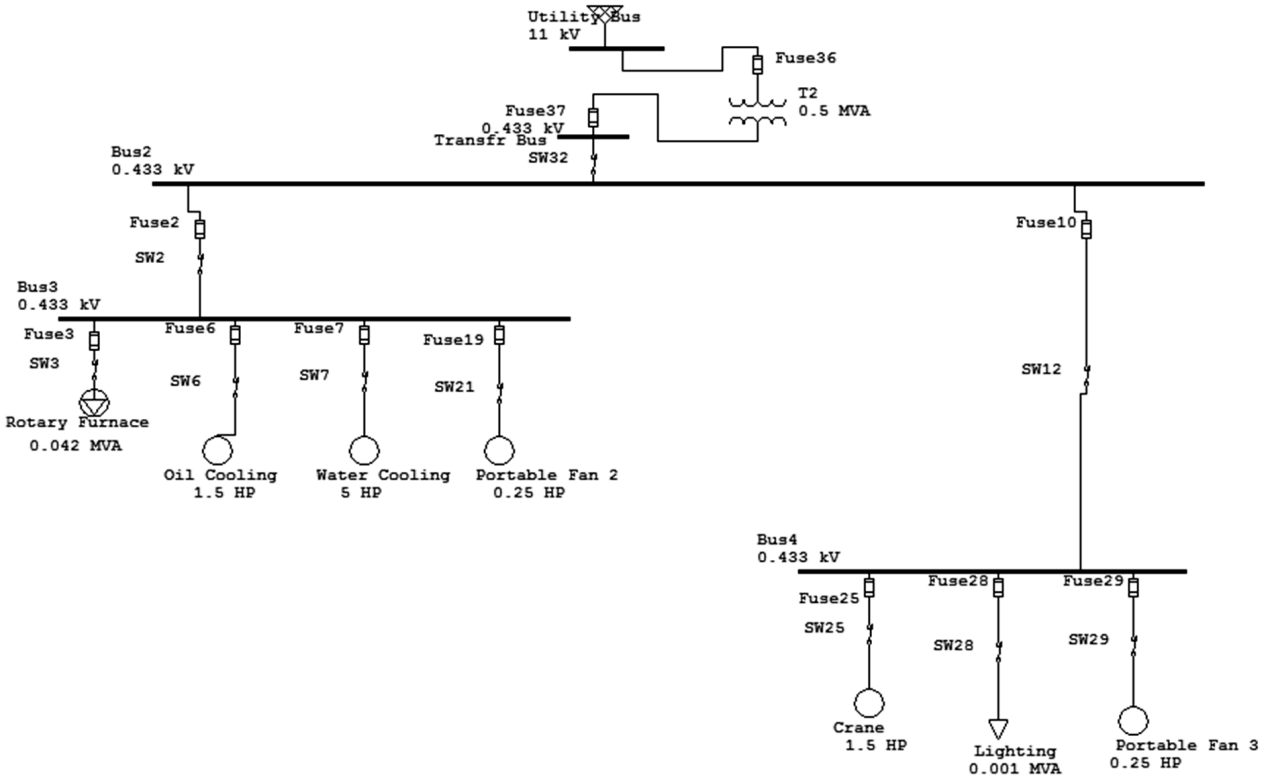


Figure 5: Service 3 Single Line Diagram

The Table 3 clearly explains about the total number of electrical appliances which are connected to the service 2 and the calculation is calculated manually and it is simulated as single line diagram using Electrical Transient and Analysis Program (ETAP).

Table 3
Service No: 3 Equipments

Bus 1	Furnace-10kW, Oil Cooling pump-1HP, Water cooling pump-2.3 KWA
Bus 2	Crane-42 KW, Lighting-100 KW, Portable Fan-0.25 HP

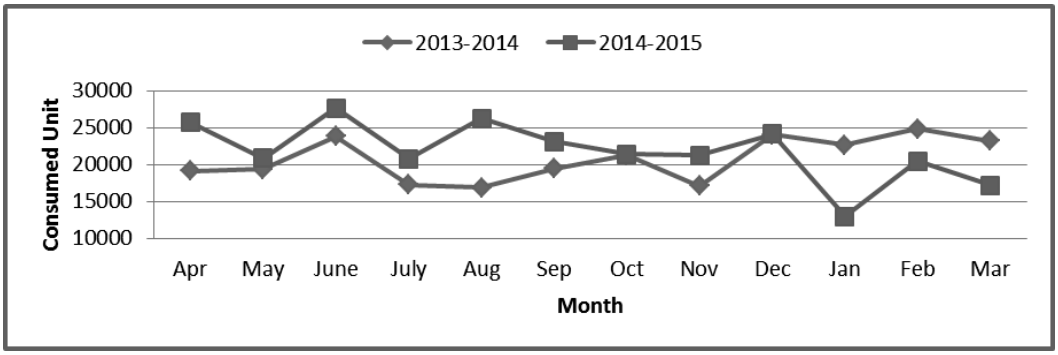


Figure 6: Service 3 Tariff details

Figure 6 explains about the monthly tariff bills in the particular industrial unit on the basis of monthly utilization of the unit consumed and the amount fixed by TNEB.

4. RECOMMENDATIONS

The recommendation is coated for a beneficial manner to reduce the consumption and tariff bills. In this the recommendations that are coated to the certain client is of two types.

- Recommendation without investment
- Recommendation with investment

4.1. Recommendation without Investment

The ETAP simulation was carried out by using the above data and recommendations were given. Also the following recommendation was given which can be implemented without investment and some amount of energy can be saved.

- It is observed that all the tube lights, fans are accumulated with dust particles. This causes to draw higher current and hence more consumption.
- The observation indicates that heat losses from the furnace are more. This increases the energy consumption to maintain the required temperature.
- The base of the oven is not properly maintained, so it is recommended to clean it at frequent intervals.
- It is noticed that the lids of the furnace are not closed properly. Hence proper designing of lids that are used in the furnace to close them is required.
- Training of operators who work on this furnace to close them properly.

The above recommendations, i.e. is coated and submitted to the industry and they are following it by heading a supervisor to implement this recommendation in an effective manner and it is seen that in the future if this is maintained 3% reduction in power consumption can be obtained.

4.2. Recommendation with Investment

The industrial layout consists of three service No. in this the recommendation are coated for implementation so that the reduction in the power can be obtained subsequently by the reduction in the tariff bills.

Recommendation for Service no: 1, The recommendation for the service 1 is given below as follows

- The capacity of the GCF may be reduced from 27 KW to 20 KW at the same is functioning only with less than 20 KW of load.
- The capacity of the VCF may also be reduced to 20 KW
- To add a capacitor Bank of 20 KVA with APFC panel.
- The ETAP simulation was conducted after implementing the suggestion and the reading are taken below

In the given Table 4 the audit of implementation of recommendation is given in which total variation of before the audit and after the audit is seen in an effective manner.

Table 4
Service No: 1 Recommendation

Description	*Before Audit*	*After Audit*
LOAD	98 KW	74 KW
AMPS	155 A	105 A
PF	0.8499%	0.9429%

The Table 5 states the cost benefits for the recommendation that can be implemented by which the reduction of power consumption is seen in a effective manner to reduce the power consumption and demand.

Table 5
Cost Benefits for the recommendation

Total No. of GCF	2 Nos.
Total No. of VCF	2 Nos.
Reduction in KW	24
Total No. of KWh saved monthly	24 × 10 hrs/day × 30
Average cost/Unit	₹ 6/-
Cost benefit	7200 × 6 = 43200
Payback period	Investment cost/ Annual saving × 12
	10,00,000 × 12
	43200 × 12
	23 Months

Recommendation for Service no: 2, The recommendation for the service 1 is given below as follows

- The Short Blasting Furnace capacity has been reduced from 10 HP to 8 HP for the same is operated with a maximum load of 8 HP.

- The capacity of the air compressor is reduced to 40 HP from 50 HP
- Add a capacitor Bank of 10 KVA with APFC panel.

In this Figure 7 the recommendation with ETAP is done and the variation of load and amps is given due to which the improvement in power factor is obtained.

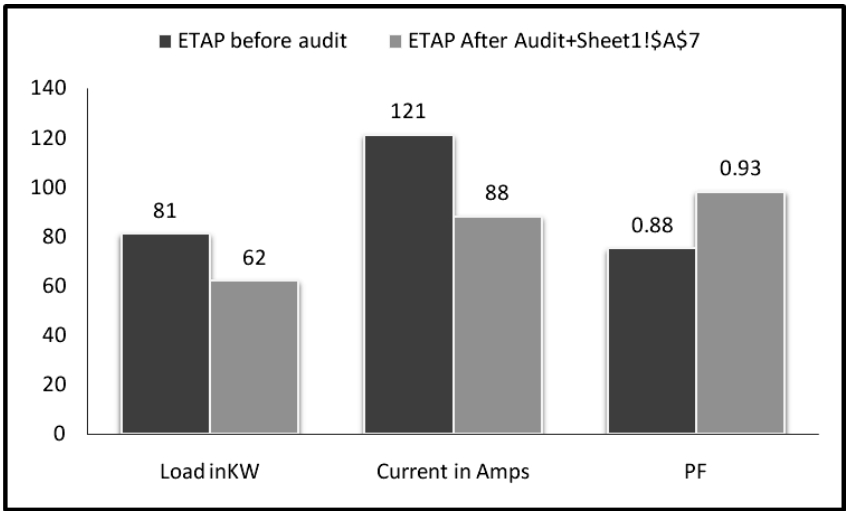


Figure 7: Recommendation with ETAP

The cost benefits graph is given below in the Figure 8 in this the amount of unit saved in a month and also the amount of cost saved in a month is given below from this it is seen that if the industry implement the recommendation coated above will have the reduction of both in power consumption and also in the tariff bills.

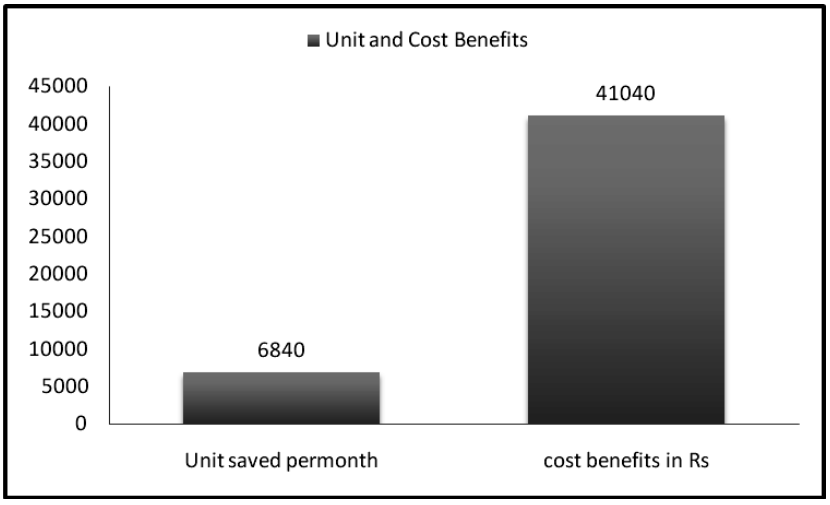


Figure 8: ETAP Unit and Cost Benefits

Recommendation for Service no: 3, the recommendation for the service 3 is given below as follows:

- The capacity of the rotary furnace has been reduced from 42 KW to 32 KW.
- Capacitor Bank of 16 MVA is added to APFC panel.

In this Figure 9 the recommendation with ETAP is done and the variation of load and amps is given due to which the improvement in power factor is obtained.

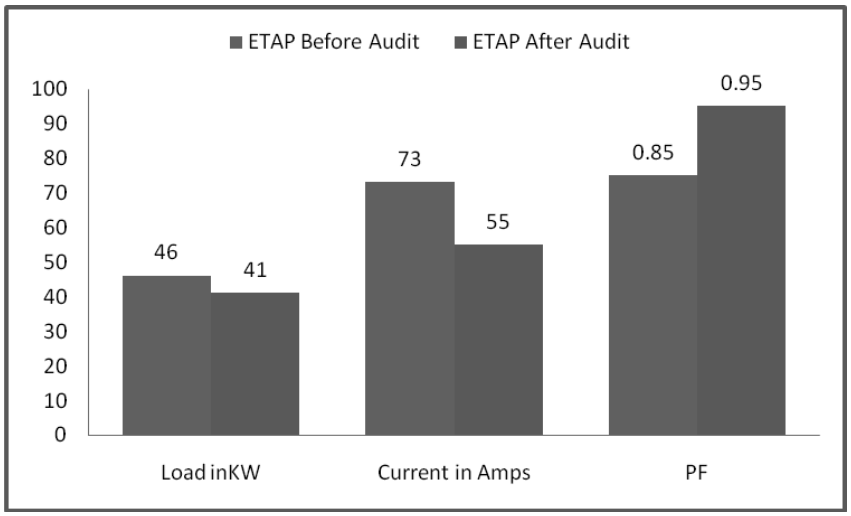


Figure 9: Recommendation with ETAP

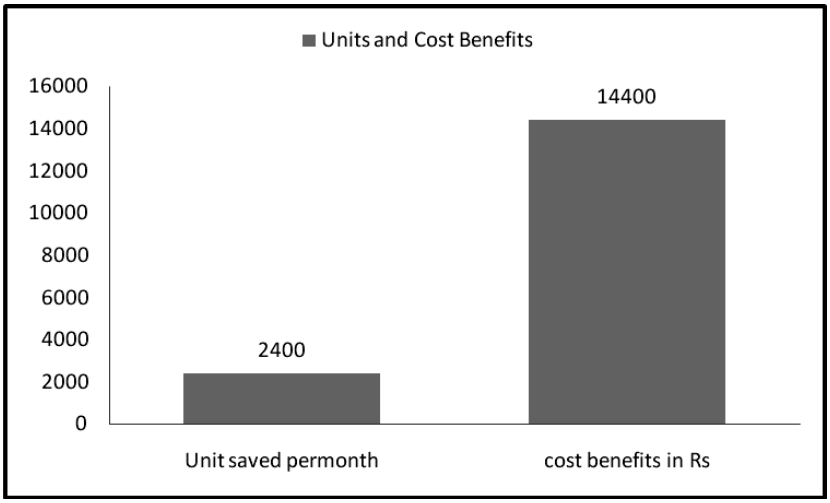


Figure 10: ETAP Unit and Cost Benefits

The cost benefits graph is given below in the Figure 8 in this the amount of unit saved in a month and also the amount of cost saved in a month is given below from this it is seen that if the industry implement the recommendation coated above will have the reduction of both in power consumption and also in the tariff bills.

Energy Saving With and Without Audit

The ETAP simulation was carried out in the above 3 cases and the energy consumed before and after energy audit is drawn as a graph is given in Figure 1, 2 and 3. It can be very well seen that there is a substantial reduction in the number of units consumed, which results in a reduction in the monthly electricity bill of the company

Service No. 1. Unit Consumed Without & With Audit- The graph given below in the Figure 11 gives the outcome of unit saved before the audit and after audit in a beneficial manner. The above graph clearly explains about the tariff reduction with respective with and without an audit. The cost benefit of doing Electrical energy is about ₹43200/- per month.

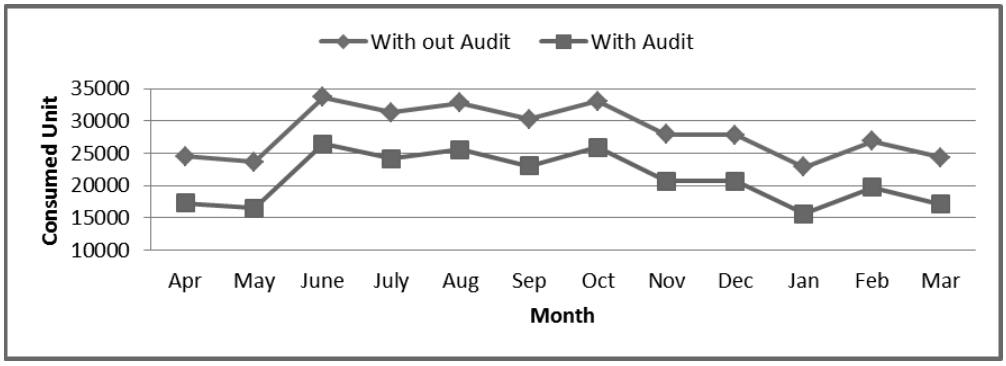


Figure 11: Service No. 1 with and without Audit

Service No. 2. Unit Consumed without & with Audit- The graph given below in the Figure 12 gives the outcome of unit saved before the audit and after audit in a beneficial manner. The above graph clearly explains about the tariff reduction with respective with and without an audit. The cost benefit of doing Electrical energy is about ₹41040/- per month.

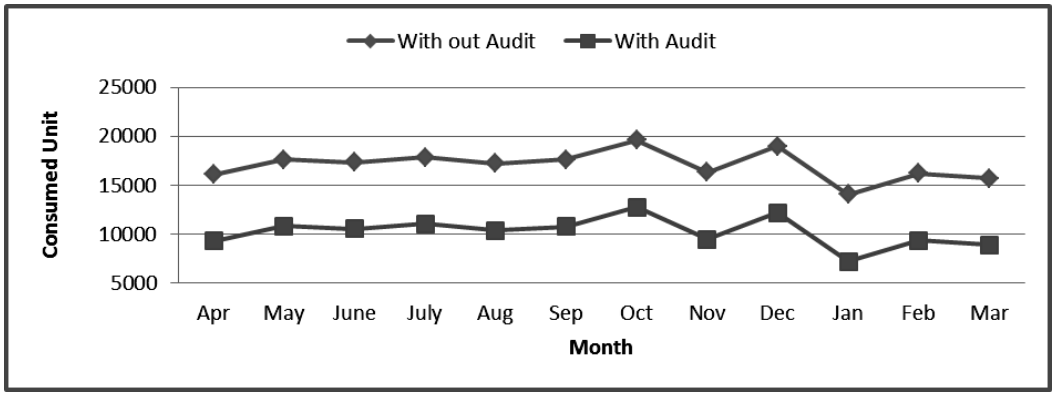


Figure 12: Service No. 2 with and without Audit

Service No. 3. Unit Consumed without & with Audit- The graph given below in the Figure 13 gives the outcome of unit saved before the audit and after audit in a beneficial manner. The above graph clearly explains about the tariff reduction with respective with and without an audit. The cost benefit of doing Electrical energy is about ₹41040/- per month.

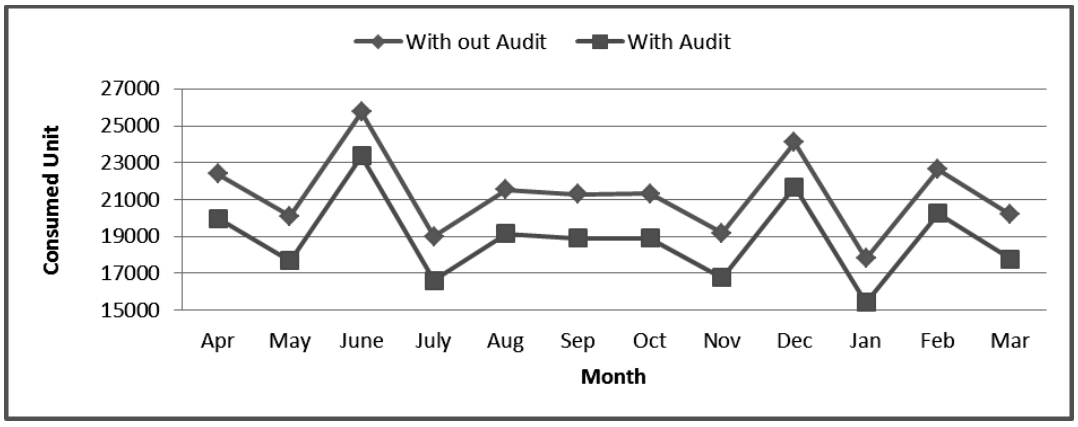


Figure 13: Service No. 3 with and without Audit

5. CONCLUSION

This paper delivers a report on the Electrical Energy Audit of a LT Industrial service located at Chennai. The Energy audit recommendations were simulated using ETAP Software and there is a substantial savings, energy consumed by Industry. These recommendations were communicated to the Client and they have agreed to implement the same within a span of one year.

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