

# — ENERGY PERFORMANCE ASSESMENT FOR EQUIPMENT AND UTILITIES IN JERUSALEM COLLEGE of ENGINEERING BY USING ENERGY AUDITING

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**Abstract -** This project provides detailed information about the judicious and effective use of energy to maximise profit and energy savings in Jerusalem College of engineering. This paper gives the overview on Energy Conservation Measures (ECM) that can be commonly recommended to the educational institutions. This paper shows the strategy of adjusting & optimizing energy, using systems and procedures so, as to reduce energy requirements per unit of output while holding constant (or) reducing total cost producing of producing the output from these systems. The main objective of this paper is to maintain optimum energy procurement and utilization, throughout the organisation, to minimise energy cost/waste without affecting production & quality, to minimise environmental effects. An attempt was made through this project to balance total energy input with it uses. ETAP simulation was done to total connected load, per month load calculation and savings to show the load flow of the system. Investing to improve the energy efficiency of an educational institute immediate and relatively predictable cash flow resulting from lower energy bills.

**Keywords:** Energy auditing, ECM (Energy Conservation Measures), ETAP simulation, energy efficiency, recommendations, profit, energy savings

## I. INTRODUCTION

Energy is one of the major inputs for economic development of any country. India's installed capacity at the year of 1947 is 1362MW. I was moved to 132329MW at the year of 2007. At the year of 2015 it reaches the installed capacity rating at 301965MW. India coal reserves of about 58.6 billion tonnes and it will last for 114 years. Oil reserves of India are 5.8 billion barrels and last up to 20 years. Gas reserves of India are 1.09 trillion cubic meters which may last for 36 years according to current reserves to production ratio. Thus, demand increasing day-by-day, so we depend upon the conservation activities, the

Will be increased by 80%. About 300 million peoples in India have not access to electricity. Instead of generation of electricity saving electricity has become an essential criterion. The energy must be consumed in an efficient manner. The possible solution to match generation & demand is by increasing power generation & energy conservation measures. As a developing country it was not possible to install the full load capacity instantly so, we should concentrate on energy conservation. In this paper, the importance of energy auditing & process of energy auditing is given in detail. The energy auditing & management program have an originating with one division of saving, motivating people in all forms to undergo conservation activities. In techno managerial activity to achieve judicious and effective energy consumption pattern to ensure maximum profit & survival in competitive world. It was a well fact that one unit of energy saved at consumption avoids energy of 3 units of generation. Energy audit is an inspection, survey & analysis of energy flow for energy conservation in residential, commercial and industrial buildings. Lighting system consumes approximately 25% of electrical energy utilisation in buildings and AC consumes highest electrical energy in buildings with approximately 56% of electrical energy utilisation in buildings. A sincere attempt has been made to conduct the energy audit based on lighting in Jerusalem College of engineering, Chennai and sophisticated computer simulation programs to evaluate and recommend the energy retrofit for the facility.

## II. ENERGY AUDIT METHODOLOGY

Energy audit as per the "ENERGY CONSERVATION ACT" (2001), "The verification, monitoring and analysis of use of energy including submission of technical report containing recommendations for improving energy efficiency with cost benefit analysis and an action plan to reduce energy consumption". This Act led to the creation of Bureau of Energy Efficiency (BEE). This will led to the major schemes of performing energy auditing.

- Energy Conservation Building Codes(ECBC)
- Standards and Labelling(S&L)
- Demand Side Management (DSM)
- Bachat Lamp Yojna(BLY)
- Promoting Energy Efficiency in Small and Medium Enterprises(SMEs)
- Designated Consumers
- Certification of energy auditors and energy managers

#### TYPES OF ENERGY AUDIT:

- Preliminary Energy Audit
- Targeted Energy Audit
- Detailed Energy Audit

#### PRELIMINARY ENERGY AUDIT:

Preliminary energy audit, which is also known as walk through audit and diagnostic audit relatively quick exercise and uses exiting, or easily obtained data. The scope of preliminary audit is to:

- Establish energy consumption in the organization (Source: energy bills and invoices).
- Obtain related data such as production for relating with energy consumption.
- Estimate the scope for energy savings.
- Identify immediate (especially no-/low-cost) improvements.
- Set up a baseline or reference point for energy consumption.
- Identify areas for more detailed study/measurement.

#### NO-COST ENERGY MANAGEMENT MEASURES:

- Proper dusting and cleaning of lighting equipment's.
- Use of high efficient equipment's.

#### LOW-COST ENERGY MANAGEMENT MEASURES:

- Shutting equipment when not needed
- Replacement with appropriate lamps and luminaires.

#### DETAILED STUDY/MEASUREMENT:

- Covering from direct to direct steam heating equipment and recovery of condensate.
- Installing / upgrading insulation on equipment.
- Installing BLDC motor equipment instead of conventional motor to reduce the losses.
- Evaluating waste heat streams for potential waste heat recovery.

#### TARGETED ENERGY AUDITS:

Targeted energy audits often results from preliminary audits. They provide data and detailed analysis on specified target project. Targeted audits therefore involve detailed surveys of the target subjects and analysis of the energy flow and cost associated with the target. Final outcome is the recommendation regarding action to be taken.

#### TARGETED ENERGY AUDIT BASED ON:

- Lighting system
- Boiler system
- Steam system
- Compressed air system

#### DETAILED ENERGY AUDIT:

- Detailed energy audit is a comprehensive audit and results in a detailed energy project implementation plan for a facility, since it account for the energy use of all major equipment.
- It considers the interactive effects of various projects and offers the most accurate estimate of energy saving and cost.
- It include detailed energy cost savings calculations and project implementation cost.
- One of the key elements in a detailed energy audit is the energy balance.
- Detailed energy auditing I carried out in three phases:
  - i. Pre audit phase
  - ii. Audit phase
  - iii. Post audit phase

#### PHASE 1: PRE AUDIT PHASE

- plan and organise
- walk through and audit
- Informal interviews with energy and production managers
- Conduct awareness meeting

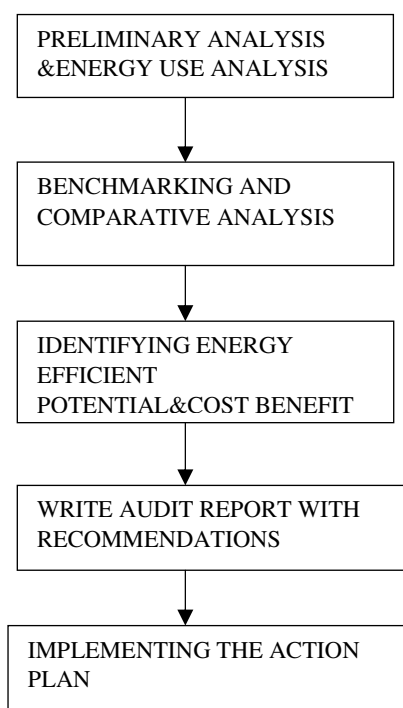
#### PHASE 2: Audit phase

- Preliminary data gathering: Historic data and Base line data
- Process flow diagram: flow chart
- Energy utility diagram: single line power distribution diagram water /air / steam distribution diagram ,log sheet , name plate detail design , operating data and schedule of Operation

- Conduct survey and monitoring: motor survey , insulation and lighting survey, efficiency of each machine
- Identification and development of energy conservation (ECON) opportunities: Review previous ideas of energy auditor and improve it
  - Cost benefit analysis:
    - long term measures
    - medium term measures
    - short term measures
- Report and presentation to top management: Recommendations with cost calculation

PHASE 3: POST AUDIT PHASE: Implementation and follow up

#### FLOW CHART OF AUDIT PROCESS:



#### CASE STUDY

This study deals with the Energy auditing on educational institute. This institute includes class rooms, laboratory, auditorium, and seminar hall and office room. Energy auditing was done to reduce the wattage, to increase the efficiency and

To reduce the electricity bills. Replacement was also recommended to reduce the wastage of electricity.

Name of institute: Jerusalem College of engineering

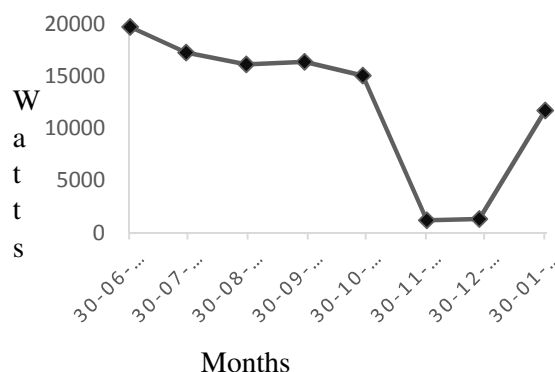
Address: Vellachery main road, narayanapuram, pallikaranai, Chennai-600100.

#### TOTAL CONNECTED LOAD:

We did energy auditing in Jerusalem college of engineering . In jce the total number of class rooms are 29 , total number of labs are 14. It also includes principal room , broad room 1, broad room 2, exam cell, academic dean , seminar hall, auditorium and reception. The total number of lights are 717, total number of fans are 327, total number of AC are 61, total number of computers are 279, 8 UPS . The over all total connected is 649kW

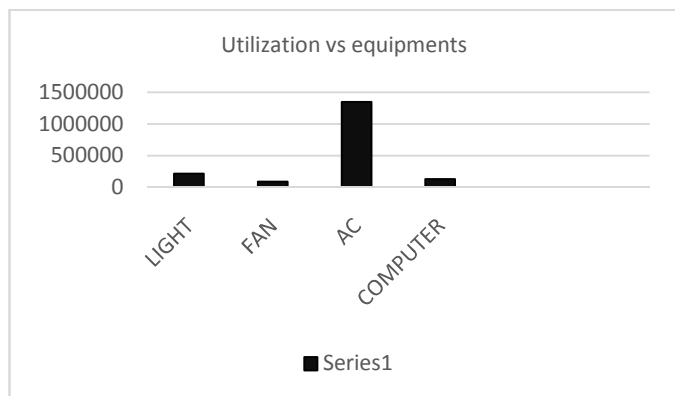
Graph 1 – Tariff analysis (Month vs. wattage)

The comparison tariff details give us the total usage of units in a particular educational institute. In this graph the consumption get increased during the summer period and it get decreased during the winter period. From this it is clearly understood that due to the usage of AC the consumption get increased.



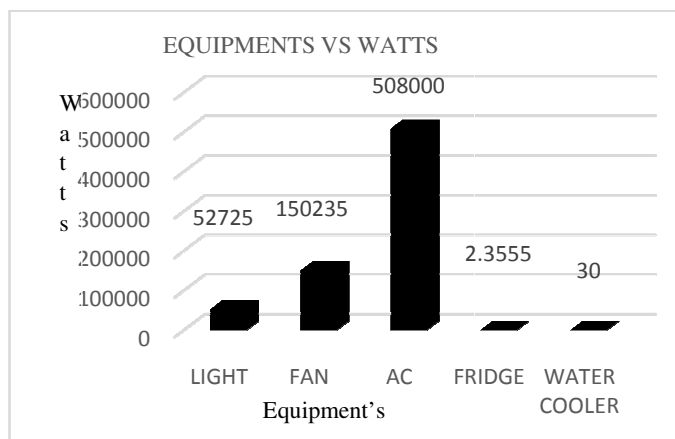
Graph 2 – Daily utilization chart

The graph was drawn between the equipment's and their utilization per day. In this utilization chart the usage of each equipment consumption per day was analysed and its data was graphed. From the graph it was seen that when compared to light, fan, computer and AC. The consumption of AC is high.



Graph 3 – Wattage vs. equipment's

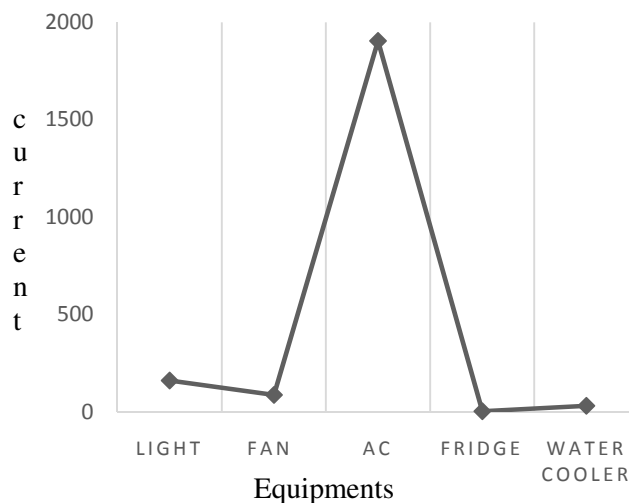
This graph was drawn between the wattage of each equipment's and the wattage. This wattage was analysed during the audit. By using this graph the AC wattage is high when compared to lightings.



Graph 4 – Real time load analysis

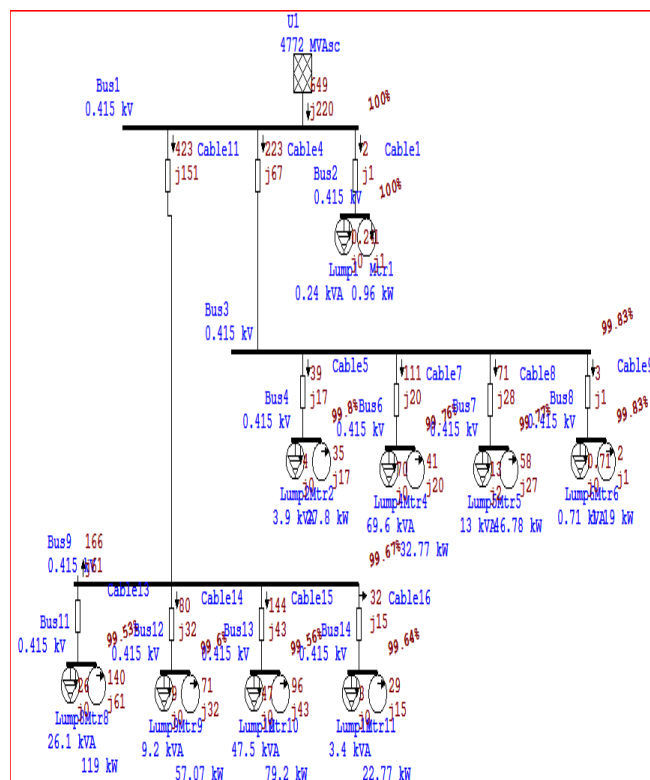
This graph was drawn to understand the unbalanced load connection. This unbalance load will lead to power factor reduction leads to inefficient system. This graph was drawn

between the equipment's and its current ratings.



#### ETAP SIMULATION ON TOTAL CONNECTED

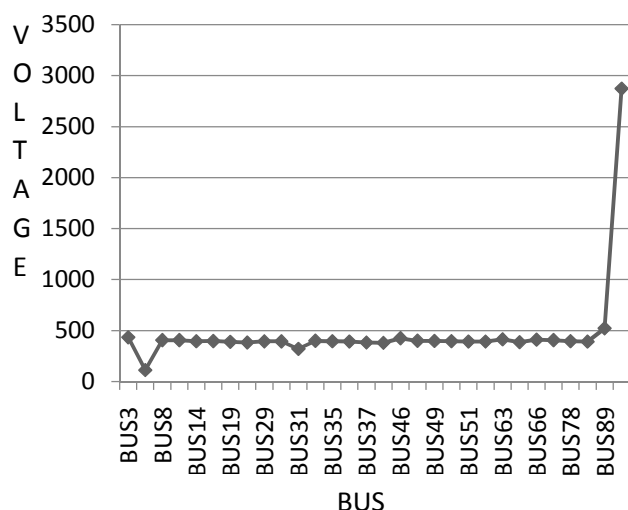
The simulation was done to total connected load and the report was taken based on the voltage generated in each bus and current generated in each bus.



### REPORT ON TOTAL CONNETED LOAD SIMULATION:

	MW	Mvar	MVA	%pf (lag)
Source (or) Swing bus	0.718	0.330	0.727	89
Source (or) Non-swing bus	0	0	0	
Total demand	0.718	0.330	0.727	89
Total motor load	0.689	0.319	0.697	89
Total static load	0.028	0.011	0.030	93
Total constant load	0	0	0	
Total generic load	0	0	0	
Apparent losses	0.100	0.100		
System mismatch	0	0		
Number of Iterations = 2				

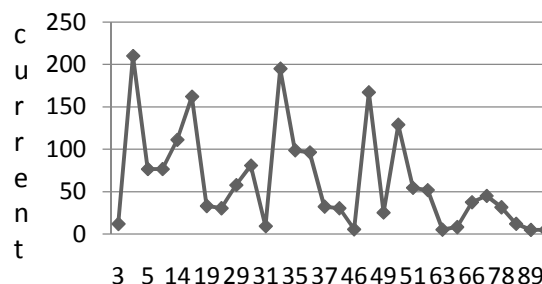
Graph 5 – ETAP VOLTAGE LOAD ANALYSIS



This graph was plotted based on the voltage on each bus based on the ETAP simulation. Single line diagram was drawn and the diagram was subjected to the load flow

analysis by using newton rapson method. From the graph the voltage at bus 89 is very high this shows the load is very high corrections should made and voltage should be balanced.

Graph 6 – ETAP CURRENT LOAD ANALYSIS

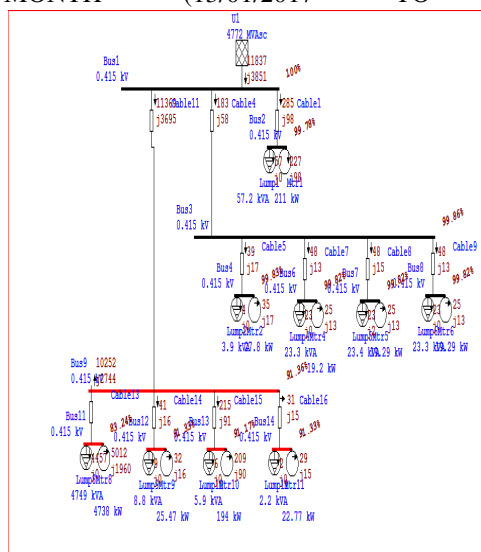


This graph was plottedbaed on the current on each bus based on the ETAP simulation.From the graph the current at bus 3 and 35 is very high this shows the load is unbalanced so it should be made balanced

### POWER CONSUMPTION AND ELETRICITY COST PER MONTH

In jce the total number of class rooms are 29 , total number of labs are 14.It also includes principal room ,broad room 1, broad room 2, BUS, auditorium and reception, are 515, total number of fan to be replaced by BLDC fan are 121, total number of AC to be replaced by 21,total number of computers to be replaced by 181, 8 UPS .The over all power consumption per month is 11.23 kWh. The cost per month consumption 1,25,369 Rs.

## ETAP SIMULATION ON POWER CONSUMPTION PER MONTH (13/01/2017 TO 16/02/2017)



## REPORT ON POWER CONSUMPTION PER MONTH SIMULATION

	MW	Mvar	MVA	%pf (lag)
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ASSESSMENT DATE	ASSESSMENT ENTRY DATE	KWH Reading	KVAH reading
30/1/17	16/2/17	1626.59	1750.09
Maximum demand	Power factor	Consumed unit	Total bill amount
85.84	0.92	11718	99260

Source (or) Swing bus	13.121	4.533	13.882	94.52
Source (or) Non-swing bus	0	0	0	
Total demand	13.121	4.533	13.882	94.52
Total motor load	12.589	4.422	13.343	94.52
Total static load	0.432	0.011	0.432	99
Total constant load	0	0	0	
Total	0	0	0	

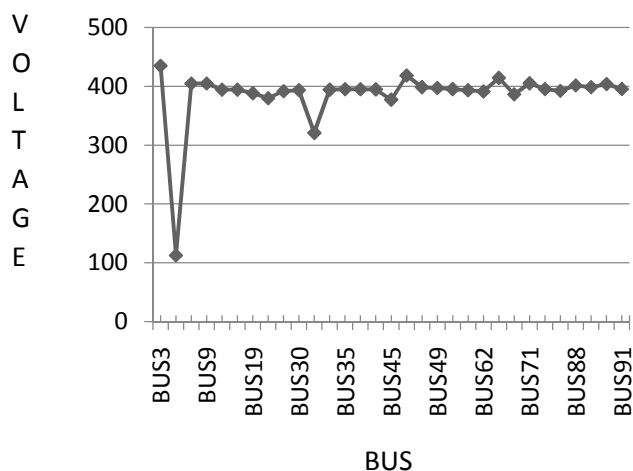
generic load				
Apparent losses	0.100	0.100		
System mismatch	0	0		
Number of Iterations = 3				

The simulation on power consumption per month was done and the report was taken. The power consumption per month from the report was 11MWh and the tariff readings was 11MWh.

CONSUMPTION BILL:

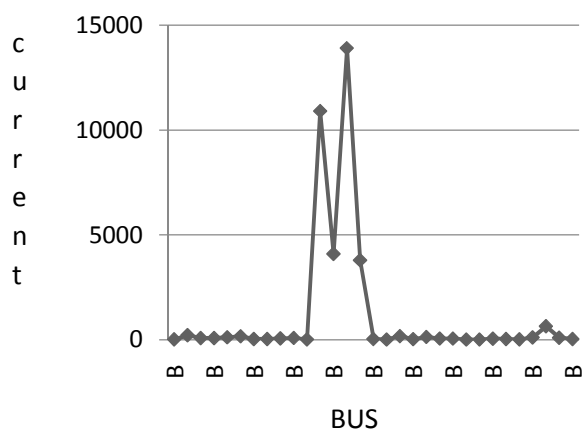
REGION	09-Chennai south	PHASE	3
CIRCLE	401-south 2	LOAD	112Kw
SECTION	249-medavakkam	TARIFF	LM2B2
SERVICE NUMBER	102	METER NUMBER	482986
ADDRESS	chennai	ACCD	23361
SERVICE STATUS	LIVE	MCD	OTHERS
SLAB RATE			
FROM UNIT	TO UNIT	RATE(Rs )	MAX.UNIT
	1 ABOVE		7.5999
Min.chrg	0 fixed charge		120/kW
BPSC*	0 Welding charge		0%
E.Tax:	5%(CC+DPF+WD+RDFC)		

**Graph 7 – ETAP VOLTAGE LOAD ANALYSIS**



This graph was plotted based on the voltage on each bus based on the ETAP simulation. Single line diagram was drawn and the diagram was subjected to the load flow analysis by using newton rapson method .the voltage at bus number 9 is very less so it must be balanced through audit.

**Graph 8 – ETAP CURRENT LOAD ANALYSIS**



This graph was plotted based on the current on each bus based on the ETAP simulation.From the graph it was noted that the current at bus35,45 is unbalanced it must be made balanced.

## RECOMMENDATIONS

### (A) Without Investment Recommendations:

- In refrigerator regularly defrost manual , defrost refrigerator and freezers , as frost buildup increases the amount of energy needed to keep the motor running
- Don't open the doors of the refrigerator frequently. As it cost around 0.15 paisa
- Proper dusting and cleaning of fan should be done
- Instead of two fans you can replace it to be one which you use frequently
- Decoration light should be especially used only occasionally
- Instead of CFL used outside you can install LED as it consume less energy
- For air conditioner use windows with sun films and curtains
- Don't set your thermostat at a colder setting than normal when you turn on your air conditioner. It will not cool your home any faster and could result in excessive cooling
- Seal the door and windows properly
- You can use table fan in the room of size 25 sq.mm
- Don't keep your refrigerator or freezer too cold

### (B) With Investment recommendations:

- Fluorescent light replacement with LED lamp:
  - Energy consumption or electricity use can be the difference maker in lighting. By using LED lights compared to the current florescent lights. LED lights are familiar and efficient in using 24/7 lighting systems and major advantage flows through the LED is that LED will maintain its brightness level at same fixed rate throughout the entire level. Luminous efficiency of LED light is high as compared to florescent lights
- Normal scaling fan replacement with BLDC fan:
  - As we compared the Induction motor fan with the BLDC motor fan, the induction motor fan will consume more power up to 75 watts where as we move towards the BLDC motor fans it will



produce wattage up to 28 – 50 watts & induction motor is very less efficient compared to the BLDC motor and its weight is comparatively high.

- AC replacement of 5 star rated AC:
  - Efficiency of AC is usually given by EER (Energy Efficient Ratio). this was given by Amount of heat Removed per hour/ power consumed. The star rating of AC was decided by the EER ratio. Higher the star rating will lead to the low power consumption and high efficient equipment's.
- Computer to LED desktop computer:
  - The conventional desktop computer consumes power at the rate of 250 watts whereas the LED desktop consumes power at the rate of 100 watts. so it is efficient to replace the conventional desktop to high efficient desktop to reduce power consumption

energy savings that can be obtained in an educational Institution, thereby energy crisis can be reduced considerably. The Following facts have emerged after the detailed energy auditing of said building

1. Energy saving per year is 75304 kWh
2. Total Cost reduction per year is 602432 rupees
3. Pay-back Period of various appliances.

The Proposed paper gives strong warning to the consumer not only in terms of the energy bills, but also the energy crisis in the near future to all sectors of people. By implementing the recommendations suggested in this project, there will be a reduction of around 52 % of the energy and 50.1 % of cost reduction. The Pay-Back period for various appliances have also been calculated. Energy Auditing is a continuous process and organizations should carryout auditing periodically.

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ITEMS	TOTAL NUMBER OF EQUIPMENTS	NUMBER OF EQUIPMENTS TO BE REMOVED	NUMBER OF EQUIPMENTS TO BE REPLACED AS LED,BLDC FAN,5 STAR RATED AC,LED DESKTOP COMPUTER
LIGHT	717	146	400
FAN	327		121
AC	61	-	21
DESKTOP	279	-	181

Table3 - TABULATION OF NUMBER OF EQUIPMENTS TO BE REPLACED AS LED, BLDC FAN, 5 STAR

#### I. CONCLUSION

A famous quote "Energy saved is Energy generated". This shows that apart from increasing the generation capacity at higher cost, one must go for the energy audit to save the electricity at much lower cost. Because the demand for electricity is continuously growing and it is putting stress on the power utilities to increase the capacity to meet the load demand.

In this paper, a detailed study has been made to reduce the electrical energy consumption in the complete campus of Jerusalem college of engineering. It highlights the amount of