

University Laboratory Power Audit Study with Conservation Recommendation

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Abstract— Reducing electricity consumption in commercial buildings is important in addressing the growing concerns of global warming, atmospheric quality and energy security. Energy audit is a proven effective measure for energy savings through identification of energy management opportunities for improvement by means of buildings. The energy study of various sector of commercial, industrial and residential area indicates that considerable amount of the energy can be saved. The power auditing is done in the university laboratory and it is recommended and proposed new layout for the laboratory with energy efficient technologies. Extra lights are replaced according to the Lux value and ILER calculation. The proposed lighting layout is suggested for implementation.

Keywords— Energy Audit, Energy Saving and Illumination

I. INTRODUCTION

This Energy is the ability to do work and work is the transfer of one form of energy. Energy exists in several forms such as heat, kinetic, light, electrical energy. The entire progress of a country is dependent only on Energy. Recent days, energy saving has become essential rather than electricity generation. If we think for potential cost saving in each of the components (energy, material, employees), energy would invariably emerge at the top, so efficient use of energy and its conservation is the least cost option in any strategy. The energy demand is increasing because of the increasing population in country hence; country is facing peak power and average electricity shortage of 12% and 7% respectively. To satisfy the energy needs of Tamil Nadu, TNEB has a total installed capacity of 20103MW [1] which include of all, State Government, Central Government, Independent power producer and renewable power generation. To meet the ever increasing energy demand, TNEB has proposed a number of next generation projects to be constructed. The per capita consumption of Tamil Nadu is 1000 units. It was found from the survey that India is the world's fifth largest electricity generator but still there are many places in India which are in

dark and they are very far away from the term "electricity". So it's the time for energy saving. It is possible only by effective Energy Audit and Energy management. The recent contributions by the researchers are presented below.

Awanish Kumar et al.[2] has conducted an intelligent electrical energy audit under an initiative house, and presented the suitable recommendation with the help of an suitable software package and concluded that the installation of new machines and equipment with low cost effective and efficient technique required to achieve high efficiency of energy user. S.U Kulkarni et al. [3] discuss the common aspects of electrical management in small and medium size industries. They carry out the audit in three way lighting audit, power load audit and harmonic analysis. The author suggested nine recommendations and concluded with saving of total amount of Rs-8, 98, 700/year. Arun Kumar Ahuja et al.[4] has done energy auditing in IIT ROORKEE campus in Uttarakhand. The team mates have used "ELECTRA" software for data analysis. The team has concluded the auditing with few recommendations like "replacing resistance regulators of fans by electronic regulators. Malikat Singh et al. [5] presented a physically based model and formulation for industrial load management and reducing the lighting cost. The author recommended that the electromagnet tubes and chokes should be replaced by electronic choke in phase manner and concluded energy audit is the best method to save electrical energy. Mukesh K Saini et al. [7] suggested possible idea to conduct a energy audit in an industries. The author suggested that the payback period will be 13 months; he also suggested change the traditional welding set with IGBT etc. Mehul Kumar et al.[8] done case study of Energy conservation and Energy audit in industries. He concluded the energy audit type is of types which add completeness to the energy conservation .In the present scenario most of the common people are wasting power by different methods in their houses, shops etc.

Malik Sameeullah, Jitendra Kumar, Kanhaiya Lal, Jagdish Chander et al.[9] conducted an energy audit in hostel building of NIT Kurukshetra. Energy audit of hostel buildings were performed in two ways The first phase of auditing also known as preliminary auditing was performed to collect the basic information like collecting electricity bill, detail information of hostels, type of load connected and pattern of electricity used by different loads.The second phase of auditing also known as detail auditing was performed to collect details of equipments rating and faulty design practise in buildings. “IIT Kanpur Halls of Residence energy audit” by anand kumar et al [10] mishra and team.they conducted auditing in hostel rooms for fans,lighting, air conditioners and energy usage in hostel kitchens.they recommended with Installation of biogas plant at IIT Kanpur, 3.2 Replacement of rheostatic regulators with electronic, installation of solar water heaters.

To create energy awareness to the general public, Dr. M.G.R Educational & Research Institute, University Chennai has taken initiative called ‘MGR Vision 10 MW’ under leadership of Dr. L Ramesh to save 10 MW in 10 years. In this pilot audit study-1 was conducted by the team of members in the year 2015 at various residential houses and industries. The outcomes of the studies are published in indexed conferences and Journals [11-16].

This work is the pilot study-2 of Vision 10 MW. This paper presents the electrical audit study in the University laboratory. The study is conducted for the existing layout and the proposed layout is recommended for best power consumption in the laboratory.

II.DATA OBSERVATION:

An energy audit is an inspection, survey and analysis of energy flows for energy conservation in a building. process to reduce the amount of energy input into the system without negatively affecting the output. It shows where the power consumption is more in the given system. It can also be called as controlling of the power to avoid losses for maximize efficiency. Energy savings of the order of 5 to 20% are possible by optimizing use of Energy with better housekeeping, low cost retrofitting measures and use of Energy efficient equipment at the time of replacement, renovation or up gradation. Energy Audit will help to understand more about the ways energy and fuel are used in any industry, and help in identifying the areas where waste can occur and where scope for improvement exists. The Energy Audit would give a positive orientation to the energy cost reduction, preventive maintenance and quality control programs which are vital for production and utility activities.

The audit conducted in the laboratory with the recommended procedure and collected all the data from the existing layout and the required lux level calculation is made with the support of the data.

PROCEDURE:

- Pattern of the energy use in the laboratory is identified.
- Wastage audit calculation is done.
- Existing layout sketch for all electrical equipment is drawn.
- Theoretical and practical lux level is calculated using formulae and lux meter respectively.
- Present issues related to existing equipment in laboratory is found.

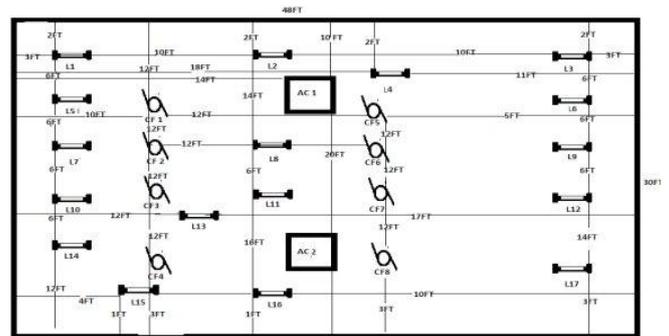


Fig.1 Existing lighting layout

The existing lay out consisting of 17 lights, 2 AC and 8 fans. The power rating of each of the equipment was calculated. The lux level reading of the light was taken. ILER (Installed Load Efficiency Ratio) calculation is done for the existing lighting system.

Power Rating Chart:

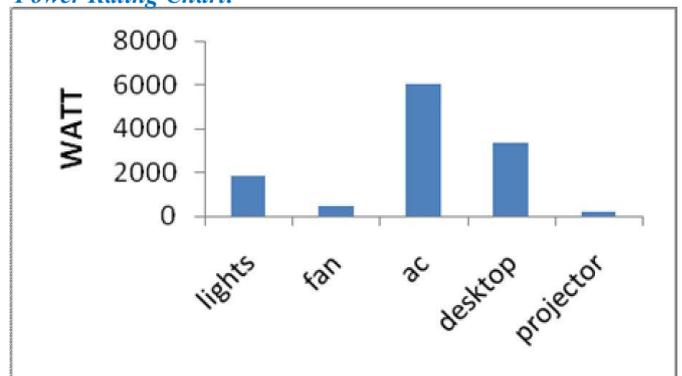


Fig.2 Total Power Rating Graph

The above graph explains about ratings of each equipment.

Theoretical Lux level calculation:

Installed Lux / lumens: No. of fittings*no. of lamps*Idl=17*3*2800 =142800 lumens

Installed lux/m^2=1066.30lux/m2

Total watts of light=1836w

No of fittings required = $E \cdot A / F \cdot UF$
 $*MF = 450 \cdot 132.92 / 2800 \cdot 0.65 \cdot 0.73 = 59814 / 1328.6 = 45$ Lights
 or 15 set
 1 set in IBM lab is = 3 lights

ILER Calculation:

Floor area = $48 \cdot 30 = 1440$ or 133.92 m^2
 Room index = $1 \cdot b / \text{height} \cdot (1+b) = 48 \cdot 30 / 2.1 \cdot (48+30) = 0.81$ [No unit].

The table:1 shows that number of lux measurements required based on room index value.

TABLE I

Room Index Value	No. of Measurements
Below one	9
Between (1 – 2)	16
Between (2-3)	25
Above 3	36

As the room index is below one, nine measurements are taken.
 The total lux is = $1267w$
 Average lux = $1267 / 9 = 140.7w$
 Total watts = $1836w$
 Watt/sq.m = $1836 / 133.92 = 13.70 \text{ watt/m}^2$
 Average lux / (watt/sq.m) = $140.7 / 13.70 = 10.3 \text{ m}^2$
 Lux level required = 36
 ILER = 0.28 [No unit]

ILER TABLE:

TABLE II.

ILER	Assessment
0.75 or over	Satisfactory or good
0.51- 0.74	Review Suggested
0.5 or less	Urgent action required

The ILER value of the university lab is 0.28 so according to the result of the ILER 0.28, urgent action is required.

A. Wastage Audit:

Wastage auditing is done for six days from Monday to Saturday (21.9.15 to 26.9.15) with partial load starting from low consumption to higher. The average reading for six day is shown in the table III.

TABLE III

Time	Lights	Fan	Desktop	Air conditioner
10am	2	2	-	1
11.30am	2	1	-	-
1.00pm	4	1	-	-
2.30	6	2	-	-
4.00pm	5	1	-	1

The total capacity connected in the university lab = $11671w$ or 11.671 kw .

The total energy used in a year is $25,732.35 \text{ kwh}$

The cost of energy consumed = Rs 1,80,126.

The average energy wastage in one day by calculation is = 40 kwh

In one year = 12600 kwh

The cost of energy wastage = Rs 88,200

Therefore if we use the equipment in a wise way the cost of Rs. 88,200 can be saved.

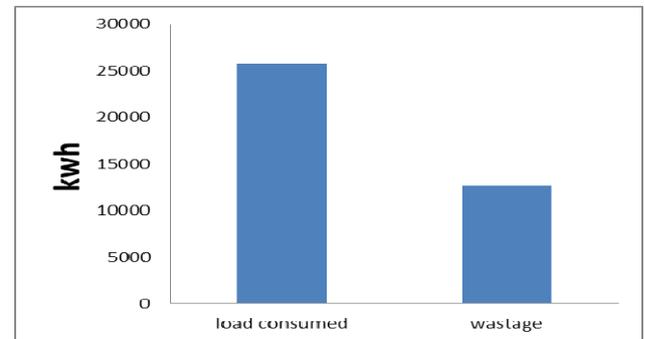


Fig.3 Wastage in kwh

The graph represents wastage of power in a year in the university lab.

III. RECOMMENDATION

After successfully completion of the audit the recommendations are suggested for better energy saving. The energy used in a year is $25,732.35 \text{ kwh}$. The wastage in one year is 12600 kwh . So by suitable recommendation we can save considerable amount of energy.

1. Recommendation without investment
2. Recommendation with investment.

A. Recommendation without investment

- Encourage the students to turn off the computer monitor when they are not using them.
- Switch off the extra lights and fans when not required. Switch off one AC when there is no lab.

At present all employees are struggling to find their respective light switches. This can be resolved by providing, tagging on each table with identity number. This can be mentioned also in respective switches then On/Off issue can be resolved.

In this the rearrangement for the existing layout is proposed for reduction in the light and the respective savings.. The position of light is rearranged with respect to the calculations. It will help to consume less power, by removing two sets of lights and two fans according to calculation which resulted.

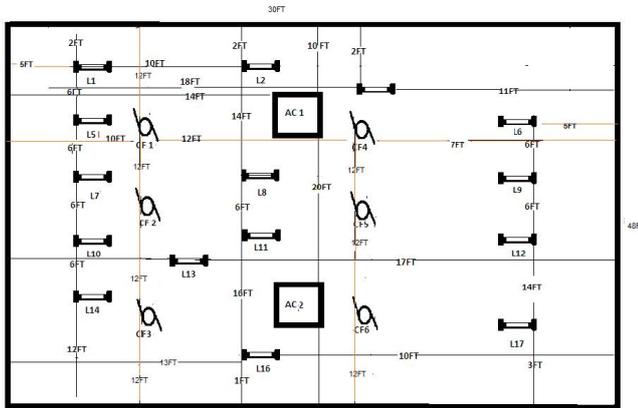


Fig.4 Proposed Rearranged layout

Total energy consumed before recommendation: 5106.78 kwh.

Removing 2 sets of lights and 2 fans after recommendation:
Total energy consumed after recommendation: 4365.9 kwh.

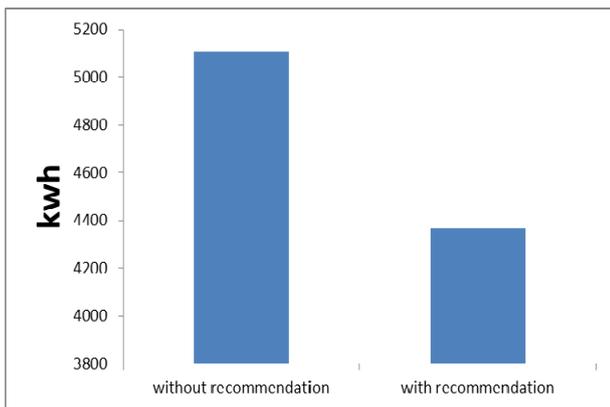


Fig.5 Energy saved without investment

So the energy saved is 740.88kwh.

With reference to the suggested recommendation provided by the authors' in wastage audit and other rearrangement of layout, the saving in power is represented in figure 5.

B. Recommendation With investment

Some recommendation suggested here for energy conservation provided through minimum investment needed initially. This can be suggested by various energy efficient technologies and devices like LED light, star rated fan and other energy efficient devices. Some activities are listed below.

- Replace existing lights with LED lights Change the light cover to glass.
- Fix a air separator in door to avoid entry of outside air
- Ensure Periodic maintenance for AC units
- Two fans has been removed as they are of no use.
- Wall fans are recommended because AC'S are there in the lab . It will be more efficient,

Recommendation with LED:

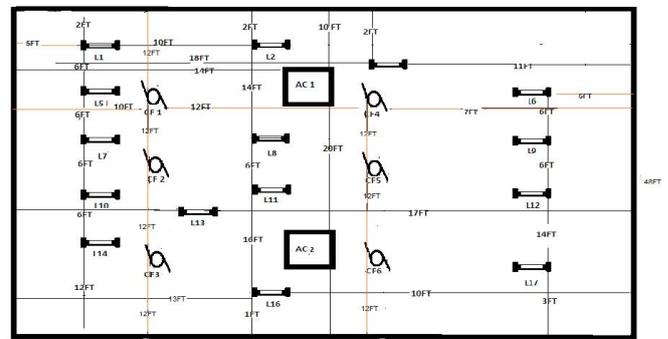


Fig.6: Proposed lighting layout

As we know that LED consumes less power than CFL and tube lights we have prepared a proposal with 15 sets of LED. Each set 3 LED.

Replacement of CFL tubes with 8w LED

Total no. of CFL tubes=17 of 108 w

It consumes Energy=12.852kwh/day

Yearly it consumes=4048.38kwh

The cost of energy consumed=Rs 28,338.66

If we use energy efficient equipment like LED then,

No of LED =15 of 24 w

It consumes Energy=2.52kwh/day

Yearly it consumes=793.8kwh

The cost of energy consume=Rs 5556.66

So the unit saved=3254.58kwh/year

The cost of unit saved=Rs 22,782.

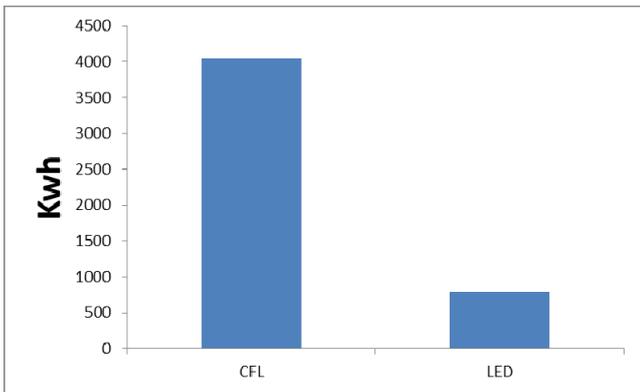


Fig.7 Unit consumption between CFL tubes and LED

Proposed Layout III:

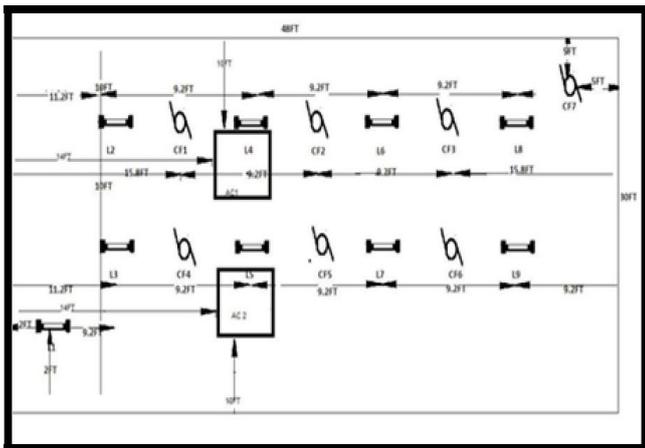


Fig.7 Proposed lighting layout 3

In proposed layout III nine sets of LED have been used. In this layout position of the lights are changed according to survey we have done .we have used 10W LED bulb as it will be enough lux required by area. As it is computer lab most of the time people are working in computer so there is no need of more lights in the lab.

No of LED =9 of 30 w
 It consumes Energy=1.89 kwh/day
 Yearly it consumes=595.35 kwh
 The cost of energy consume=Rs 4167.45
 So the unit saved=3453.03kwh/year
 The cost of unit saved=Rs 24,171.21.

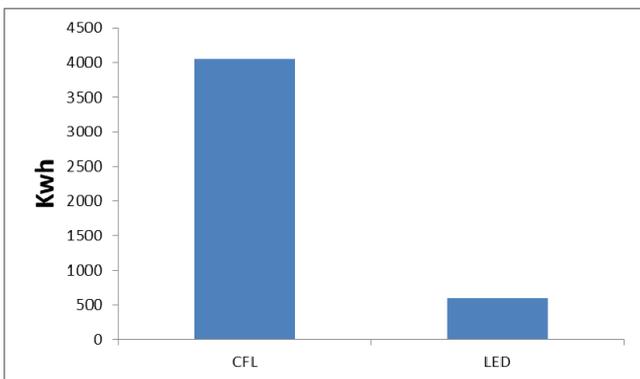


Fig.8 CFL vs LED

Recommendation with star rated air conditioner:

After auditing we came to know that AC consumes 60% of the load connected, this is because AC'S which are present in the lab are not energy efficient so we are decided to change the AC with star rated equipment as it consumes low power.

No of AC connected=2 of 3000w
 It consumes energy=42kwh/day
 Yearly it consumes=13230kwh
 The cost of energy consumed=Rs 92,610

If we use star rated AC then,
 No of ac connected=2 of 1500w
 It consumes energy=21kwh/day
 Yearly it consumes=6615 kwh
 Cost of energy consumed= Rs46,305
 The unit saved=6615kwh
 The cost of unit saved=Rs 46305

Bar diagram for the unit consumption between normal and energy efficient AC'S

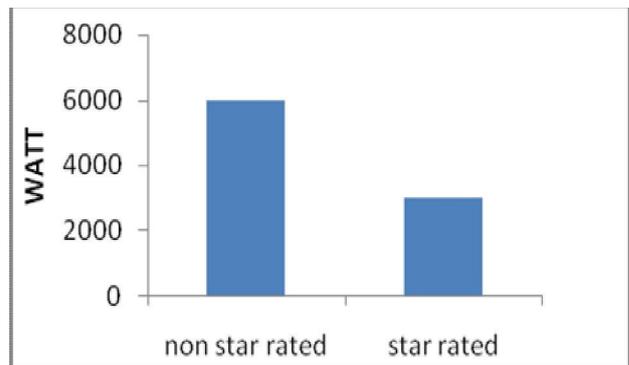


Fig.9

TOTAL SAVINGS GRAPH :

The below graph represents the costs of total savings for each proposal given above respectively

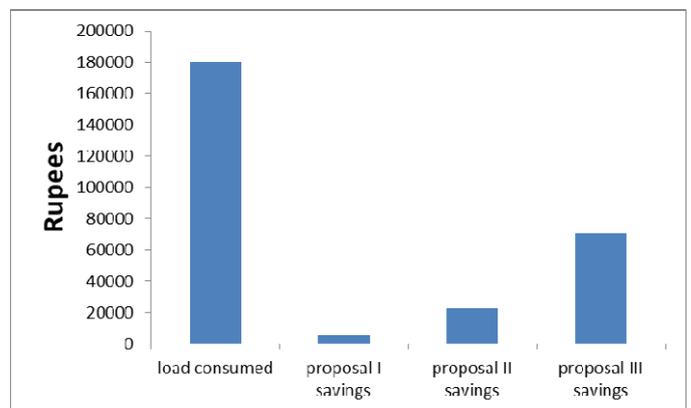


Fig.10

IV. Conclusion:

After successfully completion of auditing at IBM lab in “Dr MGR Educational and research institute University” we came to know there are two things that consumes more power that is lighting and cooling. . Extra lights are replaced according to the lux value and ILER calculation. Using of LED lights instead of CFL tubes, star rated Ac’s instead of normal one and wall fans . Using IED lights 3254.58 units can be saved yearly and by using star rated A.C 6615 units can be saved yearly. Energy audit process must be carried out accurately enough to identify and quantify energy cost saving that are likely to be realized through investment in Energy saving measures.

V. Acknowledgement:

The authors’ expressed their valuable gratitude to Er. A.C.S Arun kumar, President of Dr. M.G.R Educational and Research Institute University, who provide constant support to the M.G.R Vision 10 MW initiative. We convey special thanks to the faculty of the Computer science Department for their interest and Dean E&T for their valuable suggestions in the present work.

References:

- [1] http://www.tangedco.gov.in/template1.php?cid=0&su_bcid=184
- [2] “ The impact of ETAP in residential house electrical energy audit” by Awanish kumar,sashi ranjan, M. Bharath kumar singh, P riyanka kumari.
- [3] S.U Kulkarni and kalpana pail “Energy audit of an industrial unit-A case Study” International Journal of emerging science and engineering, Volume-2, Issue-1,November 2013
- [4] ARUN KUMAR AHUJA “Energy Audit Of IIT-Roorkee Campus “in January 2010.
- [5] Malikat singh, gurpreet Singh and haarmandeep Singh ”Energy audit a case study to reduce the lighting cost”
- [6] Asian journal of computer science and information technology,2012,PP 119-122
- [7] Mukesh K Saini S.Chatterjee and Lini Mathew, “Energy audit of an industry”, International Journal o scientific & Technology Research Volume 3, Issue 12, 2014
- [8] Mehul Kumar J Panchal, Ved Vyas Dwivedi and Rajendra Aparnath, “The case study of energy conservation & audit in Industry sector” , International Journal of Engineering And Computer Science, Volume 3 Issue 4 April, 2014.
- [9] “Energy Audit: A Case Study of Hostel Building” Malik Sameeullah, Jitendra Kumar, Kanhaiya Lal, Jagdish Chander.
- [10] “IIT Kanpur Halls of Residence energy audit” by anand kumar mishra.
- [11] Keerthi Jain, N, Kishore Kumar, Ramesh, L and Madhusudhana Raju, (2015), “Comparative Analysis of Residential Houses for Effective Reduction in Power Demand” Research India Publications, International Journal of Applied Engineering Research, Volume 10, Number 6, PP 5489 to 5494.
- [12] Awanish Kumar, Abhishek Raj, Ajit kumar yadav and Ramesh, L, (2015) “Energy Audit for a Residential House with Considerable Recommendation for Implementation” International Journal of Applied Engineering Research, Vol. 10,No.20, PP 15537-15541
- [13] Madhusudhana Raju, Ramesh, L and Balamurugan, (2015), “Residential House Energy Conservation Analysis through Proposed Package” Research India Publications, International Journal of Applied Engineering Research, Volume 10, Number 6, PP 5526 to 5531.
- [14] Keerthi jain, K, Kishore Kumar, N, Ramesh, L, and Madhusudhana Raju, M, (2014), “An Analysis to Save Electrical Energy in a Residential House” International Journal of Engineering Sciences, Vol:6(2), PP 59-66
- [15] Awanish kumar, M.Thanigivelu, R.Yogaraj and L.Ramesh (2015), “The Impact of ETAP in Residential House Electrical Energy Audit”, Elsevier Proceeding of International Conference on Smart Grid Technologies – August 2015.
- [16] Keerthi Jain, K, Kishore Kumar, N, Muralikrishnan and Ramesh,L, (2015), “An Analysis to Save Electrical Energy in a Residential House Using ETAP” Published in Springer Proceeding of International Conference on Communication, Computing and Power Technologies (ICCCPT-2015)–April 2015 - Chennai