

Comparative Analysis of Residential Houses for Effective Reduction in Power Demand

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Abstract

The present installed capacity of electric power generation in India is 255.012GW and the total annual generation of electricity from all types of sources is 1102.9TWh. The power generation and the load demand is about 298GW by the year 2016-17. The possible solution to match the generation and demand is by increasing power generation and energy conservation measures. As a developing country it is not possible to install the full load capacity instantly, looking over this scenario the initial work has been started on energy conservation through electrical energy audit under the Vision 10MW. The electrical energy audit team have completed 25 houses and 2 commercial buildings till date. Three houses are identified for comparison study with the 25 houses. This paper presents the proposed procedure which is adapted to conduct the electrical energy audit with suitable recommendation. The comparative analysis study of these houses is to identify the critical problems and to provide the suitable solution for energy conservation and management. The outcome of the implementation with and without audit is represented through graphical result

Keywords: Energy Saving, Energy Audit, Visual Basic Software and Renewable Energy.

1. Introduction

Energy audit is a process [1] of checking how energy is used and identifying the areas where wastage can be minimize if not totally eradicate. Energy audit consists of several tasks which can be carried out depending up on the type of audit and the function of audit it is a periodic activity to ascertain the objective of energy usage and the amount of wastage energy can be calculated and minimized by collecting the historical data, age of equipments, Efficiency of the equipments etc.[2]Energy Management is the Techno-Managerial activity to achieve judicious and effective energy consumption pattern to ensure maximum profit and survival in a Competitive World. Literature shows that the potential of increasing energy efficiency is large, and that most of the potential has very favourable economics. It is well fact that one unit of energy saved at consumption avoids energy of three units of fresh capacity addition.

We present a small portion of the above programs focusing efficient usage of energy in a house. The housing sector is to be concentrated more in the following area:

- Lighting

- Air leaks and insulation level in the air-conditioned rooms
- Star rating of the equipments like Refrigerators, Air-Conditioners, etc.
- Temperature setting of the Water Heaters, Refrigerators, Air-Conditioners, etc.
- Full loading of equipments like washing machines, Grinder, etc.
- Usage of energy efficient equipments like CFL/LED Lamps, energy efficient fans, Micro oven instead of ordinary oven, etc.

According to the review of literature [3] the author proposed the energy efficient time table, which can able to save energy in all the institutions in Tamil Nadu through energy efficiency measure using energy efficient time table and power factor correction for individual electrical appliances. [5]The total gap between the demand and generation can be reduced to 20 percent. Each institution will get the benefit of cost saving in electric energy consumption bill. The author [6] provides overview of the lighting energy audit procedure suitable for an academic institution. Design recommended in the project covers general lighting only. This work covers the principles and practices governing good visual environment for duration. It also recommends the level of illumination and quality requirements to be achieved by general principles of lighting. Matteo Dongellini [7] has demonstrated that energy audit enables to collect information which are very useful to define a factory energy model by means of which the energy balance of the site is analyzed. By means of the factory energy model it is possible to study the impact of possible improvements of the site in order to achieve the mitigation of its environmental impact and to reduce energy costs.

This paper reviews efficient usage of energy in the double bed room housing sector. The comparative energy usage and recommendation analysis of sample three houses is considered in this paper. This ultimate work started under Vision 10MW in which we completed 25 houses this paper gives the sample of three homes that are in three conditions good, better ,bad which is compared to get a appropriate results.

Vision 10MW is an energy awareness initiative forum that was inaugurated in our university on Oct 2014 to reduce 10MW electrical energy in a span of 10 years energy audit, intelligent energy management, and energy saving awareness programs.

2. Procedure

The first phase of energy audit starts with site inspection work. In this paper the first initiative we done is doing auditing in one home and giving them a appropriate results and recommendation and suggestion regarding their usage of electricity and also making a assumption to reduce the tariff of electricity bill. According to this we started the analysis of the pre-site work and conclude the analysis and recommendation to reduce the usage of electricity and educate them for consumption of energy with cost analysis. An execution procedure model is given in the table 1, that is given below which will gives a brief knowledge how an energy audit is done and the recommendation is given to the clients as per the procedure to get an appropriate result based on the consumption and also reducing the energy tariff in electricity bills. The main vision for this auditing is to bring awareness among the society and save the demand for the nation. We have made an Executive activity to conduct this electrical energy audit and its is given below;

- Collect all the Load details with maximum demand of the Electrical Equipment ,Calculate the Usage Load After single line diagram put the values
- Plot Real time load curve by taking the energy meter KWHR for 20 days.
- Calculate the connected load with respective to single diagram.
- Plot a graph in between years and Tariff
- Identify and Calculate the unnecessary usage of power wastage in the layout with graph
- Draw the Power Utilization Chart with respect to the Layout
- Calculate the daily utilization of Power by all the equipments and convert to pie chart.
- Data Collection of all the major equipments and find out the performance
- Interaction about the energy usage with suitable survey
- Identify the Energy Saving and Conservations Opportunity
- Report on suitable recommendation with existing and implementation suggestions
- Plot Cost Benefit Analysis with Breakeven Chart
- Check the earth resistance and report on the status of earthling in that concern
- Provide Awareness' on Electrical Safety to the Person there.
- Submission of Suitable Energy Audit Report with Breakeven Analysis.....

3. Electrical Energy Audit Survey

The electrical energy audit survey was taken by completing 25 homes in which we have taken 3 homes for comparative analysis and study has been done in the respective three homes given below,

- NAME: RAMBABU ADDRESS:PLOT NO 14 1ST MAIN STREET NORTH RANGANATHAPURAM MANGADU.600101 DATE:12/10/2014

- NAME: Dr .RAMALINGA ADDRESS:No, 13 AD block 5th cross street anna nager west Ext.. DATE:16.10.2014
- NAME: Ms.N.kavitha No 1, Venkatesa nagar 1st Street, Saligramam, Chennai-93 DATE: 20.11.2014

Usage Tariff Analysis - The comparison tariff details give us the total usage of units in a particular 2BHK house in this graph it is clearly understood that the usage of tariff differs from one home to another according to their usage.

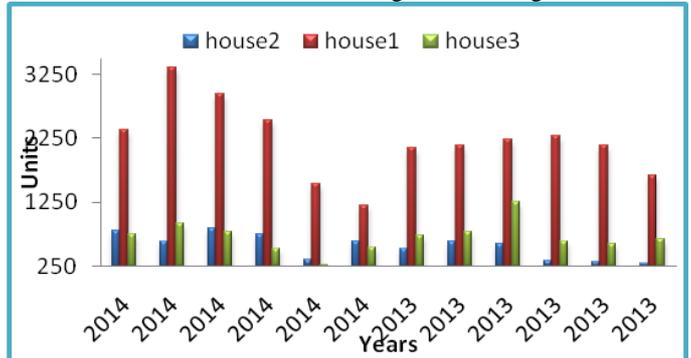


Fig 1. Tariff details

In this graph it is clearly understood that in the times of summer the tariff bills are increased and the consumption is also high it may be found that due to the usage of air conditioner at the times of summer the units are increased. In the graph it is seen that the consumption of units is very high compare to the other two houses it is because the equipments and the usage of the this home is not energy sufficient and there is no control in there usage of electricity.

Daily Utilization Chart - The graph shows the daily utilization in a particular home in which we can differentiate the equipments that are used most and the common appliances in this graph are AC, Fridge and fans tube light which are basically used at the most as given in the percentage of this individual 3 houses..

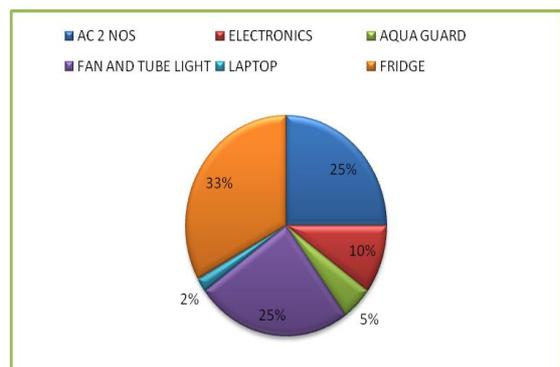


Fig 2. Daily Utilization Chart

In this daily utilization chart we can able to find out the equipments that are used most in a particular house and analysis the condition of usage .In this graph the daily utilization of the three homes are taken individually and combined it into a single graph were the equipments that are mostly used that are determined..

Age of Equipments- The age of equipments are given below in the graph of all the three houses in which the age of each equipments are given

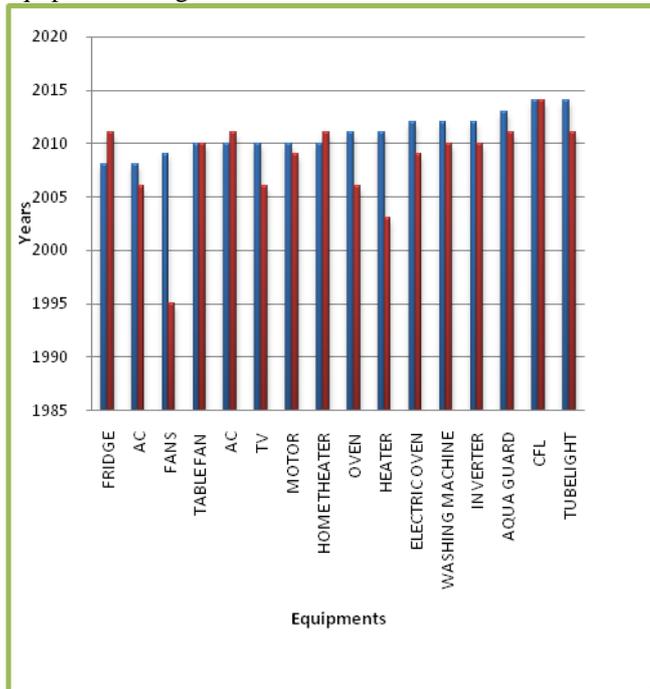


Fig 3. Age of Equipments

In this graph fig. 3 the age of the equipments are given were the age of each equipment are determined in this graph to find the oldest equipments that are used in these three homes.

Real-time Load Analysis - Loads analysis is very much necessary to find out whether the loads are balanced in this three houses, In this houses we can see from fig. 4 that the load are not balanced and due to low power factor in this three home we can find out that the star rated appliances consumption is also very high.

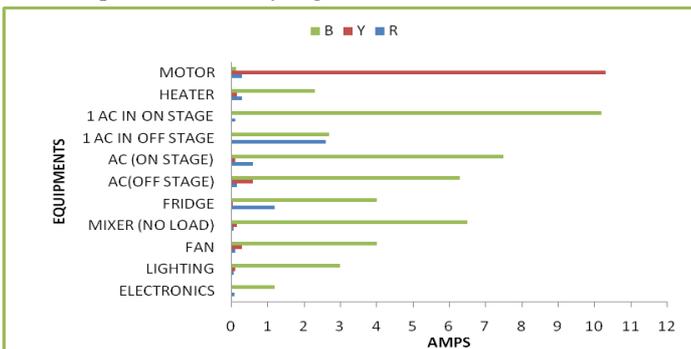


Fig .4 Real Time Load Analysis

The graph shows the real time load analysis graph were it is found that the consumption of the equipments are high. In this analysis it is found that the loads are not balanced in these three homes and also the Ac consumption which is star rated doesn't exists the consumption as given according to the BEE report.

Analysis in Earthing - In the comparison of these three houses in fig. 5, we can see that in the house 3 the earthling is not proper and the condition of the earthling is very weak, due

to which power factor is very low and the power consumption is very high.

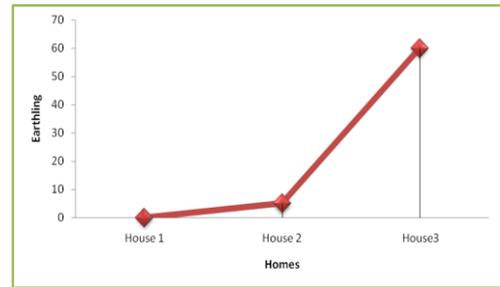


Fig.5 Earthing Status

Analysis of Safety - Safety is very much essential for all the equipments and the usage of the appliances in these three homes it is seen that there is no safety of any of the electrical means and they are not even aware of the safety issues in their houses the earthing is weak and there is no proper insulation in many place.

4. Recommendations

According to the certain analysis recommendation are given below to have a comparative analysis of three homes in which suitable recommendation are given below as follows,

4.1 Recommendation Without Investment - According to the layout of the home, we have recommended some of the best saving tips by which you can save electrical energy and tariff without any investment by proper utilization you can conserve energy and also reduce the tariff in your monthly bills. These are some important tips to save energy in home.[2]

- In Refrigerator regularly defrost manual- defrost refrigerator and freezers; as frost build up increases the amount of energy needed to keep the motor running.
- Avoid putting hot and warm food and also avoid using big vessels inside the fridge.
- Do not open the doors of the refrigerator frequently. As it costs around 0.15 paisa
- Proper dusting and cleaning of exhaust fan should be done.
- Using tube light in kitchen is good .If CFL is also there you can use CFL in morning and tube light in night.
- In washing machine always wash only with full load
- 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.

4.2 Recommendation With LED - According to the site review we can see that in these 3 houses CFL are used a lot so according to that we can go for common recommendation for using LED in this houses.

LED has two years of warranty and it also saves the consumption of units compare to the CFL and tube light this shows the results that LED is very much effective and also

very useful in consumption of electrical energy units which is proved in fig.6.

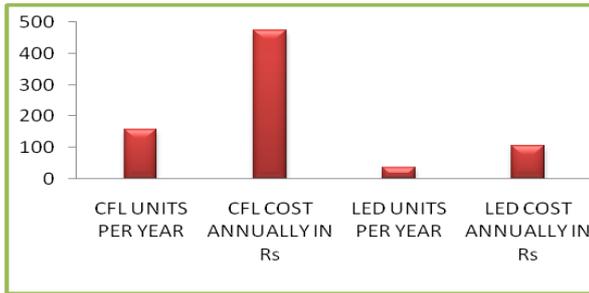


Fig 6 .CFL to LED Benefits

In this graph and in the table .1 it is clearly stated the difference of using CFL instead of LED this graph given above states the difference in cost and units

Tabel.1 Recommendation with LED

Present Energy Usage	
Total number of CFL	3
Total number of watts	3*18=54w
Number of hours in a year	8hrs*365days=2920
Total number of watts annually	54*8*365=157680w
Total units consumed	157680/1000=157.68 units/year
Cost annually	473Rs
If all the CFL (3) are replaced by LEDs	
Total number of LED	3
Total number of watts	3*6=12w
Total number of watts annually	12*8*365=35040w
Total number of units consumed	35040/1000=35.4 units per year
Cost annually	106.2Rs
Energy saved	157.68-35.4=122.28 units per year
Money saved	Rs.473 - Rs.106.2= Rs.367 per year
Payback time	
LEDs	Rs.650
Total investment	3*650=Rs.1950
Payback time	(Investment cost / Annual saving) * 12 months
	(1950 / 367) * 12= 63months

4.3 Recommendation with investment – (Star Rated AC)

In the load analysis graph in fig. 7, we can see that the energy consumption of 3star rated AC is very much high .The actual maximum current consumption should not cross 4KW but the load analysis tells that AC consumption is nearly around 8-9KW.

- The increase in KW up to 8-9KW is due to the Freon level is not proper due to which the power consumption increase

An air conditioner should always be serviced once in a six months to have the current consumption according to the star rated specification.

- This graph given below shows that if the air conditioner is not serviced and used in the same condition the consumption may increase gradually and may cause the air conditioner to not run in an effective manner.

- If it is serviced properly once in a six months you can achieve star rated output.

- In this graph if the suitable AC are serviced and properly maintained the ac will consume the star rated assumption only.

- If the AC are not properly serviced and maintained the consumption may increase due to the dust and low Freon level in the air conditioner.

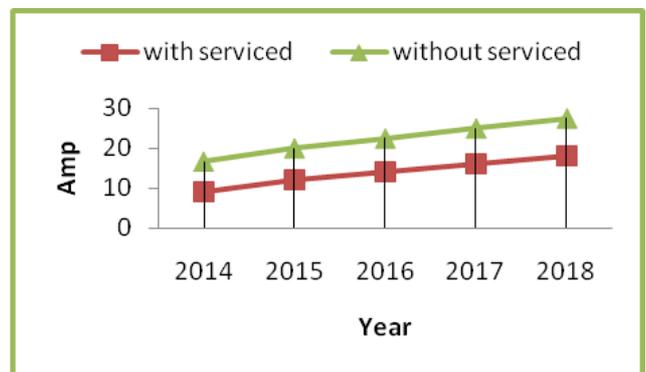


Fig 7. Air conditioner service

Table 2. Recommendation with star rated AC

Present Energy Usage	
Total number window AC	1
Total number of watts	1*2500 = 2500w
Total number of watts annually	2500*22*365 = 2007500w
Total number of units consumed	20075000/ 1000 = 20075 units per year
Cost annually	20075 * 3 = Rs.60225
If window AC is replaced by 5 star 1.5 ton split AC	
5* AC	1
Total number of watts	1*1677=1677w
Total number of watts annually	1677 * 22 * 365 = 13466310w
Total number of units consumed	13466310/ 1000 = 13466.1 units per year
Cost annually	13466.1* 3 = Rs.40398.3
Payback time	(Investment cost / Annual saving) * 12 months
	(35000/19856.5)*12 =21.1518 months

Here we can clearly notice that on using 5 star AC instead of no star rated window AC can reduce about 20000 rupees per year.

Rs.60225 – Rs.40398.3= 19856.5

In this according to the analysis of these three homes one home has star rated AC so it is not efficient to recommend them for the replacement of Ac but in rather two homes replacement of ac is very much essential because they use window Ac which is not star rated and its consumptions is also very high. To reduce the tariff bill up to 40% we have recommended to change the oldest AC in two homes as the condition is very bad and the consumption is also very much high. For an effective consumption and to reduce the units and the tariff bill recommendation of air conditioner is give in the table as follows as it gives the payback time of the investment.

4.4 Recommendation With Star Rated Fan – According to the analysis and comparison of the three homes a common recommendation is given for replacing any of the two fans to star rated fans in which the watts are reduced and also due to this the units and tariff bills are reduced at a certain level.

Tabel.3 Recommendation for star rated Fan

Present Energy Usage	
Total number of ceiling fan	2
Total number of watts	2*60 = 120w
Total number of watts annually	120*26*365 = 1138800w
Total number of units consumed	1138800 / 1000 = 1138.8units per year
Cost annually	1138.8* 3 = Rs.3416.4
If all the ceiling fans (5) are replaced by energy saving models	
Total number of ceiling fan	2
Total number of watts	2*50=100w
Total number of watts annually	100 * 26 * 365 = 949000w
Total number of units consumed	949000/ 1000 = 947 units per year
Cost annually	947* 3 = Rs.2847
Cost benefits	3416.4-2874=550rs

These calculations that are given above are with cost benefits that if the certain two fans are replaced by star rated fans the consumption and the units are reduced.

4.5 Mandatory Recommendation with DG Based Inverter

All the three houses use inverter so for effective saving of energy we can go for mandatory recommendation for solar inverter in which the inverter is converted into solar.

Tabel.4 Mandatory Recommendation

CONVERTING INVERTER	INTO SOLAR
Battery Capacity	150Ah
Volt and battery output	12VOLT*150Ah=1800wh
Back up of the concerned battery	1800wh/800W=2.25hours
Charging current should be 1/10 of battery	150*(1/10)=15A
Calculate the watts	P=12V*15A=180WATTS
How many solar panels required for charging the battery	180/60W=3 SOLAR PANEL OF 60WATTS

The calculation given above states that how much panel is required to charge the battery.

4.6 Recommendation of DG

As we all know that solar as become a main and sufficient for generation of electricity so if the home is fully operated with solar the certain client may save money after certain period and can also sell electricity.

Table5.Recommendation with DG

Recommendation of DG	
Solar panel capacity	1KWp
Cost for 1KWp solar panel	Rs.85000
Subsidy (30%)	Rs.20000
Final investment cost	Rs.85000-20000 = Rs.65000
Solar Power Generation	
Solar power generation Chennai 4 to 5 KW per day for 1KW panel	
No of working days	300 per years
Total energy production	4*1*300 units per year 5*1*300 units per year
Cost and Benefits	
Number of units of grid power substituted	1200 units per year 1500 units per year
Cost of grid power	Rs.3 per unit
Power saving per year	1200*3=Rs.3600 1500*3=Rs.4500

5. Energy Saving With & Without Audit

In this paper the comparison analysis of the three homes is done for which suitable recommendations are given below, if the client goes for the recommendation they can save upto 40% of total units and reduce the tariff bills which is proved in the fig. 8 for the post and pre audit

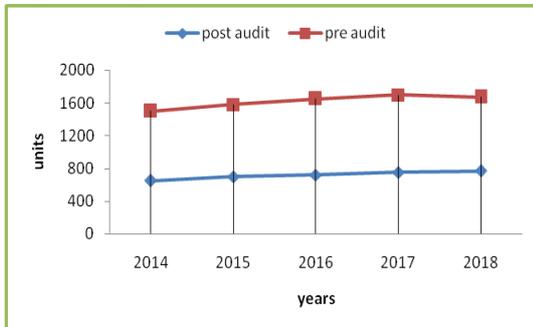


Fig 8. Pre Audit and Post Audit

6. Conclusion

This paper delivers a electrical energy audit of a 3 residential house in Chennai with a suitable recommendations to save energy as per the motto 'SAVE ENERGY TO REDUCE DEMAND'. The outcome of all the recommendation clearly shows that the payback period will reach within four years as per today and the client is agreed to implement all the recommendation within the span of six month.

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