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Energy Audit for a Residential House with Considerable Recommendation for Implementation

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Abstract— Energy has become a routine process in our lifestyle. Our country is facing a huge problem of Electrical Energy demand, because our generation did not match our demand, so from our point of view rather than generation, why not be concentrated about saving energy? This is possible only by an effective energy audit. It is a process of evaluating a building or a plant which uses energy and identifying opportunities to reduce consumption. Our vision is saving Electrical Energy by conducting an Intelligent Electrical Energy audit under an initiative forum "MGR vision 10MW". We started our first initiative with auditing a residential house, and presented the suitable recommendation and effective manner of conducting an Electrical Energy Audit.

Keywords: Distributed Generation, Energy Audit, Renewable Power

I. INTRODUCTION

The entire progress of the country and the lifestyle is solely dependent on Energy. Now a days, saving energy has become an essential criteria rather than generation of electricity. We may find plenty of ways for generation but we should also concentrate on consuming it, in a systematic manner. It is only possible by the effective energy audit and energy management. An energy audit can be defined as a process of evaluation where one identifies opportunities to reduce electricity consumption of a building or plant that uses energy. There are three basic levels for doing electrical energy audit, they are as follow. The walk through audit, Standard audit, Computer simulations [1].

To satisfy the energy needs of the Tamil Nadu, TNEB has a total installed capacity of 20103MW [2] 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. But all of these programs concentrate on generation of power. From our opinion rather than generating, one should think about saving energy. The per capita consumption of Tami Nadu is 1000 units. It was found from a survey [3] that India is the world's fifth largest electricity generator with total installed capacity of 2,28,722MW but even though many of the place in India is still in the dark, and they are very far from the term "electricity".

The review of recent work in energy audit is discussed. S.U kulkarni et al. [4] discusses 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 [motor, meter etc.] and harmonic analysis. The author suggested nine recommendations and concluded with saving of total amount of Rs-8, 98,700/per year. Malkiat singh et al. [5] presented a physically based model and formulation for industrial load management and reducing lighting cost. The author recommended that electromagnetic tubes and chokes should be replaced with electronic chock in phase manner and concluded energy audit is the best method to save electrical energy. Mukesh k saini et al. [6] suggested possible idea to conduct a energy audit in an industries. The author suggested that the payback period will be 13months; he also suggested change the traditional welding set with IGBT etc. After audit author recommended several point A.C ventilation should be regularly cleaned etc. And he concluded that implementation of energy saving measure decision of the management of the factory. Mehulkumar et al. [7] done case study of energy conservation and energy audit in industries. The result of energy audit brings the possibilities of energy saving in simple measure by improving technique and efficient machinery. He concluded the energy audit is of types which add completeness to the energy conservation. The energy conservation measure described in research paper which provides very different perspective to the wastage of energy and implementation platform that address all aspect.

We individually show that, in present scenario most of the common people are wasting power by different methods in their houses, shops etc. To overcome these problems, we need to do energy audits with proper recommendations. Dr. MGR Educational and Research Institute (University) had taken initiative of "Vision 10MW" under the leadership of Prof. L.Ramesh to save 10MW energy within a period of 10 years. As a part of this initiative we the members working on conducting energy audit with variety of houses.

Our first work executed with effective energy audit on a double bed room house with complete recommendations. The paper discusses how energy audit will help us save energy in our electric bill with necessary analysis and presented necessary recommendation for the audited house.

II. METHODOLOGY

Energy demand has grown a lot in the society, that government not able to meet. Because our demand is high in comparison to generation, government is taking steps to solve the problem by finding different new power which we are wasting by the different ways. It only possible by the audits and making people aware about the wastage, and recommend to save power. By doing that people can be aware and we also contribute our efforts towards the society.

- We can create awareness in people to save energy.
- By doing that we can reduce wastage.
- We need not concentrate on generation.
- We can do some good things for our nation

As we know that India is fifth world largest electricity generators even though we are facing problem due to power shortage. So to reduce the power shortage, government introduced many plan to generate energy, but our Moto is to save energy by making people aware about the wastage of power by doing effective energy audits.

The steps of the procedure which designed by our team is presented below

1. Preparation of Power Distribution Single line Diagram
2. Real Time Load Curve
3. Load calculation of single line diagram
4. Energy meter Tariff Survey for past 10 years
5. Real time power loss
6. Power utilization chart
7. Equipment Life cycle Analysis
8. Interview with faculty members
9. Energy conservation opportunity
10. Recommendation
11. Cost benefits
12. Study of Status of Earthing
13. Awareness' on Electrical Safety
14. Submission of Suitable Energy Audit Report with Breakeven Analysis

III. ANALYSIS OF DATA

The energy audit for our initiative through first house executed on 10th August 2014 at Er. Kanya, who is the Assistant Professor in Computer Science Department. Her house is a "2 BHK" house including balconies with three phase connection.

The supply voltage in the house is checked for phase to neutral and phase to phase. Phase to phase is 220v which we obtained and Phase to neutral is 0. Then the audit started with the above said procedure. The single line diagram of the house is represented in figure 1. Then the continuation of the work executed with collecting all the readings of all equipment, daily usage/monthly usage. which we described in the report below

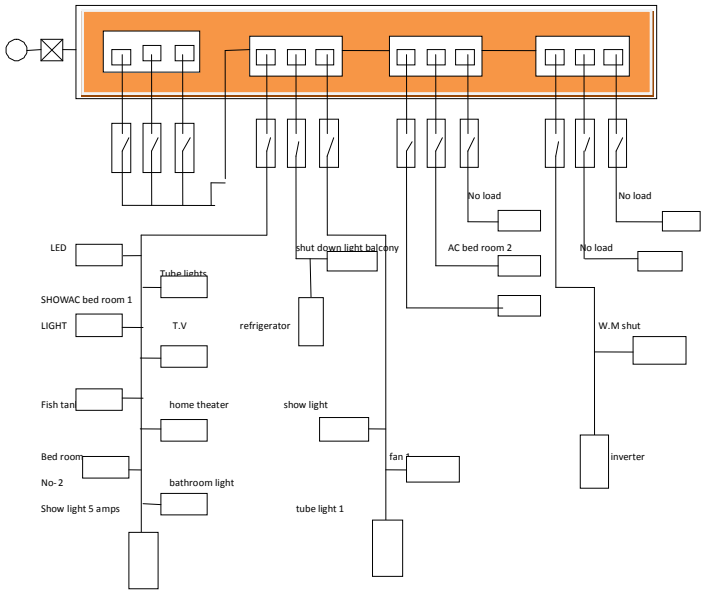

Fig. 1. Single Line Diagram

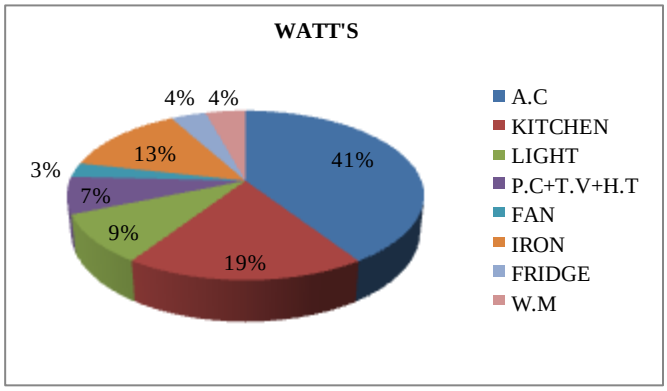

Fig. 2. Power Consumption Pie Chart

From the pie chart what we saw is the maximum power is consumed by the air conditioner (41%). The second place is held by the equipment used in the kitchen which is about 19%. The iron box consumes 13%. All lights consume 9% and after that, the computer, television, home theatre consume 7%. The fridge and washing machine consume 8%, the fan consumes 3%. So, the maximum energy is consumed by air condition and less power consume by fans.

Fig. 3 shows that the age of equipment which is used in the house. It gives an idea about the performance and power consumption of the equipment. It's also giving some rough idea about past performance of the equipment. According to the graph, we show that most of the equipment is purchased in 2010 because Ma'am had purchased a new house.

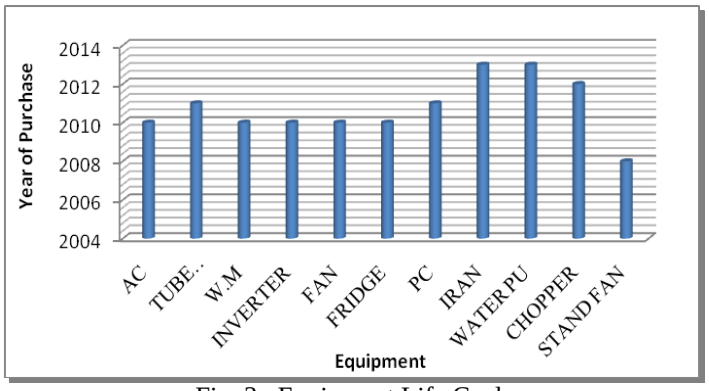

Fig. 3. Equipment Life Cycle

Fig. 4 represents the real time load curve reading which shows that when all electronics items are turned on, the rating on R is 0, Y 1Amp, and on B 0 . Next is lighting which having R 0, Y0.7 and B 0 amps respectively. The major reading obtained from AC, Grinder and washing machine. The total reading we obtained is R+Y+B=31.5 amps.

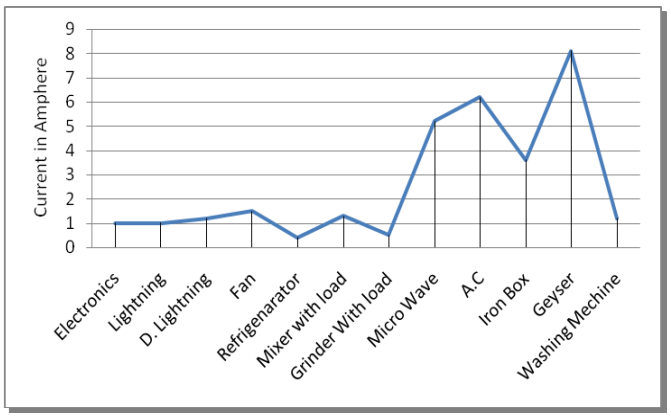

Fig. 4. Real Time Load Curve

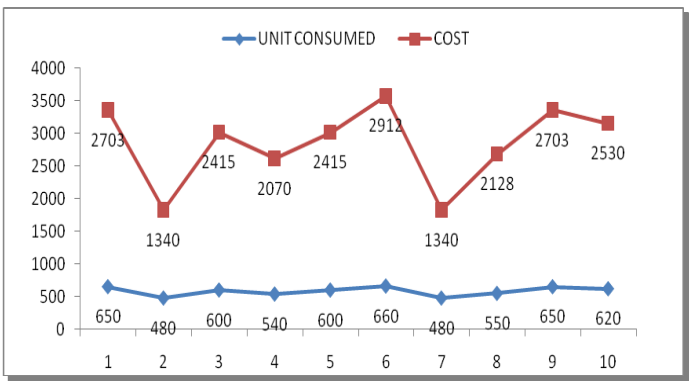

Fig. 5. Unit Consumption and Cost for Past Two Years

Fig. 5 represents the tariff history of past 3 years, According to the tariff analysis, the average energy consumed is 593.33 units, the two value are exactly same according to the data dated (4/4/2013) (4/2/2014).the average price consumption is Rs-2262.3. The highest amount paid by the user is 2835 on dated 06/08/2014. So our opinion is we need to audit this house because from the graph we found that the user uses more than 500 units per months.

IV. RECOMMENTATION

According to our team we have given three recommendations after doing energy audit. First is **"Without Investment"**, second is **"With investment"**, and third is solar implementation

A. Recommendation Without invesment

- R Y B does not have a balanced load. It is found that in R=6.1 A, Y=21.6A and B= 3.8A so our first recommendation is to change the unbalanced load into a balanced one, so that we can get good input voltage.
- We found that the gap between refrigerator and the wall is very close, which led to the bad efficiency of the refrigerator and it also consumes more voltage. So we recommend the house owner to maintain proper distance.
- We also found very hot milk is keep inside the refrigerator.
- The dust is deposited on condenser coil led the motor to work harder and use more electricity.
- On the ceiling fan dust is deposited which also led the motor to work harder.
- Every time the entire charger is in ideal mode which also consumes electricity.
- A chimney is placed instead of exhaust fan which is not required. It consumes more power than an exhaust fan. so our recommendation is to replace the chimney.

B. Recommendation With LED

After the analysis the following recommendations are suggested with investment. There are 8 Tube Light in this house. Total number of fan used in this house is 4, and there is 1 refrigerator. Electrical appliances which can be replaced by energy saving units were identified. Total wattage of energy used by Tube light, Fan, and Refrigerators has been presented in the graph.

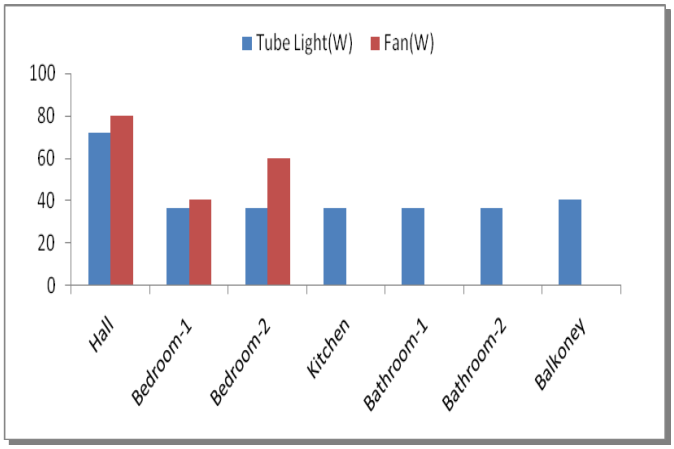

Fig. 6. Basic Lighting Analysis for Conversion

In this case study the total watts per type of appliances which has the most number of wattage consumption was reviewed, and it was found that florescent light consumed around 385w and ceiling fan consumed about 350w and the refrigerator consumed about 245w. We analyze that if all the tube light is replaced by LED, then we can save the maximum energy in the house and we also save money by doing that. The calculation and description is given below and the graph is drawn below.

TABLE I. **LED CONVERSION CALCULATION CHART**

Present energy uses	
Total number of florescent light=	8
Total power in watts=	292W
Total hours in a year=	5hr*365=1825hr/yr
Total watts annually=	292*5*365=532900W
Total units **consumed**=	532900/1000=532.9W unit/yr
Cost annually=	532.9*3=1598.7 Rs
If all tube light(8) replaced by LED's	
Total number of LED's=	8
Total number of watts=	8*10=80
Total number of watts annually=	80*5*365=146000W
Total units consumed in a year=	146000/1000=146W unit/yr
Cost annually=	146*3=438 Rs
Saving	
Energy saved=	532.9-146=386.9W unit/yr
Money saved=	1598.7-438=1160.7 Rs/yr
Payback time	
LED's=	800 Rs
Total investment	8*800=6400 Rs
Payback time=	(investment/ annual saving)*12months
(6400/1160.7)*12=551.39 month	

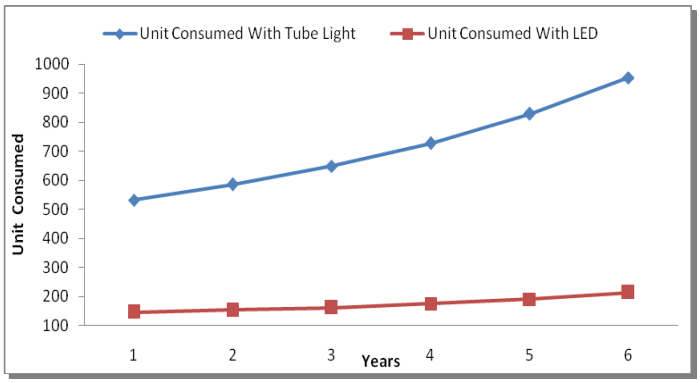

Fig. 7. Unit Consumed With and Without LED

Fig. 7 represents the comparison of the implementation of LED by replacing tube light. It clearly shows that for the next five years there is gradual unit saved through the replacement of LED. After five year the house can save 600 units per annual which will be great help for them for their budget. So we strongly recommend the house to replace tube light with LED.

C. Recommendation With DG

Table 2 represents the eequipments' which are having maximum uses per day.

TABLE II. **MAXIMUM USAGE CHART**

Equipment	Watts	Hours/Day	Total (Watts)
Fan	40	6	240
Fan 2	80	4	320
Tube light 1	40	5	200
Tube light 2	40	8	320
T.V	100	4	400
Computer	365	1	365

If all equipment is working, then it consumes 1845 watts per hour. So in a year, it consumes 673425 watts. If we divide per year consumption by 1000 we got kW unit which is 673.42unit per year. 673.42*5=3365RS.

Fig. 8 states the consumption without D.G and with D.G. The differences are clearly shown with the help of the graph. We are considering this graph for a period of five years. If we compare both we found that without D.G it consumes approx. 7000 whereas with D.G it consume 5500 in year 2014.

Fig.9 shows the differences before audit and after audit in the house. There is a huge difference between both the graphs, which show the unit consumptions before audit and after audit. We consider for the period of five year. We consider the electric unit increment to be around 10% and solar unit by 5% , so we get this final graph or differences.

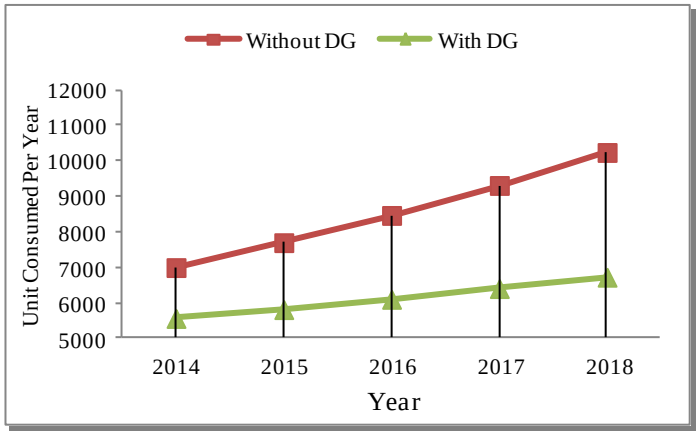

Fig. 8. Comparison with and without DG

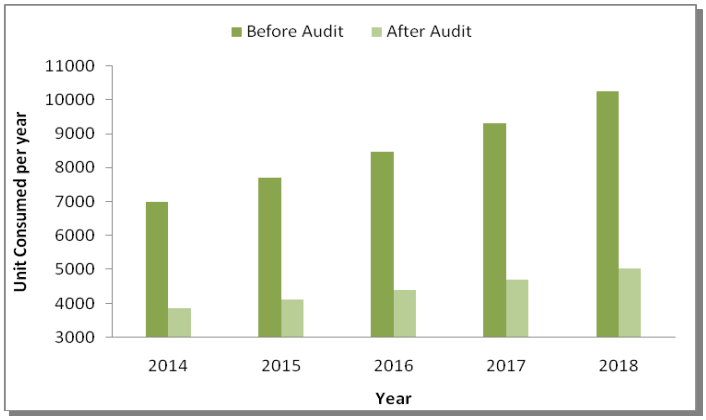

Fig. 9. Comparison of Unit Cost With and Without Audit

We the team of energy audit strongly recommended the houses to implement the idea presented in this paper on 20th Oct 2014. They agreed to implement within three months of time.

V. Conclusion

As we all know that the energy saving technique till now are only implemented in the industries to reduce their fine by increasing their power factor above 0.95. But no one or the government did not spread the awareness to the domestic users about conservation of energy. As a result of that presently the wastage of energy is mostly done by the domestic users. In residential area one should think about installing new machines and equipment with cheap, effective and efficient technique to achieve high efficiency of energy user. The present audit work executed in 2-BHK residential houses in Chennai. The effective recommendation is presented with different graphs. The audited consumer agreed to implement the idea presented in this paper. We also recommends aspects of using renewable resources, tree plantation around the building and make changes in the installation procedure for an effective, efficient, cleaner and greener environment.

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