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ENERGY AUDITING OF A HOUSE USING MATLAB

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Abstract- Energy crisis is one of the crucial problems faced by all the countries in the world due to depletion in natural resources used for energy generation and the huge investment for generating energy from alternate resources. This article shows the present situation of energy crisis in the state of Andhra Pradesh and suggested some of the major areas of energy conservation practices so that there may be a chance to see the state of Andhra Pradesh as "NO POWER CUT" state in India. A viable and immediate solution in this juncture is the energy conservation as cited by the slogan "Energy conserved is Energy Generated". Optimum use of electrical energy, not only results in cash savings, but also improves the economy of the country substantially. Hence there is an urgent need for energy management and control, which ultimately concludes with the practice of energy conservation. Energy as we all know is a crucial input in the process of economic, social and industrial development. Energy consumption is increasing at a very fast rate. With growing demand for energy it has become essential to minimize energy leakages. This article shows the present status of energy crisis in "Andhra Pradesh" state. This article also shows about the gap between power generation and demand and it suggest some of the methods to make the gap between power generation and demand is equal to Zero.

I. INTRODUCTION

It may be possible to see the gap between power generation and demand is equal to Zero. In this article, we have taken a simple case study of Energy Audit of a house. The number of units consumed before conservation methods and the number of units consumed after the conservation methods are estimated. A MATLAB Program was written for the above cases and tested if there is a savings in both the units consumed and the cost. The result shows that there is a possibility to see the gap between power generation and demand is equal to Zero.

As electricity is an essential commodity without which anybody cannot live. The electricity demand is due to increase in population and also due to growth in civilization. All the nations of this world are trying to bridge the gap between power generation and demand. But they face an energy crisis due to

- Depletion in the natural resources such as Coal, Oil, Gas etc.
- No new major hydro potential resources are available for exploration.
- Huge investment cost in nuclear resources.
- Non-availability of major, Non-conventional, reliable, stable electrical energy generating systems.

Hence the energy conservation is the need of the Day.

II. CONSERVATION OF ELECTRICAL ENERGY

At the outset let us discuss the concept, the meaning, the definition and the idea of the conservation of energy. Many a times common people think that the conservation of energy is something like to save or to reserve the available energy for future by reducing the energy consumption or by the suppression of the demand. "Energy Conservation" should be considered as the wise and efficient use of the available energy for achieving maximum activities with productive work and profitability. Thus conservation does not mean the curtailment in energy-use at the expense of industrial and economic growth. It means the efficient utilization of energy resources ensuring the same level of economic and industrial activity with less inputs of energy. Energy efficiency is achieved when energy intensity in a specific product, process or area of production or consumption is reduced without affecting output, consumption or comfort levels "Energy Conservation "has become the catch word of everybody, starting from the Government bureaucrats, technocrats to even general public. All concerns are thinking about the conservation of energy but only a few are conscious about the same.

The whole gamut of energy related problems of Economic and Social Infrastructure of our societies now demands and deserves urgent, cogent and incisive consideration and attention for the improvisation of the present practice of the consumption of energy, especially the Electrical energy.

Under such circumstances, although the Government is expected to take measures to increase generation, the consumers also owe responsibility to utilize the energy conservatively and most judiciously.

The optimum use of electrical energy not only results in cash savings, but also improves the economy of the country substantially. Thus there is urgent need for Energy Management and Control, which ultimately concludes with the practice of Energy Conservation.

III. POWER STATUS OF ANDHRA PRADESH

Andhra Pradesh has a total installed capacity of 16,265.97 MW, of which the state's Power – Generation utility. Andhra Pradesh Power Generation Corporation Limited (APGENCO) accounts for 8924.86 MW. The state plans to add 9, 000 MW of capacity by the end of 2015.

Table (1) shows the installed capacity of power (in MW) in Andhra Pradesh. This table includes all the power generating sectors which include APGENCO, Private Sector, and Share from Central Sector. APGENCO supplies about 57 percent of energy requirements of the state. Table (2), (3) & (4) shows the installed capacity of power (in MW) in APGENCO. These tables include different types of power generating stations which include Thermal Power Generating Stations [Table (2)], Hydel Power Generating Stations [Table (3)] and Wind Power Generating Stations [Table (4)].

Andhra Pradesh state's installed capacity is higher than the neighbouring state's installed capacity (Tamilnadu 11,000 MW). But our state is in energy crisis. According to the power generation and demand analysis, there is a deficiency of 25 Million Units per day. Because of this shortage of power, the state's Power – Transmission utility, Andhra Pradesh Power Transmission Corporation Limited (APTransco) will charge power cuts in various fields. Table (5) shows the various fields in which APTransco will charge. In the state of Andhra Pradesh, there are many small and heavy power generating stations. Some of them are situated in Ramagundam, Kothagudem, Vijayawada, and Moddunuru.

All these generating stations uses Coal as a fuel and these are termed as Thermal Power Generating Stations. Nagarjuna sagar and Srisailam are known as Major Hydel Power Generating Stations in Andhra Pradesh. Some of the small Hydel power Generating Stations are Pochampadu, Singuru, Penna Ahobilam, Seleru, Somasila.

These are also Hydel Power Generating Plants, but of small capacity generation and its power generating capacity depend up on Water availability.

That is, during the rainy Season, these plants generate maximum power.A wind power plant in Ramagiri, Gas based power plant in Vijjeswaram, like these power generating stations are used to generate the power under the state's Power – Generation utility. Andhra Pradesh Power Generation Corporation Limited (APGENCO).Even then, based on the Power Demand of Andhra Pradesh, there is a deficiency of 25 Million Units per day. To compensate this power, an additional power generation of 2000 MW is required.

INSTALLED CAPACITY OF POWER IN ANDHRA PRADESH (AS ON 01-11-2011)		
S.NO	POWER GENERATING SECTORS	POWER (MW)
1.	APGENCO	
	THERMAL	5092.5
	HYDEL	3829.36
	WIND + SOLAR	3.00
	TOTAL APGENCO	8924.86
2.	JOINT SECTOR	
	GAS (A.P.G.P.C.L.)	272.00
3.	PRIVATE SECTOR	
	THERMAL	00000
	GAS	2494.70
	MINI HYDEL	104.40
	WIND	376.89
	CO-GENERATION &	508.50
	BIO-MASS PROJECTS	
	MINI POWER PLANTS	74.31
	OTHERS	144.55
	TOTAL PRIVATE SECTOR	3703.39
4.	SHARE FROM CENTRAL SECTOR	
	RAMAGUNDAM	919.11
	MADRAS ATOMIC POWER PLANT	47.09
	NEYVELI LIGNITE CORPORATION	346.04
	KAIGA NUCLEAR POWER PLANT I, II & III	220.68
	SIMHADRI	1000
	TALCHER (PH-II) UNIT-3,4,5,6	430.30
	TOTAL SHARE FROM CENTRAL SECTOR	3,364.52
TOTAL (APGENCO + JOINT SECTOR + PRIVATE SECTOR + CENTRAL)		16,265.97

TABLE (1)

THERMAL POWER GENERATING STATIONS		
STATION NAME	UNIT	CAPACITY (MW)
Dr.NARLA TATA RAO THERMAL POWER STATION	UNIT 1	210
	UNIT 2	210
	UNIT 3	210
	UNIT 4	210
	UNIT 5	210
	UNIT 6	210
	UNIT 7	500
TOTAL CAPACITY		1760
RAYALASEEMA THERMAL POWER PLANT	UNIT 1	210
	UNIT 2	210
	UNIT 3	210
	UNIT 4	210
	UNIT 5	210
TOTAL CAPACITY		1050
KOTHAGUDEM THERMAL POWER PLANT	UNIT 1	60
	UNIT 2	60
	UNIT 3	60
	UNIT 4	60
	UNIT 5	120
	UNIT 6	120
	UNIT 7	120
	UNIT 8	120
	UNIT 9	250
	UNIT 10	250
	UNIT 11	500
TOTAL CAPACITY		1720
KAKATIYA THERMAL POWER PLANT	UNIT 1	500
TOTAL CAPACITY		500
RAMAGUNDAM	UNIT B	62.5
TOTAL CAPACITY		62. 5
TOTAL APGENCO THERMAL		5092.5

TABLE (2)

IV. HYDRO POWER GENERATING STATIONS

STATION NAME	CAPACITY (MW)
UPPER SILERU	240
DONKARAYI	25
LOWER SILERU	460
PRIYADARSHINI JURALA	195
SRISAILAM RIGHT	770
SRISAILAM LEFT	900
NAGARJUNA SAGAR	815. 6
NAGARJUNA SAGAR RIGHT CANAL	90
NAGARJUNA SAGAR LEFT CANAL	60
POCHAMPADU	75
NIZAMSAGAR	10
PENNA AHOBILAM	20
SINGUR	15
MINI HYDRO	12.16
TUNGABHADRA (AP UTILISATION)	57.6
CHUCHKUND (AP UTILISATION)	84
TOTAL APGENCO HYDRO	**3829. 36**

TABLE (3)

V. WIND POWER GENERATING STATIONS

STATION NAME	CAPACITY (MW)
WIND POWER PLANT	2
TOTAL APGENCO WIND	2.0

TABLE (4)

In the month of March and April, there is a severity in the power cut. There are many reasons for power demand particularly in these two months.

1. There is no water in Dams, hence no generation of power from Hydel Power Generating Plants
2. Even Thermal Power Generating Plants require some amount of water to run the plant. If sufficient water is not available, the Thermal Power Plant may not run. Onmonth back, two units of Kothagudem Power Plant were shutdown due to no water in Kinnerasani Reservoir.

Exactly, at this situation, power requirements increases very rapidly due to the following.

1. During summer, fields require more water. Hence Farmers will switch on their motors continuously round the clock for their fields

to water up. Because of this, there is a maximum usage of power.

S.NO	FIELD	LOADS
1.	AGRICULTURAL	MOTORS, PUMPS LIGHT LOADS
2.	INDUSTRIES	ELECTRICAL DRIVES INDUSTRIAL HEATING INDUSTRIAL WELDING AIR CONDITIONING COMPRESSORS ELECTRICAL LIGHTING AUXILIARY CONSUMPTION
3.	DOMESTIC	LIGHTING,FANS,PUMPS REFRIGERATORS KITCHEN APPLIANCES WASHING MACHINES WATER HEATERS AIR CONDITIONERS AIR COOLERS

TABLE (5)

2. During summer, Domestic power requirements are more. That means all the Fans, Refrigerators, Air Coolers and Air Conditioners are run almost around the clock beside basic appliances running. The usage of power in the Andhra Pradesh State is as follows, shown in Table (6). The average power requirement from one year to another year in our state is increasing at a rate of 8.21 %. But the power generation is not that much extent. Hence we are facing lot of power cuts.

Is there any chance of "No Power Cut" in the State of Andhra Pradesh? "Yes" is the answer. There are two ways to see our state as a No Power Cut state in India.

1. At present, the gap between Power Generation and Demand is 25 Million Units per day. To compensate this difference, a 1200 MW Power generating Plant is required. But, construction of a power generating station depends on many factors. Instantaneously, construction of a power generating plant is not a simple thing because it requires a lot of money and time. Suppose the plant may be constructed very rapidly, for Example, in case of a 1200 MW power plant, it involves Rs.18, 000/- Crore rupees to distribute the power to end consumers from generating point.
2. Usage of available Power in an effective manner. In this paper, we focused on the second way. That is usage of power in an effective manner. With small arrangements, in the state of Andhra Pradesh, there is a chance of power saving of 12,000 MU per year. That means, 1,000 MU per month, 33.33 MU per day. But, the power deficiency per day in the state of Andhra Pradesh is 25 MU. Suppose if we use the present technology and use the latest electrical appliances, then the power saving is approximately 33.33 MU per day.

1. A Government Order is passed by the Government of A.P. in the year 2006 stating that, in multistoried buildings, it is compulsory to use Solar Water Heaters. If Solar Water Heaters are not present, the Municipal Corporation should not give permission to those multistoried buildings. But this is not followed properly in the state of A.P. Where as the neighbouring state Karnataka, in its capital city Bangalore, they are following perfectly. If we follow this, the power consumption/day may be reduced to some extent.
2. The Filament Lamps (60W & 100 W) and Tube Lights (36 W & 55 W) will consume more power. Replace these bulbs with Compact Fluorescent Lamps (CFL). They may consume only 8 – 18W. Incandescent bulbs produce 10% lighting and 90% heat but CFLs produce 90% lighting and 10% heat. If two crore outdated filament lamps, tube lights are replaced with CFLs, there will be saving of 8640 MU/Year.
3. At present, Light Emitting Diode (LED) bulbs came into existence. These bulbs use only 1w power. If 50 lakh LED bulbs are used as bed lamps out of 19.86 consumers in Millions, there is a saving of 300 MU/Year.
4. The normal jet pumps will take at an average of 2.25 units of power per day. If we replace jet pumps with submersible pumps, there is a saving of 700 MU/Year if it is used for 20 Lakh pump sets out of 237.4 lakh pumps in our state.

S.NO	FIELD	USAGE
1.	AGRICULTURAL	**36 %**
2.	INDUSTRIES	**28 %**
3.	DOMESTIC	**22 %**
4.	COMMERCIAL	**7 %**
5.	OTHERS	**7 %**

TABLE (6)

5. According to Bureau of Energy Efficiency (BEE), the wastage of power in industries is equal to 3,000 MU/Year.
6. All most in all the houses, resistor regulators are used for Fans. If we replace resistor regulators with electronic regulators, there is a saving of 2,250 MU/Year.
7. According to Energy Audit Analysis, The wastage of power in 'Vidyut Soudha', Hyderabad is 2.51 Lakh units per Year. If the wastage of power is reduced to

minimum, the saving is Rs.11.48 Lakhs. If the out dated (Older) electrical appliances like Filament bulbs, Fans, Pump Sets, Air Conditioners and Air Coolers are replaced, then the power saving is Rs. 3.5 Lakh Units per year. For this replacement, the cost involved is Rs. 25 Lakhs. But nobody is showing interest in that area.

The wastage of power in 'sachivalayam', Hyderabad is 6.51 Lakh Units per year. If the wastage of power is reduced to minimum, the saving can be Rs.45 Lakhs. In 'sachivalayam', during working hours, whether the electrical appliances such as Filament bulbs, Fans, Air Conditioners and Air Coolers are required or not, but continuously these are running in the entire 10 -12 hours duration. This shows unnecessary wastage of power. Suppose, the power is utilized effectively in the 'sachivalayam', the saving of power is 6.51 Lakh Units per year. Suppose, Filament bulbs and Tube Lights are replaced with CFLs, there will be Power saving of 3 Lakh Units per year. Old Air Conditioners are replaced with new Air Conditioners, there is a power saving of one more 3 Lakh Units per year. For this replacement, the cost involved is Rs. 20 Lakhs. Hence the total power saving is 12.5 Lakh Units per year.

One can expect No Power Cut in A.P. state, if we use the power in an effective manner which is clearly shown in Table (7).

S.NO	CASE	SAVING OF POWER (M U / YEAR)
1.	MULTISTORED BUILDINGS	---
2.	CFLs	8,640
3.	USAGE OF LED BULBS	300
4.	USAGE OF SUBMERSIBLE PUMPS	700
5.	FROM INDUSTRIES	3,000
6.	FROM HOUSES	2,250
	TOTAL **(SAVING)**	**14,890**
	DEMAND **(DEFICIENCY)**	**12,000**

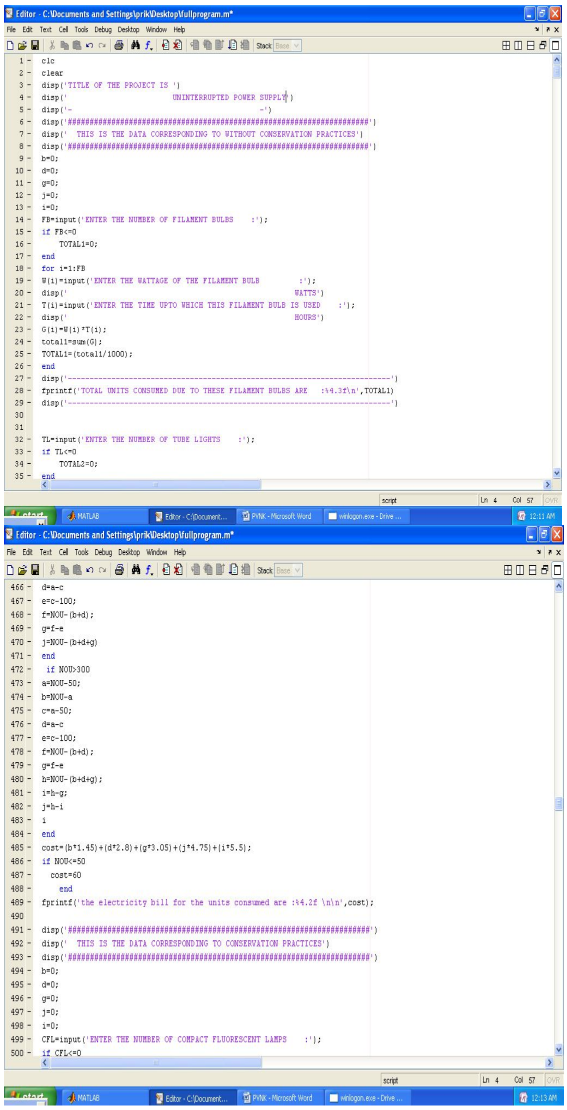
TABLE (7)

VI. CASE STUDY

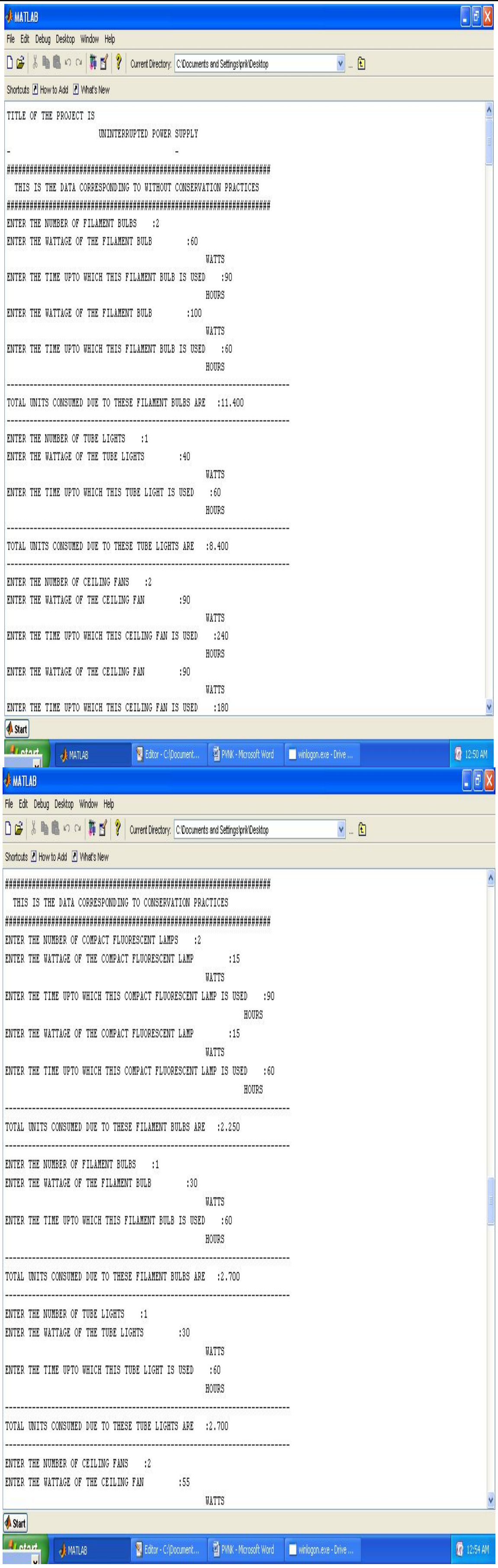
ENERGY MANAGEMENT OF A HOUSE

The above conservation options are considered and as a Case Study, these are applicable to the building unit (HOUSE). A program was written in the MATLAB and results were verified. The results showed that with these conservation options, there was a possibility of saving of a power was possible. Electricity bill before Energy Conservation Options is calculated and compared with Electricity Bill after Conservation Options are implemented. This comparision shows that energy savings worth equivalent to 40% of the total bill identified. The total investment envisaged in purchasing CFL's, 5 Star rated Refrigerator, Havel's Fans etc is about Rs.50,000/- with a simple payback period of less than 1 Year. These results were shown in the following Tables..

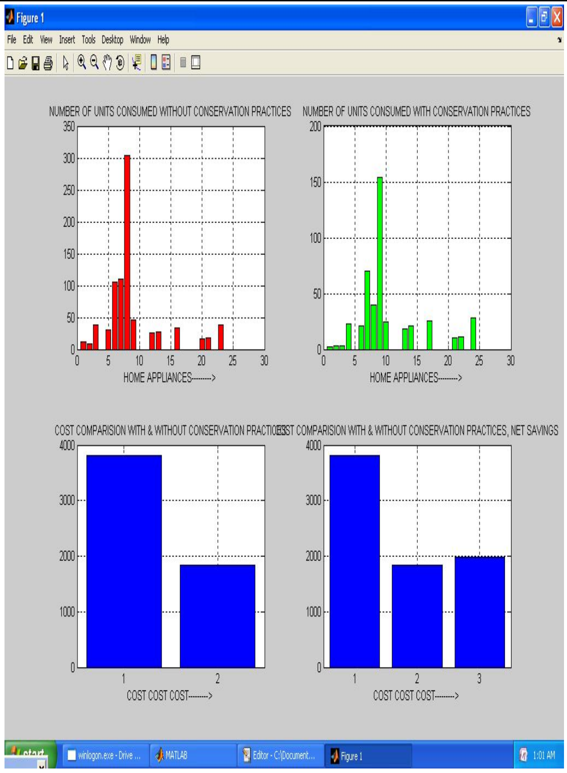
VII. MATLAB PROGRAM AND RESULTS



Fig(1 & 2) : MATLAB Program for the Energy Management of a House



Fig(3 & 4) : Results for MATLAB Program for the Energy Management of a House



Fig(5) : Comparisons of Number units & Cost for both the methods, with & without Conservation Options with Net Saving

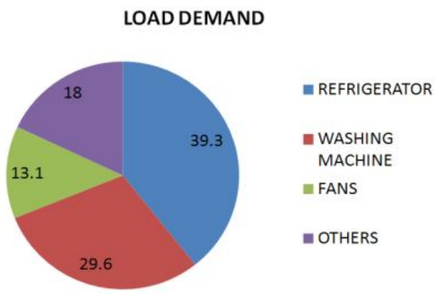
This case study relates to a building unit (HOUSE) located at the middle of the Nellore City. The energy audits indicate the scope areas for conservation of energy. Now the various energy conservation options are in the different stages of implementation.

The unit, building unit (HOUSE) receives power at 440V. The total connected load of the building unit (HOUSE) is around 5 KW. This building unit (HOUSE) consists of 1 Filament Bulb, 4 Fans, 1 Mixer, 1 Iron Box, 2 15W Bulbs, 1 Table Fan, 1 Heater, 1 PC, 1 Television, 1 Refrigerator, 1 Washing Machine etc. The average monthly power consumption is around 250 kwh and the monthly bill varies from Rs 500 to Rs 1000, at an average of Rs 600/month.

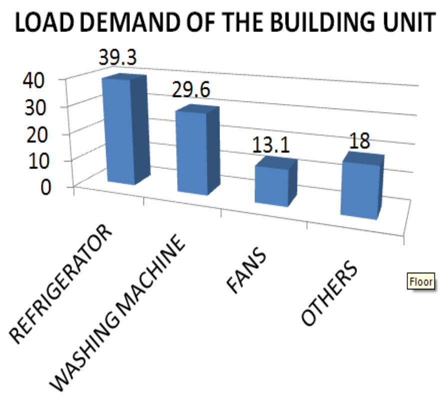
As a part of energy management, the power measurements &load analysis of all the loads & electrical equipment running were carried out by connecting the load analyzer. The figure below gives the typical load profile of the building unit (HOUSE) for one day.

VIII. ELECTRICAL LOAD DETAILS

The major loads in the building unit (HOUSE) are 4 Fans, 1 Mixer, 1 Iron Box, 1 Table Fan, 1 Heater, 1 Television, 1 Refrigerator, 1 Washing Machine etc. The table & figure herein gives the energy consumption of all the equipment in the building unit (HOUSE).



	Load	%
1	Refrigerator	39.3
2	Washing Machine	29.6
3	Fans	13.1
4	Heater	10.1
5	Iron Box	3.5
6	Mixer	2.9
7	Television & Others	1.5



From the figure it can be seen that the major energy consumption in the building unit (HOUSE) is by the Refrigerator and Washing Machine, followed by Mixer, Heater, Fans, Iron Box and Television. So, maximum concentration is given towards Refrigerator, Fans & Washing Machine to save energy.

IX. CONCLUSIONS

By carrying out energy management, energy savings worth equivalent to 40% of the total bill identified. The total investment envisaged is about Rs 50,000 with a simple pay back period of less then 12 months. Presently, these enconoptions are in various stages of implementation. Though this energy management pertains to building unit (HOUSE), almost all the suggestions are applicable to other houses, agricultural motors and industries The Filament Lamps (60W & 100 W) and Tube Lights (36 W & 55 W) will consume more power. Replace these bulbs with Compact Fluorescent Lamps (CFL). They may consume only 8 – 18W. Incandescent bulbs produce 10% lighting and 90% heat but CFLs produce 90% lighting and 10% heat. If two crore outdated filament lamps, tube lights are replaced with CFLs, there will be saving of 8640 MU/Year. At present, Light Emitting Diode (LED) bulbs came into existence. These bulbs use only 1w power. If 50 Lakh LED bulbs are used as bed lamps out of 19.86 consumers in Millions, there is a saving of 300 MU/Year. The normal jet pumps will take at an average of 2.25 units of power per day. If we replace jet pumps with submersible pumps, there is a saving of 700 MU/Year if it is used for 20 Lakh pump sets out of 237.4 Lakh pumps in the state of Andhra Pradesh. Energy saving was possible and at the same time money also saved. The results showed that there was a possibility of energy saving. Only one Conservation Technique was considered and the results were verified by writing a program in MATLAB.

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