*International Research Journal of Environmental Sciences*_____ ISSN 2319–1414
Vol. **7(5),** 50-56, May **(2018)** *Int. Res. J. Environmental Sci.*

*Case Study*

# Energy audit and conservation measures - a case study of University Hostels, Kurukshetra, India

**Nitika Rani, Avi Tomar and Smita Chaudhry***
Institute of Environmental Studies, Kurukshetra University, Kurukshetra India
smitachaudhry11@gmail.com

**Available online at: www.isca.in, www.isca.me**
Received 1st February 2018, revised 14th April 2018, accepted 1st May 2018

## Abstract

*Energy generation and use are the deciding factors for the economic growth of a developing country. Energy conservation is the best way to fulfill the rapidly raising energy demands in India. Energy conservation can be done by energy audit where the detailed analysis of an organization is done and the areas are then identified where the energy conservation possibilities can be identified. In this case study, an analysis was carried out on the energy consumption of various electrical appliances in hostels of a university campus. The observations show that by minimizing the wastage of energy by electrical appliances such as fans, tube lights, refrigerators and geysers when not in use, around Rs 4.5lakh/- per annum can be saved. Remarkable electricity savings can also be achieved by replacing the existing electrical appliances with energy efficient appliances.*

**Keywords:** Energy audit, energy conservation, energy consumption, electrical appliances.

## Introduction

One of the major factors that plays an important role for the development in developing countries is the total power availability. The total installed power capacity India as on Sept. 2017 is 3,29,298 MW out of which 2, 19,450 MW is generated from thermal power stations, 44,765 MW from Hydro, 6780MW from Nuclear and 58303 MW from renewable[1]. In India, during 2015-16, 1075 KWh was the per capita total consumption of electricity. Energy consumption is increasing with the rise in population so India's power system needs to become for times in size by 2040 to meet the required demand of electricity which is achieved by rising incomes and new connections to the grid[1].

Due to continuous rise in energy cost, energy conservation is very essential therefore in order to conserve energy all possible methods should be identified and applied to conserve energy and decrease the energy cost. Reducing energy consumption by means of preventing energy losses can be a good solution for energy conservation. Use of electricity is one of the major contributors of energy consumption in our daily life. Proper use and management of electricity usage is essential to conserve energy. Hence Energy Audit of various Institutes, buildings or industries helps to inspect the methods of electricity consumption and to find out the areas where wastage of electricity takes place so that required methods can be applied to control the energy losses[2]. Energy audit of a building can be a preliminary walk-through to a detailed analysis of audit[3]. As per the Energy Conservation Act, 2001, Energy Audit is defined as "the verification, monitoring and analysis of energy use including submission of technical report containing recommendations for improving energy efficiency with cost benefit analysis and an action plan to reduce energy consumption[4]. Energy audit is an efficient tool not only to identify the total energy consumption but to find out different possible ways for conserving energy in a building or a system[5].

Hence in the present case study a walk-through energy audit of hostels of University Campus was conducted so as to identify reasons for energy losses and also to find methods for saving that energy in the hostel campus.

## Methodology

**Study area:** This study was carried out at girls' hostel premises of Kurukshetra University. There are 12 girls' hostels in the University campus with the capacity to accommodate 3000 girls. The Preliminary Audit or Walk through energy audit was conducted in the hostels in order to determine how and where energy is used and how the energy savings can be done.

Data collection task was done at all the hostels of Kurukshetra University and other supporting entities such as library, computer facility etc. for 2 years 2012 and 2013 in order to get information regarding the power consumption pattern of all the hostels of Kurukshetra University in detail.

The complete information regarding the appliances usage were obtained from the related resource persons e.g. Wardens, Supervisors, Electricians, Attendants (hostels). Overall information regarding the different electrical appliances of all the hostels of Kurukshetra University is given in Table-1.

## Results and discussion

The consumption of electricity in University hostel is mainly for purpose of lighting, fans, refrigerators and also for water purification, computer use etc. The maximum electricity consumption was found in the month of May (61194 KWh) and minimum in October (31193KWh) in year 2012 while in 2013 the maximum electricity consumption was in June (54997 KWh) and minimum in July (28968KWh).

Equipment wise analysis of overall hostel electricity consumption is given in Figure-1, which shows that maximum energy consumption is by fans followed by geysers, refrigerators, water coolers, tube lights, laptops and computers. In terms of energy savings it was observed that energy losses occur in the area where there is continuous use of fans, lights, computer system, and geysers even when not required.

**Table-1:** Total number of electrical appliances in all girls hostel.

| No. of hostel | No. of rooms | Fans | Refrigerators | Tube lights | Computers | Water coolers | Geysers | Laptops |
|---|---|---|---|---|---|---|---|---|
| 1 | 54 | 63 | 1 | 80 | 2 | 2 | 4 | 77 |
| 2 | 75 | 86 | 1 | 95 | 2 | 3 | 4 | 123 |
| 3 | 111 | 230 | 1 | 250 | 2 | 3 | 4 | 89 |
| 4 | 74 | 80 | 2 | 86 | 1 | 2 | 4 | 100 |
| 5 | 67 | 74 | 1 | 82 | 1 | 2 | 4 | 121 |
| 6 | 80 | 86 | 1 | 95 | 1 | 2 | 4 | 120 |
| 7 | 77 | 82 | 1 | 99 | 1 | 2 | 4 | 52 |
| 8 | 101 | 109 | 2 | 122 | 1 | 3 | 6 | 56 |
| 9 | 100 | 107 | 1 | 120 | 2 | 3 | 6 | 120 |
| 10 | 151 | 256 | 1 | 276 | 2 | 4 | 6 | 107 |
| 11 | 128 | 135 | 2 | 280 | 2 | 3 | 9 | 120 |
| 12 | 110 | 107 | 2 | 126 | 5 | 3 | 9 | 170 |

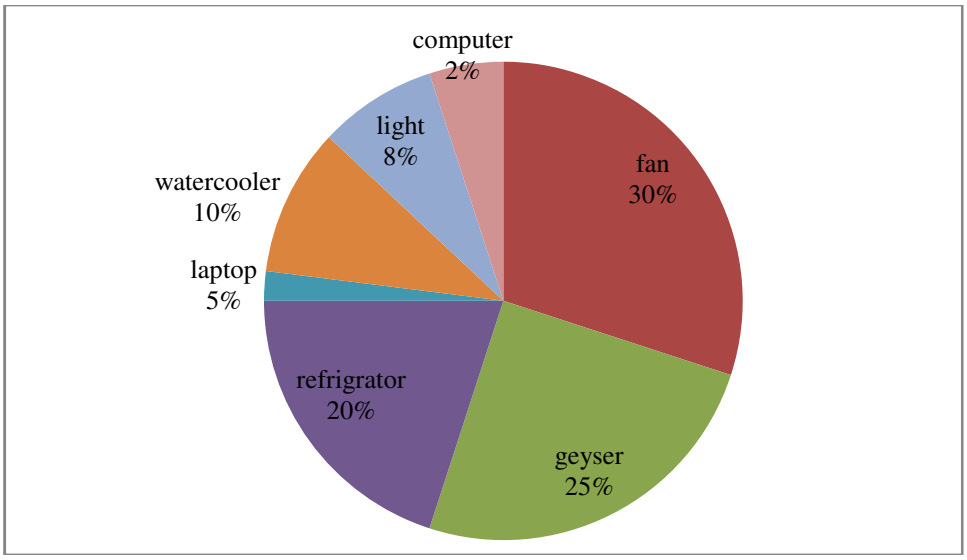


**Figure-1:** Percent electricity consumption of all electrical appliances used in hostels.

## Energy Saving Measures: Calculation of electricity consumption in hostels

**Fans:** Audit observations: It was found that total 166404units were consumed by fans when the usage time for a day was 8hours. However, when the usage time was reduced by 1 hour savings of 20800.5 units were observed. In terms of money around 1 lakh rupees can be saved.

Wattage of existing fan=60 watt = 60/1000=0.06KW,
Usage of Fan=8hr=0.06×8=0.48 units or KWh (1KWh=1unit),
Units consumed by total numbers of fans in hostels=1415×0.48=679.2 units,
In year=679.2×245=166404 units,
Cost of one unit= Rs. 6.2.
Total cost for 166404 units (per year) =166404 units×6.2 = Rs.1031704.8

Recommended energy saving measures
To minimize losses if fans are switched off for at least 1hr.
For one hour no. of units consumed= 0.06KWh
Total units consumed by total fans in hostels = 1415 = 1415 × 0.06 = 84.9 units
Total saving of units after reduction of fan usage time for one year 84.9×245 = 20800.5 units
Total monetary savings =Rs. 20800.5×6.2=Rs.128963.1

If 60watt fan is replaced by Orient 48W energy saver fan
Power drawn by existing single fan= 60W
Power drawn by energy efficient single fan=48W
Difference=12W
Total no. of fans =1415
Savings = 1415×12÷100=16.98KW
In year- 8×245×16.98=33280KWh or units
Cost of one unit=Rs.6.2
Monetary savings= 33280×6.2=Rs.206336
Price difference between the old fan and energy efficient fan is approx. Rs.400
Cost involved for replacing all the existing fans =Rs.566000
Payback period is 566000×12÷206336=32 months=2years and 8 months.

**Tube light:** Audit observations: In case of tube light number of consumed units was 174864.2 when tube light working hours were 10. However 17486.42 units were saved when their usage time was reduced by 1 hour. By doing so approximately 1 lakh rupees saving can be achieved.
Total unit consumption by tube light in one year = 479.08×365 = 174864.2 units
Total cost for 174864.2×6.2= Rs.1084158.04

Recommended energy saving measures
Total saving of units after reduction of light usage time=17486.42 units
Total monetary saving of Rs =Rs.108415.804

If existing 28watt tube light is replaced by T5 LED light of 22W
Power drawn by existing single tube light=28
Power drawn by energy efficient single tube light =22
Savings=6 W
Total no. of tube lights =1711
Savings- 1711×6÷1000= 10.266 KW
In year= 10×365×10.266= 37470.9KWH or units (one unit=one KWH)
Cost of one unit=6.2
Savings= 37470.9×6.2= Rs.232319.58

Price difference between the old one and new T5 LED tube light is approx. Rs 300
Cost involved for replacing all the existing tubes=Rs.513300
Payback period is 513300×12/232319.58=26 months=2year and 2 months.

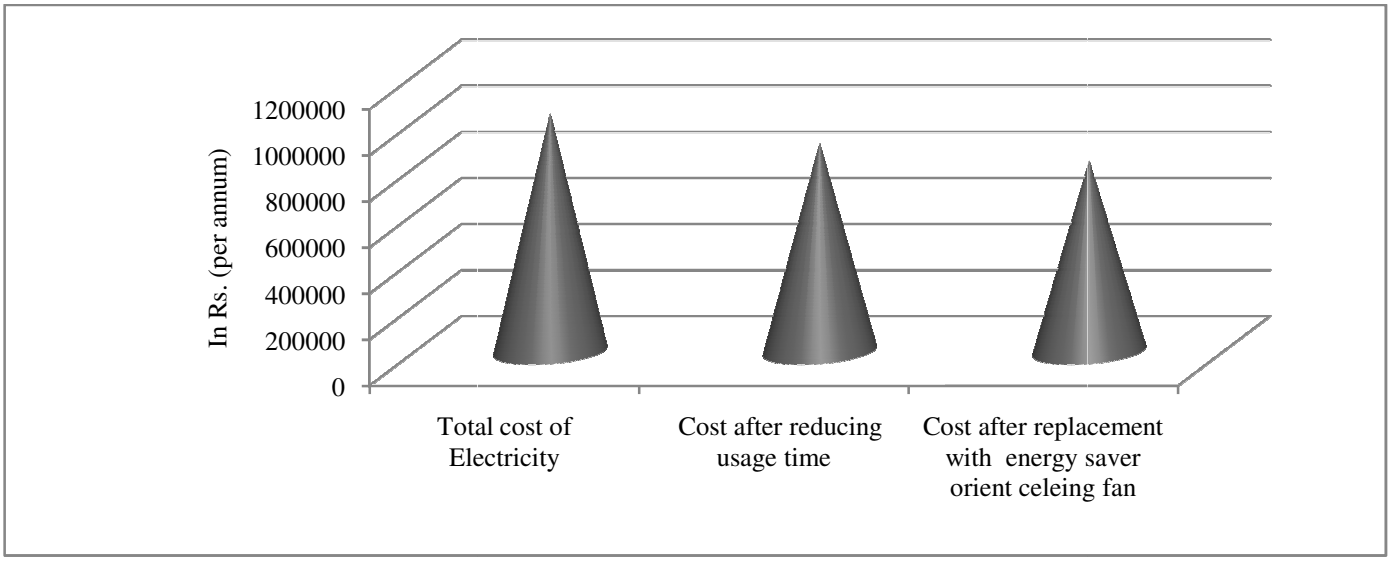


**Figure-2:** Comparison of cost of electricity between existing and recommended energy saving measures in case of fans.

**Refrigerator:** Audit observation: 280320 units were consumed if the duration of usage of refrigerator was 24 hrs when this time is reduced by 1 hour 11680 units were saved which is equal to saving of around 72 thousand rupees.
Total unit consumption by refrigerator in one year = 768 × 365 = 280320 units
Now cost for 2803202 units is = Rs.1737984

Recommended energy saving measures
Total saving of units after reduction of refrigerator usage time =11680 units
Total monetary saving = Rs.72416

Replacement of old refrigerator with Bee star rated refrigerator having power wattage between 100-400W
Power drawn by existing refrigerator-=2000W
Power drawn by energy efficient single refrigerator=400W
Savings= 1600W
Total no. of refrigerator =16
Savings = 16×1600/1000= 25.6KW
In year-24×365×25.6=224256 KWH
Cost of one unit=6.2
Savings=Rs.1390387.2

Price difference is approx. Rs. 20, 000
Cost involved for replacing all the existing refrigerators = 20,000×16= Rs. 3, 20,000
Payback period is=3, 20,000×12÷1390387= Around 3 months

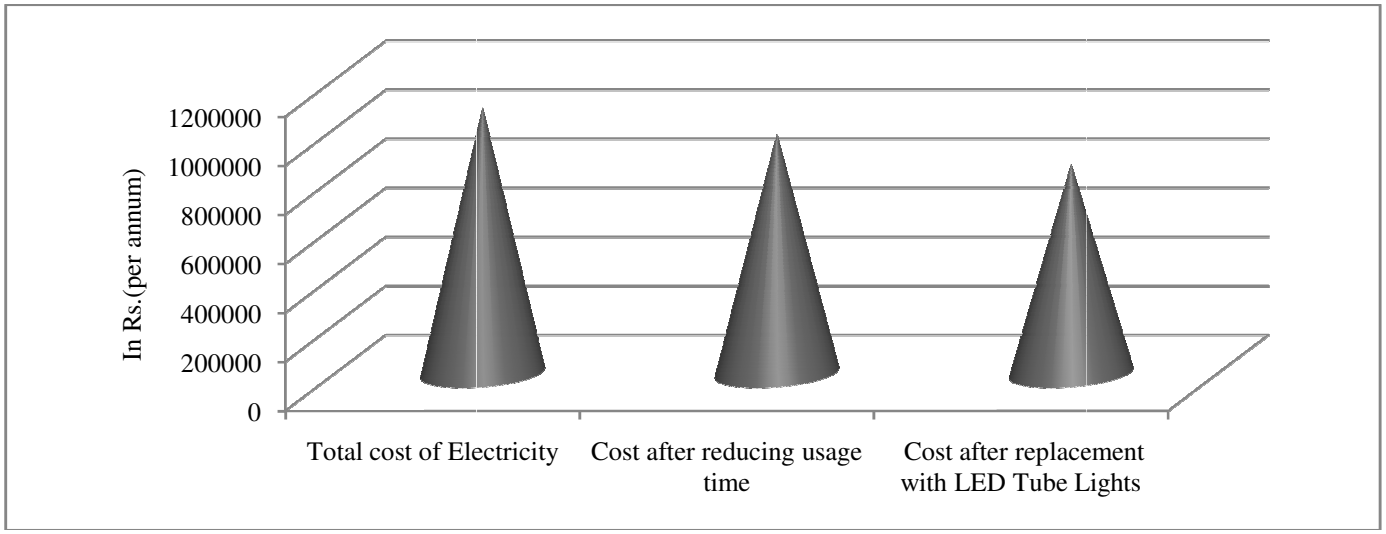


**Figure-3:** Comparison of cost of electricity between existing and recommended energy saving measures in case of Tube lights.

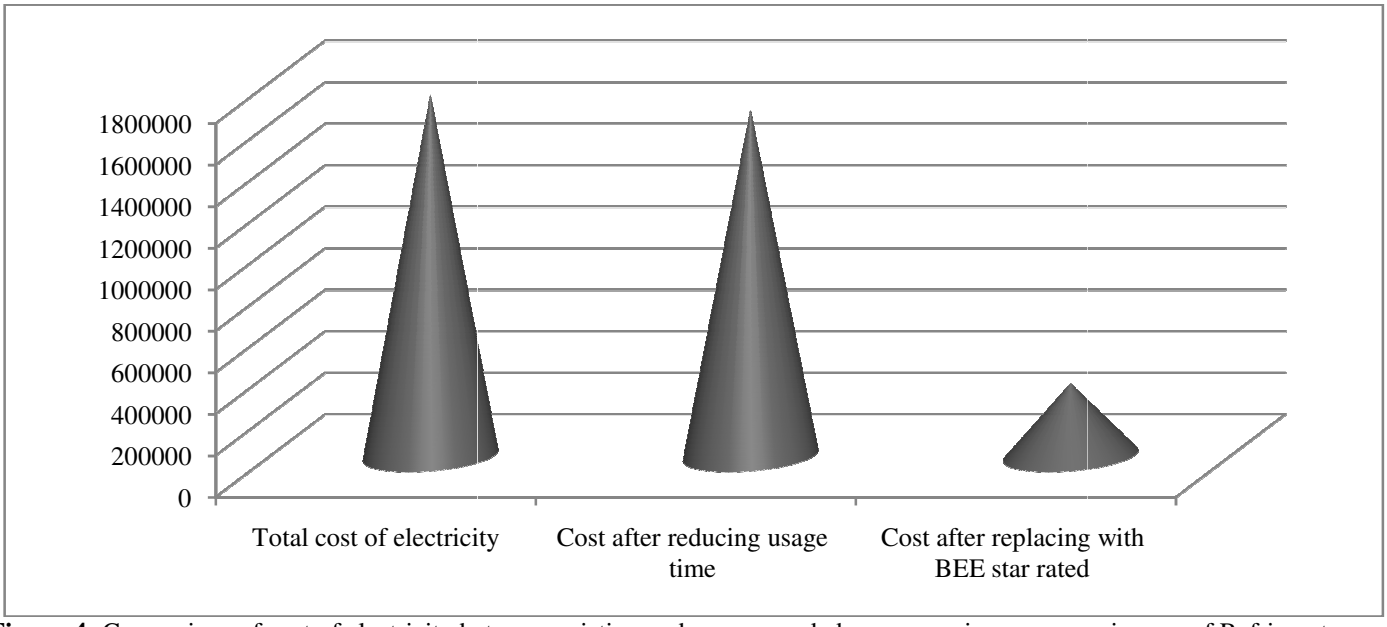


**Figure-4:** Comparison of cost of electricity between existing and recommended energy saving measures in case of Refrigerators.

**Computers:** Audit observation: If computers were used for 5 hours in a day then consumption of 10037.5 units was observed. If this usage time is reduced by 1 hour, 2007.5 units can be saved which amounts to savings of approximately 12 thousands rupees.
Total unit consumption by computer in one year= 10037.5 units
Cost for 10037.5 units is = Rs.62232.5

Total saving of unit after reduction of computer usage time = 2007.5 units
Total monetary saving of Rs = Rs.12446.5

Other method to save electricity in computers is to shut down the system properly when system is not in use instead of put it on sleep mode.

**Geyser:** Audit observation: When the usage time of geyser for a day is 8 hours then 184320 units are consumed but if this time is reduced by 1 hour, saving of 23040 units can be achieved i.e. saving of approximately Rs 1.25 lakh rupees.
Total unit consumption by geyser in six month = 1024×180=184320 units
Cost for 184320 units = Rs 1142784

Total saving of units after reduction of geyser usage time = 23040 units
Total monetary saving = Rs.142848

If normal water heater is replaced by energy efficient Heat pump water (R O Smith, Bajaj etc) of 50 ltr water capacity
Heating units = Total volume of water taken × Difference in temperature of cold and hot water × 0.0012
(1 KW is consumed by normal water heater for heating a definite quantity of water while a heat pump water heater, takes up additional 2.5 KW heat from the surroundings on the same 1 KW electricity consumed means on the same 1 KW electricity consumed by normal water heater an output of 3.5 KW is given by a heat pump water heater.)

Units for normal water heater = 50x40x0.0012 = 2.4units
(40=water temperature required minus the tap water temperature i.e. 60-20=40)
Units for heat pump water = (50x40x0.0012) ÷ 3.5 = 0.69 units
Cost of 2.4 unit=6.2×2.4=Rs.14.88
In 30 days = 14.88×30=Rs.446.4 (for regular water heater)
Cost of 0.69 unit= 6.2×0.69=Rs.4.278
In 30 days 4.278×30= Rs.128.34 (for heat pump water heater)
Difference is 446.4-128.34=Rs.318.06
Cost of regular water heater is =Rs.10,000-15000
Cost of heat pump water heater= Rs.17000-25000
Cost difference for water heater is approx.Rs.7000
Payback period for 7000Rs/-= 7000/318.06= 22 months=one year ten months.

The payback period for heat pump water heater payment is 1 year and 10 months and after that savings on electricity will be done (Energy star Rating, Bijli Bachao).

Table-2 and Figure-6 depict the comparison of units of energy consumed and saved after reducing the usage of different appliances and also the amount of money saved in the process.

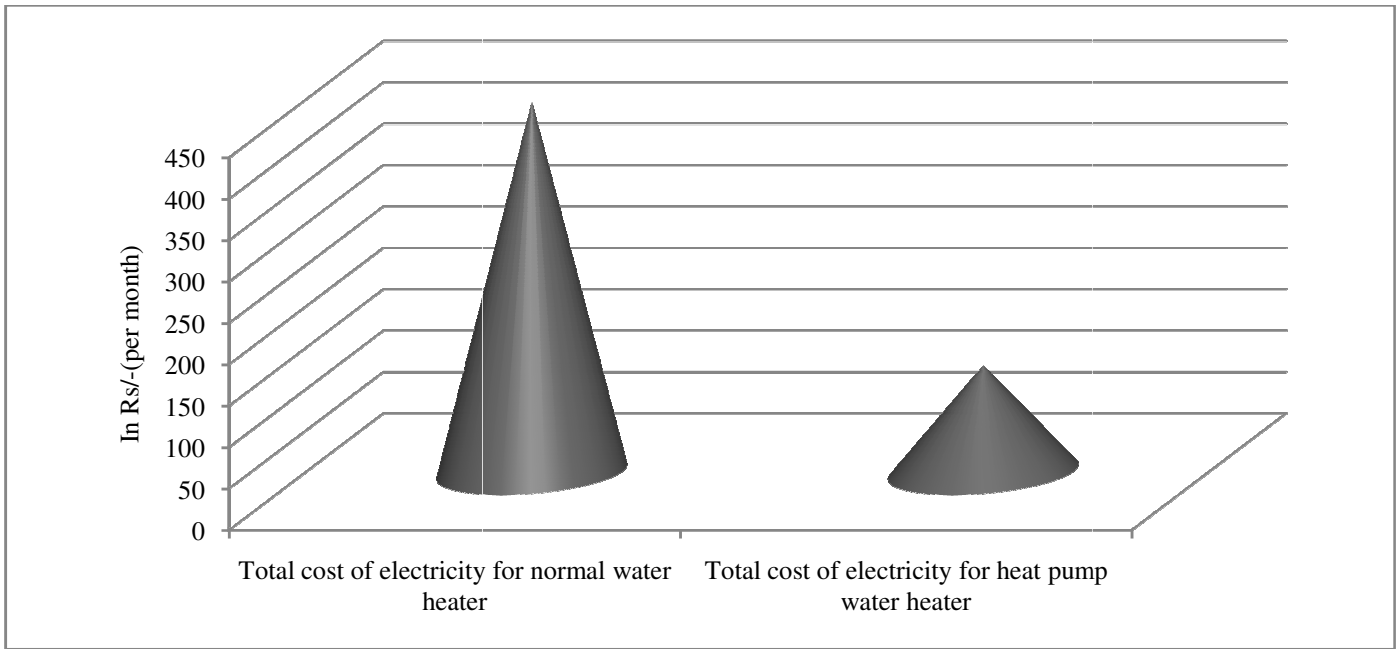


**Figure-5:** Comparison between the electricity charges between existing and recommended energy saving measures in case of Geysers.

**Table-2:** Comparison of energy consumption units and saving (Rs.) after reducing duration of different equipment usage

| Name of the equipment | Power rating (W) | Total number of equipment | Duration of usage | Total units consumed by appliances/year KWh | Total units consumed by appliances after reduction of usage time | Savings in Rs/- |
|---|---|---|---|---|---|---|
| Fan | 60 | 1415 | 8 | 166404 | 145603.5 | 128963.1 |
| Tube light | 28 | 1711 | 10 | 174864.2 | 157377.78 | 108415.8 |
| Refrigerator | 2000 | 16 | 24 | 280320 | 268640 | 72416 |
| Computers | 250 | 22 | 5 | 10037.5 | 8030 | 12446.5 |
| Geyser | 2000 | 64 | 8 | 184320 | 161280 | 142848 |

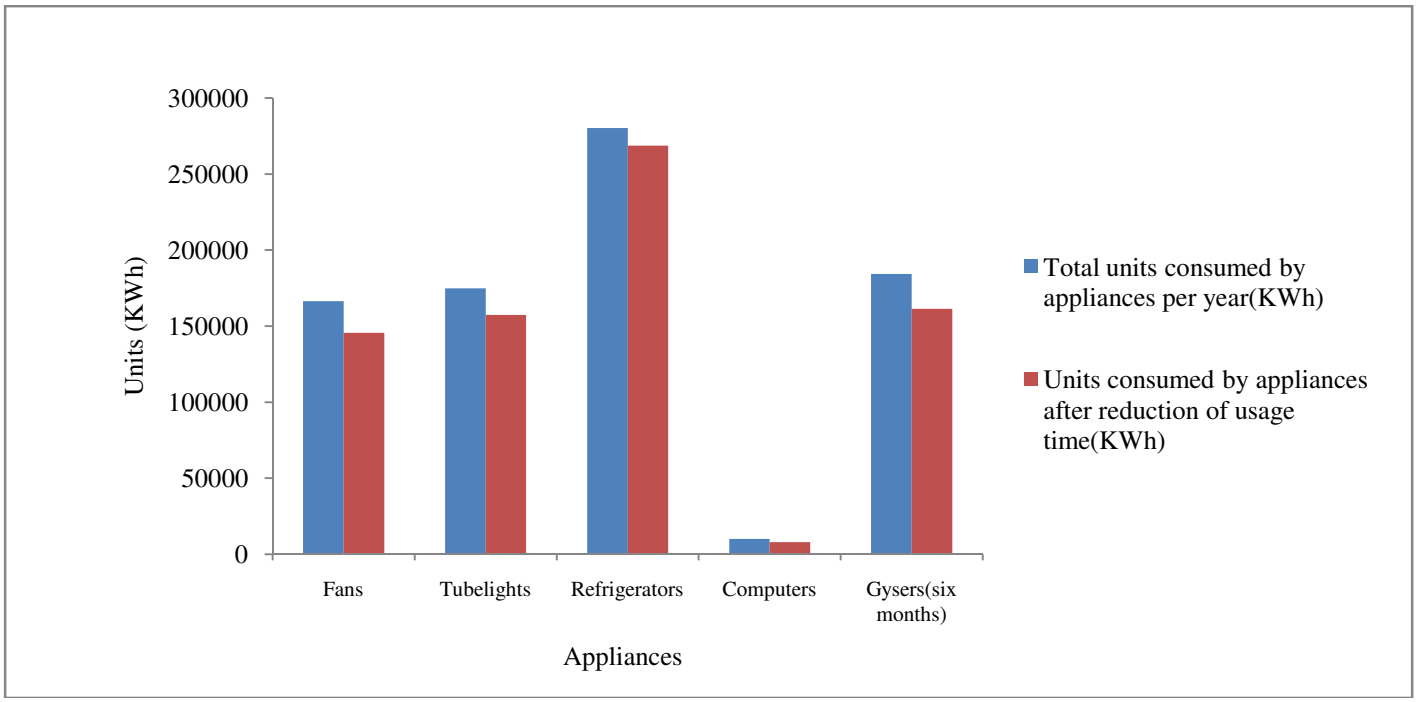


**Figure-6:** The actual units of electricity consumption and number of units consumed by reducing the usage time of appliances**.**

## Conclusion

The energy production (supply) and consumption (demand) pattern of a country not only determines whether a country is developed or developing, it also leads to some major environmental issues like depletion of natural resources, pollution/carbon emissions, desertification etc. The major reasons for increase in energy demand are rapid rise in population, luxurious style of living, improper use of electrical equipment, inadequate knowledge etc.[6].

Energy audit lowers down the power demand by conserving energy which can be achieved by implementing the suggested changes in different sectors. In this case of energy audit of hostels premises study total energy consumption of all appliances and energy conservation after suggesting energy saving measures of reducing the usage duration of appliances was estimated by energy audit. By applying the energy saving method of reducing the usage time of appliances total saving is estimated to be Rs. 4, 65,089/- per annum. Remarkable energy savings can be done by replacing the existing electrical appliances with energy efficient appliances i.e. approximately 20 lakh rupees. By adopting proper measures as suggested in the study, i.e. reducing usage time, replacements, and by making the people aware about the significance of energy conservation, the required goals of sustainable development can be achieved.

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