



A Walk-Through Energy Auditing Technique for the Government Engineering College Ambikapur

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Abstract: Energy auditing is a process used to discover energy losses in these structures. The walk-through auditing technique is used to examine the energy consumption of the Vishwavidyalaya Engineering College Ambikapur dormitory building within the academic sector. The energy audit is based on real-time energy usage measurements. The data collected during the energy audit are used to identify the energy losses of the building. The results show that the energy savings of the hostel building are higher than those of the other buildings. In addition, the energy saving of the student hostel building is also higher than that of the student's hostel building. As a consequence, as compared to energy-efficient structural designs, hostel buildings often use more energy than required.

Keywords: Energy assessment, Energy Consumption, Energy efficiency, Bill Saving.

I. INTRODUCTION

The energy crisis is a big issue around the globe today, as energy consumption is continually growing. Because of the tremendous expansion and technological breakthroughs, energy has taken center stage. Optimum energy usage is critical for every growing country. At the moment, there is a huge need for energy to fulfill the ever-increasing demand. The energy problem may be successfully handled by implementing energy conservation techniques and using energy-efficient equipment [1]. Numerous writers have shared their opinions on energy conservation via case studies, emphasizing various methodologies and energy audit systems. Soma Bhattacharya and Maureen L. Cropper [2], for example, investigated the opportunities for improving energy efficiency in India while simultaneously addressing the accompanying implementation issues. They compare India's energy efficiency to that of other nations. Biswajit Biswas, Aritra Ghosh, and Sujoy Mukherjee [3] explored an energy-saving case study on campus lighting inside an educational institution in their paper. G. Sudhakar, Kongara Ajay, T. Guru Krishna, and K. Sasank [4] conducted similar research on the approach of energy audits for residential applications. Energy consumption may be used to measure the energy effect on buildings inhabitants throughout various seasons. As a result, operations like building design and analysis, which guarantee optimum facility utilization, should not be overlooked. The overall electricity usage in university campus dormitories was determined by the authors. The authors have proposed solutions and encouraged energy conservation techniques in order to decrease energy waste and increase the usage of renewable energy sources [5]. At Chandigarh University in Gharuan Mohali, an electrical audit was performed using power system analysis software. The goal was to suggest optimum energy use while minimizing power losses [6]. Existing research, however, shows that there is a somewhat lower degree of knowledge about energy saving measures in the service sectors, such as office buildings, hostels, supermarkets, and hotels, as compared to the industrial sector [7], [8]. There is a higher focus in the industrial sector on keeping a complete database for energy use. Research done in Stuttgart, Germany, discovered that the Energy Use Intensity (EUI) for heating energy use in educational institutions was 93, excluding energy consumption from lighting and instructional equipment [9]. School buildings account for 10.8% of total power usage in buildings in the United States, behind only offices (20.4%) and retail buildings and malls (20.4%) [10]. Research undertaken in Stuttgart, Germany, found similar results. The research looked at 105 school buildings and found that newer facilities followed different building codes, especially when it came to heat transferability. As a consequence, as compared to older structures, new buildings have lower energy use intensity (EUI) ratings. Numerous attempts have recently been undertaken to improve energy efficiency, including programs such as building disclosures [12]. In Finland, a unique technique for estimating energy demand has been proposed and tested, primarily addressing the issues given by heterogeneity in building energy modeling. To improve accuracy, the system utilizes field measurements [13]. Policies and regulatory frameworks resulting from thorough facility energy audits raise public knowledge about energy management and the reduction of energy losses [14]. Various well-known numerical simulation programs, including Dest, Energy Plus, and DOE-2, may be used to study the energy performance of buildings. These tools allow for the building of architectural models as well as the modification of input circumstances to match simulation results with observed energy usage. Following that, these simulations may be used for a comprehensive examination [15]. The energy audit process, according to Woo and Moore, consists of three major stages: (i) performing a preliminary assessment of facilities; (ii) gathering pertinent data; and (iii) evaluating and inferring the data to present proposed solutions [16]. Roberts et al. investigated the influence

of energy restrictions led by an Energy Savings Opportunity Scheme (ESOS) energy audit and discovered changes in residents' behavior when provided cost-cutting incentives [17]. In their work, Gousia Sultana and Harsha H.U. [18] explored the technology and implementation of electrical energy audits in college institutes. Furthermore, they emphasized the advantages of low-energy sustainable buildings, often known as green buildings, as not only helpful for business but also a source of diverse job prospects [19]. By October 2019, the average technical energy efficiency potential for the 111 industrial businesses that have submitted audits to the program was 6.35%. However, if flaws in the audit program's execution are addressed, the genuine potential may be greater (e.g., for certain organizations, the detected technical potential was up to 40%). [21]. This research investigates the advantages of combining metered heat demand data with detailed building typology to allocate rehabilitation subsidies effectively. We calculate the missing CO₂ emissions as a result of mistakes in heat demand estimations and create an optimization model to calculate the effect of such inaccuracies on subsidy distribution. [22].

Table 1. Comparison of reference paper to justify the novelty of research work

Sr. No.	Topic Name	Author Name	Journal Name	Comparing
01	Energy Audit: A Case Study of an Engineering Building	Mhaske Somnath, Jagtap Swapnil, Jadhav Vikas, Prof. Paval K.L. S	IJERT, ISSN: 2278-0181, Vol. 8 Issue 05, May-2019	This study does not illustrate how to compute lumens, room size, ventilation, or windows. This paper tube or light bulb has been changed. The power usage does not reveal the corridor's electrical use.
02	Energy Audit: A Case Study of an Academic Building	TAKSHASHILA BHANDARI, A.G. THOSAR, M.R. BACHAWAD, PANKAJ BHAKRE	International Journal of Industrial Electronics and Electrical Engineering, ISSN: 2347-6982 Volume-4, Issue-11, Nov.-2016	A copy of the power bill was not attached to this page to demonstrate how much the bill was in which month. There is no mention of solar energy.
03	Energy Audit-A Case Study	Ranadip Roy, Senior Lecturer SETGOI, Durgapur, India.	IJSEC, DOI 10.4010/2016.1700 ISSN 2321 3361 © 2016 IJESC. Volume 6 Issue No. 6	There are no bar graphs or pie chart figures in this document. There is no reference to solar energy. There is also no information on how much money is saved each year. The monthly electricity payment is also not included.

II. Problem Statement

In India, there are several types of construction, including dorms and hotels. These constructions suffer from various sorts of energy loss, and some are recognized to have low energy efficiency ratings. Energy auditing is a process used to discover energy losses in these structures. The Walk-through auditing technique will be utilized to calculate different parameters. It is important to note that many buildings in India are not subject to energy audits. Energy auditing provides opportunities to reduce energy expenses by simply locating other energy sources or equipment. The goal of an energy audit is to increase energy savings by designing, altering, and adopting contemporary equipment. Energy audits have the potential to save money in the long term. They are used to identify possible areas for power consumption reduction. An energy audit may be used to examine buildings, facilities, or businesses to identify areas of energy waste and energy-saving solutions. The primary goal of energy conservation is to minimize the cost of electrical energy while limiting its environmental impact and enhancing overall efficiency. An energy audit's purpose is to save energy while minimizing disruptions to the environment and people's well-being.

III. Methodology

Surveying of VEC, Hostel building

The Vishwavidyalaya Engineering College hostel building is located at North 23°10'9.4404 and East 23° The Vishwavidyalaya Engineering College hostel building is located at 23° 10' 9.4404 and 23° 10' 52.7412. The total space occupied by all departments, including the library and practical labs, is 1080 square meters. According to the latitude and longitude of the Ambikapur site, solar ray availability is high in the summer and moderate the rest of the year. Maximum sun rays arise from the north-east and descend to the south-west. Based on the arrangement, the electrical load may be divided into lights, motors, and other devices such as computers, printers, and similar equipment.

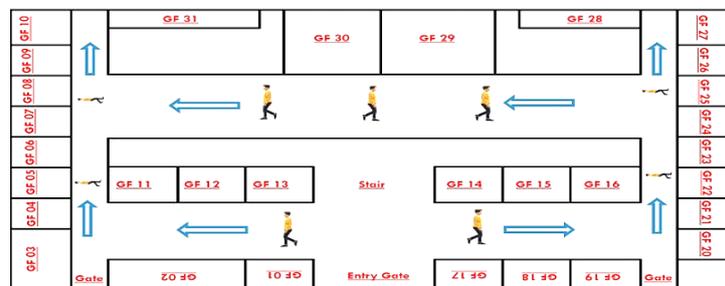


Fig. 1. Ground Floor Plan Plan

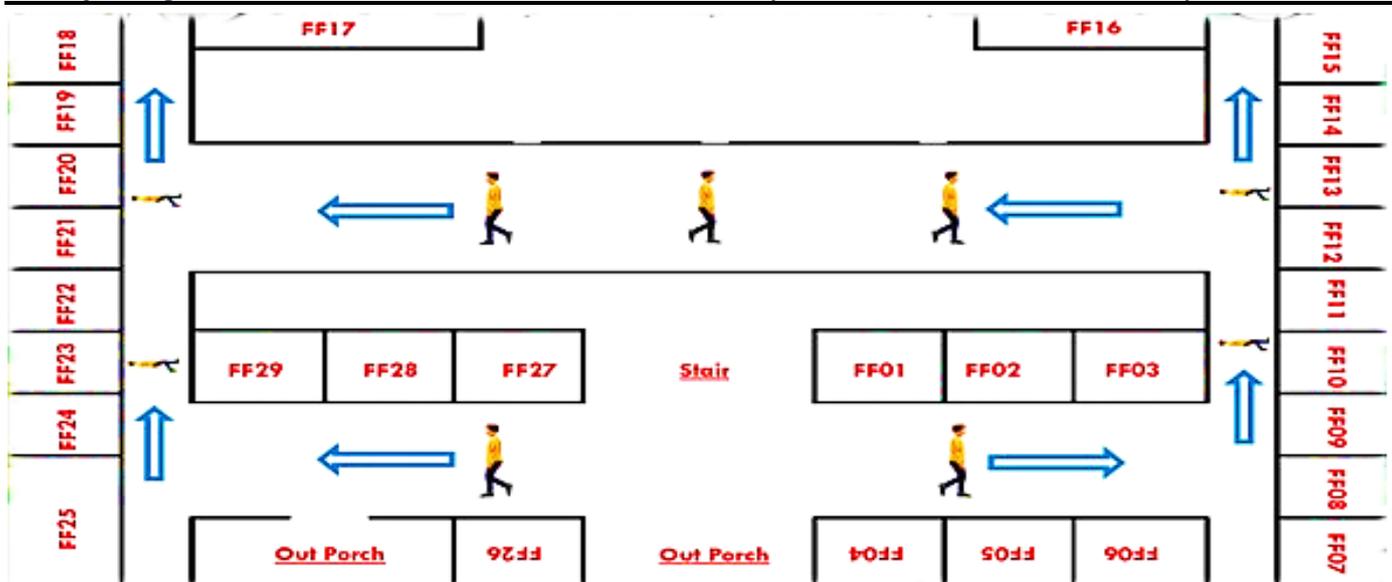


Fig. 2. First Floor Plan

1. Walk Through Audit

This audit primarily involves a visual inspection conducted by the energy auditor. While this kind of audit provides an overview of the information, it may not provide detailed insights until the auditing process is completed.

2. Mini Audit

An energy audit entails the inspector doing different tests and measurements while using particular tools, gadgets, and equipment to quantify energy usage and losses. It does, however, have a restricted scope. This sort of audit lasts more than a walk-through audit but less than a MAXI Audit.

3. Maxi Audit

This widely used kind of energy audit has a broad scope since it covers the whole industry, taking into account all areas where energy is used. It provides a comprehensive assessment of energy use and efficiency throughout the whole enterprise.

There are three steps to the energy audit:

Phase of Pre-Audit

- Analysis or study of the place to be audited.
- Talk about the guidelines and financial strength.
- Collect all relevant facts on main energy usage.
- Make a site sketch.

Actual Audit Phase

The duration of a detailed energy audit depends on the specific site, plant, or industry being assessed. The complexity and size of the facility, along with the availability of relevant data, influence the time required to complete the audit.

- Primary data investigation.
The process flow diagram and energy utility diagram are thoroughly examined during the energy audit.

Post Audit Phase

- Manage to control the efficiency if performance tends to reduce.
- Periodically review the performance of all system.

Data Collection

Data collection plays a crucial role in the energy audit process. It involves gathering various types of information, including:

- It is critical to acquire relevant information, such as power bills for the fiscal year 2022–23, during the data gathering phase of an energy audit.
- List of lighting loads such as bulbs, tube lights, fans, computers, and air conditioners (AC) for each department.
- Each feeder measures voltage, current, and power.

Data Analysis

The next critical phase in the energy audit process is data analysis, which comes after data gathering. The collected data is thoroughly evaluated during this phase to identify areas for implementation and possible chances for energy reduction.

Action taken

The steps conducted as part of the energy audit process include developing strategies based on real-time energy usage measurements.

We used the Walk-through audit approach to inspect the Vishwavidyalaya Engineering College hostel building. Once familiar with the structure, the walk-through procedure becomes reasonably simple, especially when precise drawings and other basic material detailing the structure and its functions are available. The procedure might begin with a walk around the building to assess the building envelope. Wall color, outside sun-shading devices, and window screens are among the architectural components being investigated. If the research includes a model analysis, the building is split into analysis zones. The interior audit entails ensuring that the air-conditioning system meets requirements and recording any alterations or additions. The interior audit consists of ensuring that the air-conditioning system meets standards and recording any changes or additions.

IV. Results & Discussion

Table 2 displays the connected load of the Hostel building and its KW rating. This table is used to calculate energy consumption and utilization.

Table 2. Electrical Load

	Place	Bulb Load	Tube light Load	Fan Load	AC Load	Computer Load
01	Mechanical Engg. Dept.	16	08	16	00	11
02	Electrical Engg. Dept.	06	03	06	00	04
03	Civil Engg. Dept.	06	03	06	00	04
04	Computer Science Engg. Dept.	06	03	06	00	05
05	Mining Dept.	04	02	04	00	03
06	Exam Section	02	01	02	00	02
07	Library	04	02	04	00	00
08	Student Section	02	01	02	00	01
09	Basics Science Dept.	04	02	04	00	04
10	Principal Office	12	06	10	01	11
11	Classroom (B. Tech, M. Tech & PhD)	30	15	32	00	01
12	Conference Hall	10	10	05	01	00
13	Chemistry Lab	02	02	02	00	00
14	Miscellaneous Room	16	16	16	00	00
15	Computer Lab	02	02	02	00	10
16	Hospitality	02	02	02	00	00
17	Washroom	08	08	00	00	00
18	GF Corridor	40	40	00	00	00
19	FF Corridor	33	33	00	00	00
	Total	205	59	119	02	56
	Total KW rating	$205 \times 09 / 1000 = 1.845 \text{ KW}$	$59 \times 15 / 1000 = 0.885 \text{ KW}$	$119 \times 100 / 100 = 119 \text{ KW}$	$02 \times 1500 / 1000 = 3 \text{ KW}$	$56 \times 70 / 1000 = 3.92 \text{ KW}$

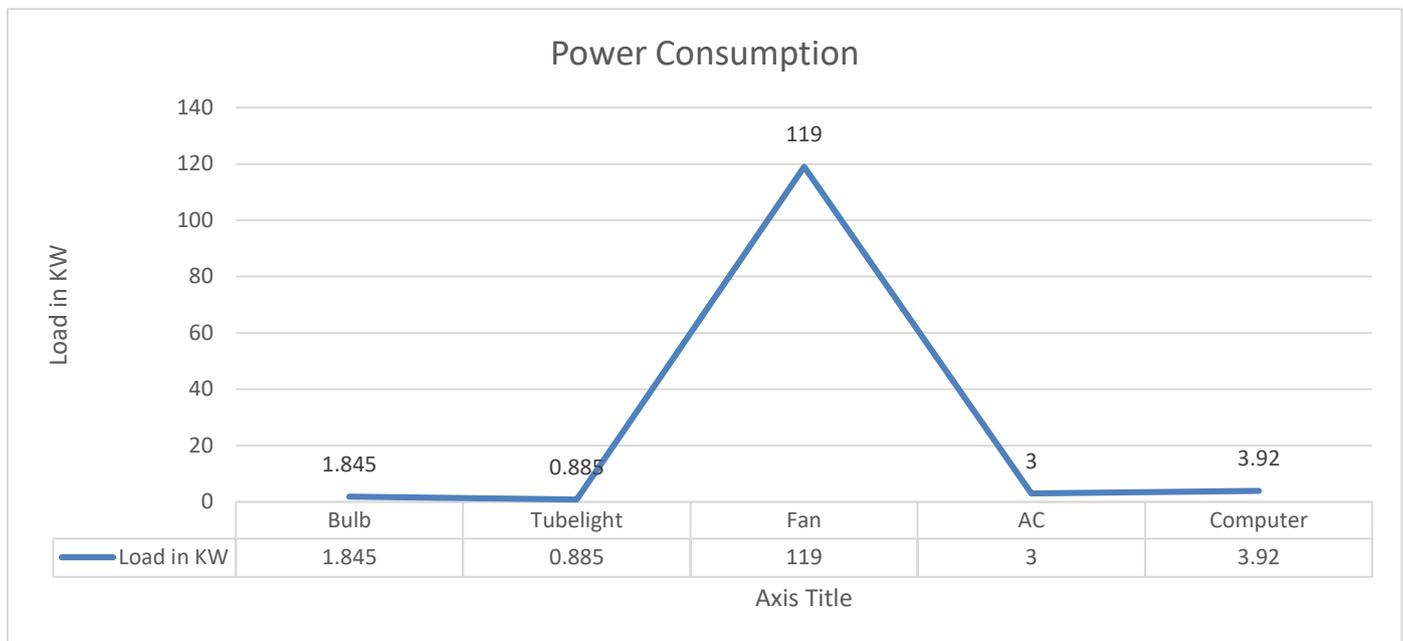


Fig. 3. Load the Line Graph

The Load Line graph in Fig. 3 clearly shows that the loads that occupied the most connected slots are the Fan and Computer loads. Because the fan is always operating in the summer, the fan load may have a significant influence on energy usage. As a result, each department's electrical demand is calculated in the KW table above. More bulbs are utilized in the GF and FF corridors. To lower the hostel building's electrical bills.

The bulb load uses 1.845 KW. Because the majority of the hostel does not get enough sunshine throughout the day, constant illumination is necessary during working hours. The cumulative illumination (bulb) energy consumption in kilowatt-hours (kWh) is calculated for a 7-hour daily operation. As a result, the overall energy consumption as a result of the lighting load is as follows:

Duration of light usage in a year, excluding Sundays

= 7 hrs. X 317 days

= 2219 hrs.

Total energy consumed = 1.845 X 2219 hrs.

= 4094.055 kWh.

0.885 KW is used by the tube light load. The total tube light load in kWh is calculated for 7 hours each day. As a result, the overall energy consumption via tube light load is as follows:

Tube load in one year, omitting Sundays.

= 7 hrs. X 317 days

= 2219 hrs.

The total amount of energy used = 0.885 X 2219 hrs.

= 1963.815 kWh.

The institute's fan load is another large energy user, with 119 fans each requiring 100 watts. The total fan load is 119 kW. Despite the increased fan load when compared to the lighting load, the effect on the power cost is relatively minor since fans are not necessary during the cold and wet seasons. The entire energy consumption of the fan load may be calculated in kilowatt-hours (kWh):

Fan use throughout the year (12 months), excluding Sundays.

= 7 hrs. X 121 (Summer lasts four months) + 4 hrs. X 192 (Winter months with rain).

= 1615 hrs.

The fan load in one year is 119 X 1615 hrs.

= 192185 kWh.

Computer and AC loads can greatly contribute to energy usage. The total alternating current load is 3 kWh. There are 56 computers in total; however, not all of them are functioning during the working day. They are normally utilized for just a few hours each day for practical training or formal work.

The overall computer load is calculated as follows:

Annual computer usage, excluding Sundays.

= 5 hrs. X 317 days

= 1585 hrs.

The total amount of energy used = 3.92 X 1585

= 6213.2 kWh.

Only during the warmer months do air conditioners use more electricity. The overall AC load consumes 3 kW of electricity. The total amount of energy used

The yearly period of air conditioning consumption, excluding Sundays

= 5 hrs. X 182

= 910 hrs.

Total amount of energy used. = 03 X 910
= 2730 kWh.

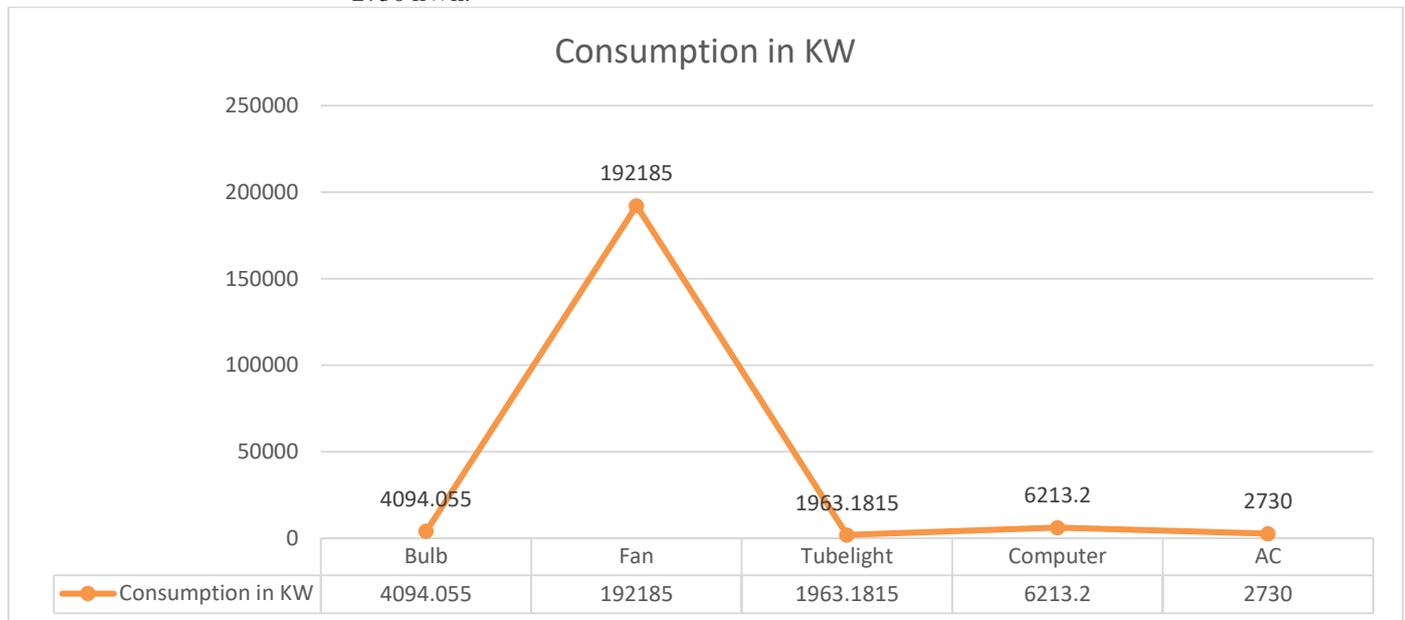


Fig. 4. Line Graph of Energy Consumption

The energy consumption line graph in Fig. 4 clearly reveals that the loads with the highest total energy consumption are the fan, computer, and AC. Total energy usage may have a substantial influence since fans will be running continuously throughout the hot day. It is done in order to decrease unnecessary energy use as well as the power expenses of the hostel building.

Now how to decide what wattage of a led bulb is required to light a room.
First of all, we are finding Lumen in a specified area (classroom).

1W= 100 Lumen

For 1 room

Area = 2.601 square meter

Lux = 500

Lumen = 2.601 * 500
=1300.05 Lumen

1W= 100 Lumen

$$= \frac{1300.05}{100}$$

= 13.005 W

$$\text{Lux} = \text{Lumen} * \text{Area}$$

Table 3. 18 (9X2) W and 12W comparison

Space Classification	Existing Light Bulb	Total Area	12 W is required.	Bulb Difference	Wattage savings
Classroom with all Dept.	196	1203.32	98	98	588
Conference Hall	10	6.131	06	04	30
Total	206	1209.451	104	102	618

During the data gathering and analysis procedure, it was discovered that the following places need a greater number of supplementary lighting stands: Table 2 provides the needed and actual amount of Bulb Watts for each location.

Replace 18 (9 X2) W bulb by 12 W

Existing Bulb Wattage = 18 Watt.

Duration of bulb usage in a year, excluding Sundays.

= 7 hrs. X 317 days.

= 2219 hrs.

Total no. of Bulb = 206

The overall energy consumption = 206 X 18 X 2219

= 8228052

= 8228.052 kWh.

Wattage of required 12 W
 Difference in Wattage of Bulb
 = (18 – 12) W
 = 6 W

The overall energy consumption amounts to 12 watts
 = 12 X 2219 X 104
 = 2769312
 = 2769.312 kWh

Difference in energy consumption
 = 8228.052 – 2769.312
 = 5458.74 kWh.

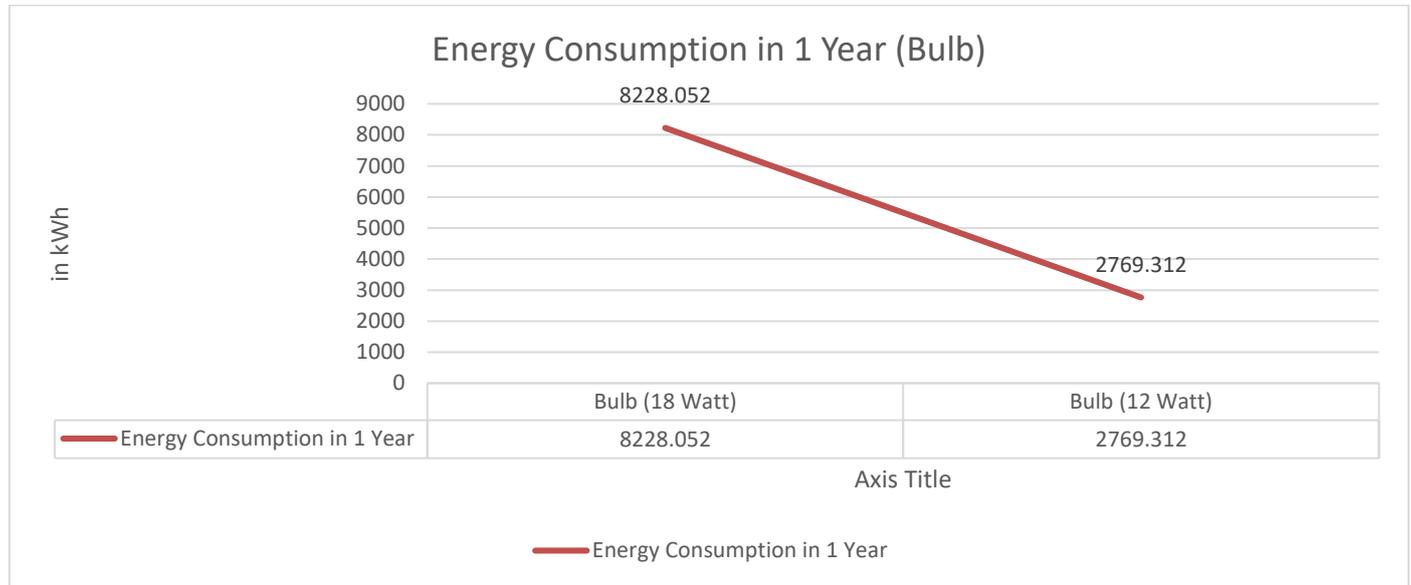


Fig. 5. Total energy consumption between 18 W and 12 W in kWh

According to the line graph of energy consumption between 18W and 12W shown in Fig. 5, the wattage of the existing bulb (18 watt) consumes electricity 8228.052 kWh in a year excluding Sundays, and the wattage of the required 12-watt bulb consumes electricity 2769.312 kWh in a year excluding Sundays. As a result, the energy difference is 5458.74 kWh.

Saving Energy Bill

Cost/ Unit @ Rs 7.29 (1 unit = 1 kWh)

= 5458.74 kWh X 7.29 Rs

= 39794.2146 Rs/Annum.

Cost of (9 X 2 = 18 W) bulb = 100 X 2 Rs/ Bulb

18 W Bulb = 200 Rs

Cost of One 12Watt Bulb = 120 Rs.

Cost of Total 104, 12Watt bulb

= 104 X 120

= Rs 12,480.

Table 4. 100 watts vs. 75 watts

Space Classification	Existing Light Bulb	Total Area	12 W is required	Bulb Difference	Wattage savings
Classroom with all Dept.	196	1203.32	98	98	588
Conference Hall	10	6.131	06	04	30
Total	206	1209.451	104	102	618

During the data collection and processing procedure, it was discovered that specific locations employ more powerful fans. Table 3 shows the current fan wattage as well as the 75-watt fans that are suggested for particular regions.

Replace a 100W fan with a 75W fan.

Existing Fan Wattage = 100 Watt.

Duration of Fan usage in a year, excluding Sundays.

= 7 hrs. X 121 (Summer lasts four months.) + 4 hrs. X 192 (Winter and rainy seasons)

= 1615 hrs.

Total no. of Fan = 119

The overall energy consumption = 119 X 100W X 1615hrs

= 19218500

= 19218.5 kWh

The needed wattage is 75 W.

Difference in Wattage of Fan

$$= (100 - 75) \text{ W}$$

$$= 25 \text{ W}$$

The overall energy consumption amounts to 75 watts

$$= 119 \times 75 \text{ W} \times 1615 \text{ hrs}$$

$$= 14413875$$

$$= 14413.875 \text{ kWh}$$

Difference in energy consumption

$$= 19218.5 - 14413.875$$

$$= 4717.625 \text{ kWh}$$

**Ventilated and Window is presence in every room. There is no general method in the work to design the wattage of fan. A common modelling of the loads will be helpful in determining the actual requirement of Fan as per IE rules. We generally use between 50-100 Watt of fan in room for all type of purpose.

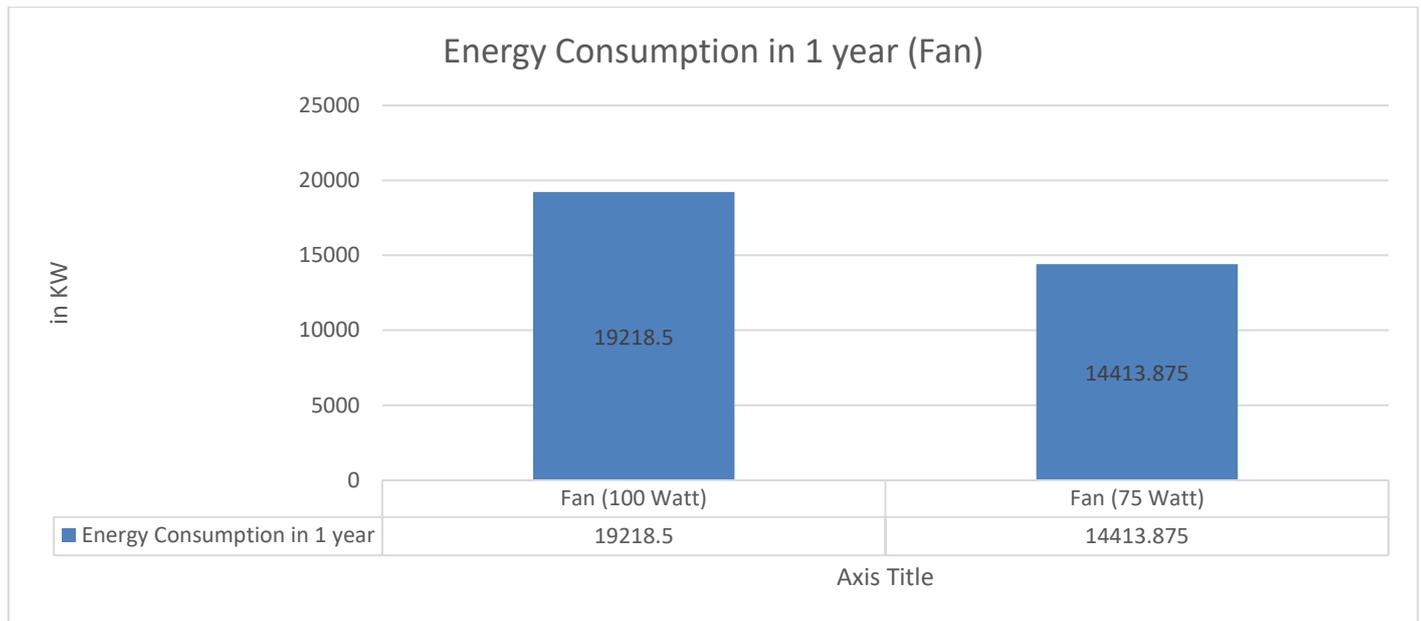


Fig. 6. Total Energy Consumption between 100 W and 75W in kWh

According to the Bar graph of energy consumption between 100W and 75W in Fig. 6, the wattage of the existing fan 100 watt consumes electricity 19218.5 kWh in a year excluding Sundays (summer, wet, and winter months), and the wattage of the required 75-watt fan consumes electricity 14413.875 kWh in a year excluding Sundays. As a result, the energy difference is 4717.625 kWh.

Saving Energy Bill

Cost/ Unit @ Rs 7.29 (1 unit = 1 kWh)

$$= 19218.5 \text{ kWh} \times 7.29 \text{ Rs}$$

$$= 140102.86 \text{ Rs/Annum.}$$

75Watt Fan

Cost/ Unit @ Rs 7.29 (1 unit = 1 kWh)

$$= 14413.875 \text{ kWh} \times 7.29 \text{ Rs}$$

$$= 105077.14 \text{ Rs/Annum.}$$

Difference in Saving Electricity Bill

$$= (140102.86 - 105077.14) \text{ Rs/Annum}$$

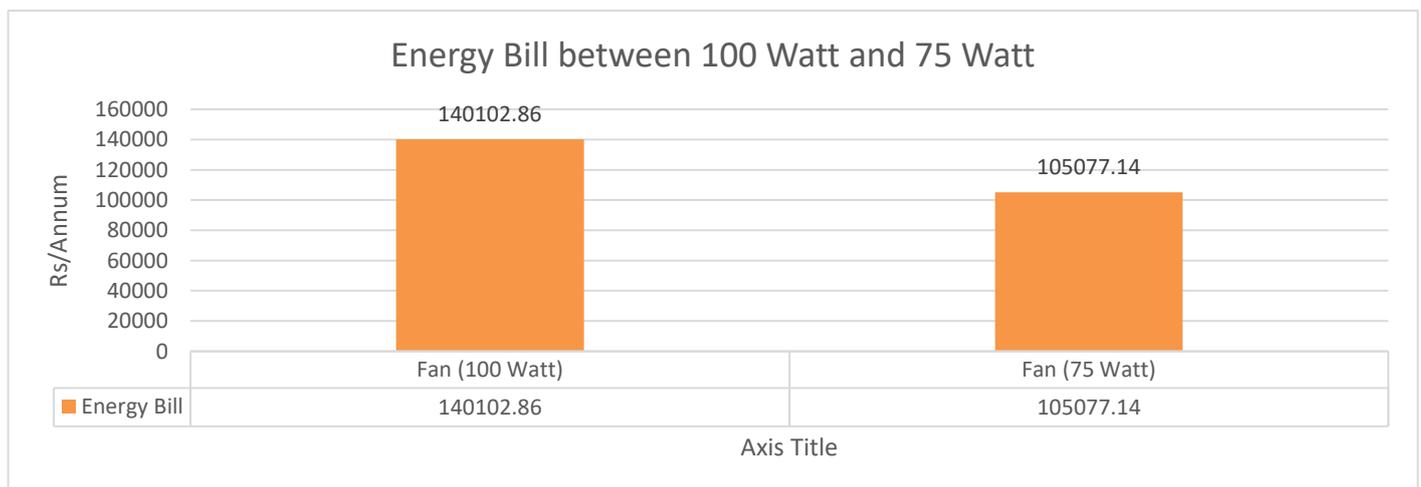


Fig. 7. Energy cost savings between a 100W fan and a 75W fan.

According to the Bar graph in Fig. 7, the wattage of the present fan's 100-watt energy bill is 140102.86 rupees per year excluding Sundays, and the needed 75-watt fan's electricity bill is 105077.14 rupees per year excluding Sundays. So, the annual savings on electricity are 35025.72 rupees.

Table 4. Monthly Electricity bill

Bill Month	Date of Issue	Current Reading	Previous Reading	Consumption	Energy Charge	Fixed Charge	Duty	Cess	Meter Rent	LT/WT	FCA	Additional SD	Rebate	Misc Charge	Average Adjustment	Previous Arrears	Demand Adjustment	Surcharge	Net Bill
Mar-2023	19-Apr-2023	754	733	630	3317.00	1850.00	0.00	0.00	0.00	0.00	491.40	0.00	0.00	0.00	-4.30	75.90	0.00	0.00	5730
Feb-2023	17-Mar-2023	733	716	510	2513.00	1850.00	0.00	0.00	0.00	0.00	397.80	0.00	0.00	0.00	-4.43	3.63	0.00	0.00	4760
Jan-2023	18-Feb-2023	716	700	480	2324.00	1850.00	0.00	0.00	0.00	0.00	528.00	0.00	0.00	0.00	5.63	10722.79	0.00	160.84	15590
Dec-2022	18-Jan-2023	700	661	1170	7583.00	1850.00	0.00	0.00	0.00	0.00	1287.00	0.00	0.00	0.00	-2.79	2.79	0.00	0.00	10720
Nov-2022	18-Dec-2022	661	637	720	4028.00	1850.00	0.00	0.00	0.00	0.00	439.20	0.00	0.00	0.00	8.02	0.82	0.00	0.00	6320
Oct-2022	15-Nov-2022	637	613	720	4028.00	1850.00	0.00	0.00	0.00	0.00	439.20	0.00	0.00	0.00	-3.12	12862.98	0.00	192.94	19370
Sep-2022	17-Oct-2022	613	459	4620	8767.00	3700.00	0.00	0.00	0.00	0.00	2409.00	0.00	0.00	0.00	-2.98	-2013.02	0.00	0.00	12860

Table 4 shows the power use, energy and fixed charges, meter rent, previous arrears, and net bill for the period September 2022 to March 2023. We established assumptions about the electricity bill, energy, and fixed fee based on this table. It is obvious that a bill was received today, and our goal is to reduce the net amount by doing an energy audit.

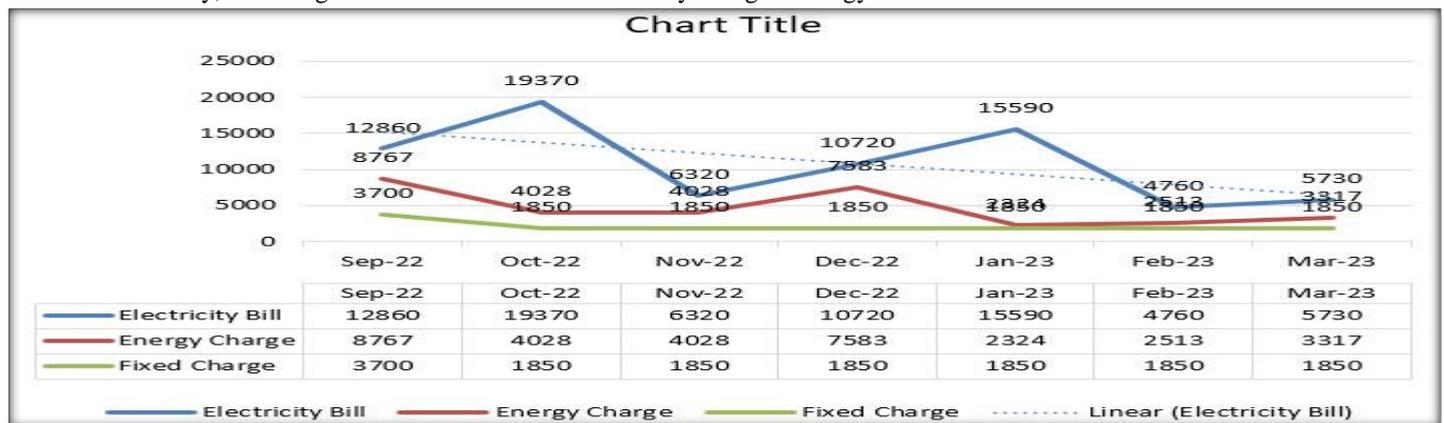


Fig. 8. Shows electricity bill, Energy & Fixed charge.

The Line Chart in Figure 8 depicts the variations in Electricity Bill, Energy, and Fixed Charge data from September 2022 to March 2023. It is obvious that a large number of invoices were received in October 2022, followed by a seven-month record in January 2023. The blue line represents the power bill, while the dotted blue line represents the energy charge. The energy charge is highlighted in red in the graphic depiction, while the fixed charge is represented by a green line.

V. Conclusions

An energy audit is a useful tool for finding problems with energy management strategies. Organizations may improve their energy systems and save on energy expenditures by conducting a walk-through energy audit. These audits are very important for society as a whole. Unfortunately, many buildings, businesses, and rooms are not constructed with energy-efficient lighting systems in mind. As a consequence, as compared to energy-efficient structural designs, hostel buildings often use more energy than required. In this study, we concentrated on the energy audit and energy conservation of the Vishwavidyalaya Engineering College Ambikapur dormitory building within the academic sector. We decided that the fan load uses more energy than other linked loads after recording the load distribution in the hostel building and evaluating the load pie chart. After lumen calculated, 27693.12 W is necessary to Vishwavidyalaya Engineering College hostel building for led bulb.

We recommended replacing 100-watt fans with 75-watt fans and 18 (9 X 2)-watt lights with 12-watt bulbs as part of our suggestions. The whole analysis concludes that

1. The total number of units saved in bulb replacement will be 5458.74 kWh, while the fan will save 4717.625 kWh.
2. We would save 39794.21 rupees a year if we replaced the light with a 12 W bulb. The bulb replacement will save 5458.74 kWh, while the fan will save 4717.625 kWh.
3. If we replaced the fan with 75 W, we would save 4717.65 Rs each year.

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