R. L. TAWDE FOUNDATIONS
SAROJINI COLLEGE OF PHARMACY, KOLHAPUR

Energy Audit Report

Prepared by

Department of Environmental Science,

Shivaji University, Kolhapur- 416004

2022-23

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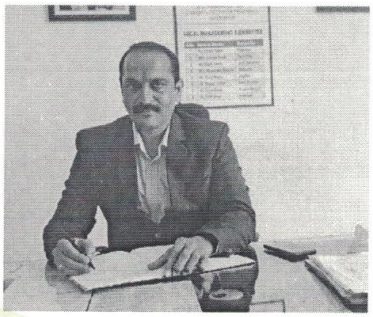
Principal Message



Today the universe is facing problem like global warming, deforestation. There are several aspects responsible for climate change. Safe drinking water scarcity, drought, flood are hot cake now a days. All these environmental issues are only discussed, at the global level but the true fact is that regional and local activities are responsible to make such issues global.

In the dire need to protect our planet from environmental pollution, it is the responsibility of everyone not to contribute activities which may harm the environment. College is the entity where students, faculty and staff gather every day to run teaching and learning process. This process require use of infrastructure, energy, water, chemical and support facilities. College has to look after optimum and economical use of these things. It is necessary to conserve the energy by non-traditional source also it is necessary to avoid entry of monoxide and other gaseous pollutants in the environment. Scarcity of water and its pollution are the hot topics. We must save the available water and keep it free from pollution. The waste generated through laboratories, kitchen of hostel must be properly treated and disposed off. Campus must be clean and green to have pleasant atmosphere for the teaching learning process. We must take maximum efforts towards carbon neutrality. In this direction along with plantation, origination of other of other nature related activities and creation of awareness among the peoples is necessary.

In this direction to be environmentally conscious, it is necessary that every college must undertake green audit of the premises and facilities. I am very happy to state that department of environmental science, Shivaji University Kolhapur under the guidance of green audit team and they have conducted the green audit of our college vey keenly. their suggestions are certainly helpful for us for the improvement.

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Certificate

This is to certify that the Department of Environmental Science, Shivaji University, Kolhapur has conducted detailed "Energy Audit" of "R. L. Tawde foundation's Sarojini College of Pharmacy, Kolhapur" during the academic year 2022-2023. The Energy audit was conducted in accordance with the applicable standards prescribed by 'Bureau of Energy Efficiency, Government of India'. Their audit involve code compliance, operations, maintenance, occupancy, and building systems etc and gives an 'Energy Management Plan', which the institute can follow to minimize impact on the institutional working framework. The analysis was based on a review of the rules governing energy efficiency and conservation, on data analysis, and on the findings of survey with key personnel in the campus's administrative management. The performance of college was found to have good quality even though some important aspects like increasing the use of solar energy and energy efficient equipments are to be considered seriously. In an opinion and to the best of our information and according to the information given to us, said Energy audit gives a true and fair view in conformity with energy auditing principles accepted in India.

Department of Environmental Science Shivaji University Kolhapur

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Chapter I

Introduction

1.1 Energy Audit, a Tool for Environmental Protection and Conservation

An energy audit is a survey that looks at how an organization uses its energy and looks for ways to conserve it. It refers to a method or system designed to lower the organization's energy consumption without lowering output. The audit offers recommendations for additional strategies and techniques for maximizing energy savings. Traditionally, fossil fuels, water, and wind have been used to produce electrical energy. The abundance of fossil fuels and their rates of depletion reinforce the need for alternative energy sources and electric energy conservation. Offering goods or services at the lowest cost and with the least degree of environmental damage is often the main goal of an energy audit and the control of energy consumption (Backlund and Thollander, 2015). Energy audits are required to identify areas for improvement, cost-saving opportunities, understand how fuel is used, where waste occurs, and identify potential savings.

An energy audit is suggested and carried out to ensure that energy-saving methods are adopted and followed in educational institutions and industrial sectors in a sustainable manner. The audit process includes the creation and completion of a questionnaire, a physical inspection of the campus, the observation and analysis of paperwork, key person interviews, data analysis, measurements, and suggestions. Energy audits consider a variety of information, such as potential energy savings, energy management, alternative research, etc. In 2010 (Cabrera *et al*.), given these details, the audit's specific goals were to evaluate the departments' adherence to relevant laws, policies, and standards, as well as the effectiveness of the sustainability management and control system. It has the ability to have a major impact on both the environmental impact and the organization's operational costs (Singh *et al*., 2012).

The Energy Conservation Building Code (ECBC), introduced in 2017, establishes minimal standards for the design and construction of energy-efficient buildings throughout India. Additionally, it offers two extra sets of incremental specifications that buildings must meet in order to reach higher than necessary levels of energy efficiency (Gnanamangai *et al*., 2021).In an effort to adopt energy-saving procedures in an organisation, the Bureau of Energy Efficiency (BEE) was established in 2002. Affixed to manufactured goods, energy-efficiency labels provide information on the products' energy efficiency (Ingle, 2014). In order to speed up energy efficiency efforts, BEE has created a system for labelling buildings' energy efficiency that corresponds with their star ratings. The BEE Star Rating Scheme is

based on the real performance of the building and equipment in terms of specific energy usage, or "Energy Performance Indicator," by using star ratings to designate products that will be helpful for energy savings in a sustainable manner (Mishraand and Patel, 2016).

Maintaining focus on energy price changes, energy supply availability and efficiency, choosing a suitable energy mix, identifying energy-saving technology, retrofitting for energy-saving equipment, and other issues is made easier with the help of energy audit programs. In general, an energy audit procedure focuses on implementing conservation concepts by providing technically feasible solutions within a set time frame while also considering organizational, financial, and other challenges (Asnani and Bhawana, 2015).It also covered finding ways to save money by lowering operating costs or the amount of energy used for every unit of output. It acts as a "benchmark" (reference point) for energy management in the business to design more energy-efficient use all around (Cabrera *et al*., 2010).

1.2. Need for an Energy

Audit Energy (both electrical and thermal), labor, and materials are frequently determined to be the top three running costs in every organization. In each of the aforementioned components, energy would invariably rank as the highest manageable cost or potential cost saver, making the function of managing energy a significant area for cost cutting. Understanding how energy and fuel are used in various industries will be made easier with the aid of an energy audit, which will also point up potential wasteful practices and areas for development. The energy audit would provide a helpful direction for programs that are essential for production and utility activities, such as reducing energy costs, preventative maintenance, and quality control. Such an audit program will assist in maintaining focus on variations in energy costs, the availability and dependability of the energy supply, choosing the right energy mix, identifying energy-saving technology, retrofitting for energy-saving equipment, etc. Energy audits often involve providing technically feasible solutions with economic and other organizational concerns within a given time limit in order to make conservation ideas a reality. Finding solutions to cut operational expenses or energy usage per unit of output is the main goal of an energy audit. An energy audit serves as a "benchmark" (Reference point) for managing energy inside a business and also serves as the foundation for developing plans for a more efficient use of energy across the board.

The idea of an eco-campus primarily focuses on sustainable energy consumption and conservation, as well as chances for savings. Additionally, it emphasizes reducing carbon emissions, calculating carbon footprints, purchasing energy-efficient equipment for cost-

effective and secure energy supply, promoting and enhancing energy conservation in all buildings, lowering the organization's energy use, lowering waste sent to landfills, and incorporating environmental considerations into all agreements and services deemed to have a significant environmental impact.

Studying auditing for energy management in terms of energy savings and opportunities is possible. Despite the fact that energy is generally invisible, we can observe its effects in the form of heat, light, and power, so we know it exists in wire, pipes, and other non-living elements. Energy use, energy sources, energy monitoring, illumination, vehicle movement, electrical and electronic appliances, and transportation are all covered by this indication. Energy use is undoubtedly a crucial component of campus sustainability; thus, its inclusion in the assessment doesn't call for any justification. While energy is heavily consumed, opportunities for energy conservation may be considered. An energy-efficient light-emitting diode (LED) uses less than 10 W compared to an old incandescent (tungsten) bulb, which shows a good trend toward energy savings. The three ways to reduce energy use that are related to environmental degradation are covered by energy auditing. Following an audit, ideas and recommendations may be made, which are then helpful for reducing energy use. Any organization that cares about the environment must therefore regularly use both internal and external auditors to review its energy usage procedures.

Any organization's energy management strategy depends heavily on the conduct of energy audits, utilizing both internal and external energy auditors. In order to find better ways to control the environment's influence, it is necessary to quantify the impact of energy potential within a business. Measurements of the carbon footprint within the organization based on the quantity of carbon emissions produced by the electrical appliances, vehicles, and human population may be attempted in addition to the audits of the organization's water, liquid, and solid wastes, biomedical and electronic wastes, energy potential, and biodiversity. It calculates the amount of carbon dioxide equivalents inhaled by the company that performs carbon accounting. It is important to understand how much the company is doing in terms of energy management to support sustainable development. Therefore, it is advised that stakeholders measure each organization's carbon footprint in order to help keep the campus environmentally friendly.

1.3. Aims and Objectives of an Energy Audit

An effective technique for creating and implementing an organization's complete energy management plan is an energy audit. A systematic identification of energy efficiency,

conservation, and savings opportunities at the audit sites' premises is the goal of an energy audit. The auditing procedure is performed in accordance with the following.

- Examining the energy-saving opportunities and steps taken at the audit sites.
- Identification of new energy-saving options and other conservation strategies.
- Implementing alternative energy sources can help with energy management decision-making and energy-saving opportunities.
- supplying technical details on how to create an energy balance as well as advice on where to go for it for specific applications.
- Analysis of the campus' most recent electricity bill in detail, awareness of the pricing plan offered by the State Electricity Board and the central government, and detailed calculations of energy consumption.
- List the different ways that energy is used, including electricity, LPG, firewood, gasoline, diesel, and electric stoves, kettles, and microwaves.
- Analysis of the last two to three years' worth of energy bills, the last years' worth of LPG cylinder purchases, and the cost of water used for human consumption and plant watering.
- Use of installed laboratory equipment and instruments, incandescent (tungsten) and CFL lighting, fans, air conditioners, cooling devices, heaters, computers, photo copiers, inverters, generators, and cooling apparatus.
- In the organization, alternative or unconventional energy sources are used or installed (photovoltaic cells for solar energy, windmill, energy efficient stoves, Biogas, etc.).

1.4. Benefits of an Energy Audit

➢ Reduced costs of energy

The most obvious advantage is that the Organization will spend less money on energy costs the less energy it consumes.

➢ Identify problems

An energy audit can identify any potential problems with the equipment. The auditor might, for instance, discover tiny leaks in the pressurized air system. If these leaks go unnoticed, they could end up costing a lot of money. Additionally, auditors can spot harmful health threats, including carbon monoxide emissions from defectively vented equipment. The company will be able to quickly rectify these kinds of problems with a routine energy audit, ensuring the workers' health and safety.

➢ Enhanced employee comfort

The organization might learn of modifications made to the insulation and air sealing during the

audit. The completion of these improvements will contribute to the creation of a more dependable and efficiently heated or cooled workspace for the employees. Because more contented workers are typically more productive, the organization will not only save money on energy but also potentially enhance general health.

- Specific recommendations

Discovering new energy-efficient devices can be made easier by working with an energy specialist. The expert will create a customized plan and suggest the upgrades that would provide the highest ROI. These could consist of modernized lighting systems, a fresh HVAC system, weatherization techniques like air sealing and insulation, and more. Many of the ideas will pay for themselves quickly with drastically lower energy costs, even though others may have a hefty upfront cost.

- Promote environmental concern

The organization will demonstrate to its clients and staff that it cares about the environment by making efforts to become more energy efficient.

- Rising property value

Making a facility more energy efficient in accordance with an energy auditor's suggestions could also raise its market value. An increased home value is a result of things like solar panels, high-efficiency LED lighting, and weatherization measures.

- Extended equipment life

For optimal energy savings, an energy auditor might advise updating part of the equipment. If the organization decides to modernize, it can anticipate long-lasting equipment as well as energy cost savings. This is because newer, more energy-efficient equipment doesn't need to work as hard to give the same level of performance as older, out-of-date devices.

- Energy audit assessment

Energy audits will assess the organization "as a whole," with the objective being to consider a variety of potential alternatives rather than just one or two specific initiatives (electrical, mechanical, envelope, and water).

- Energy audit possibilities

In addition to informing on opportunities, the audit will provide information with a financial analysis. Prioritization based on monetary gain and return on investment will then be possible. It gives technical details about the suggested energy-saving measures.

- Analysis of the energy audit's quality

A high-quality audit will utilize statistical techniques to analyses previous energy use and identify potential problems. To better comprehend the environmental advantages of the decisions, provide information with emissions analysis. Recognize where your energy goes and what needs the most of your attention. Provide benchmark data so that we can compare our energy consumption to that of others.

Chapter II

Methodology

2.1 Background of R. L. Tawde foundation's Sarojini College of Pharmacy, Kolhapur Energy Audit preparation:

Satellite image of R. L. Tawde foundation's Sarojini College of Pharmacy, Kolhapur (Source: Google Earth)

Established under aegis of the R. L. Tawde foundation's in 2017, the Sarojini College of Pharmacy is approved by AICTE, Pharmacy Council of India, New Delhi and affiliated to Shivaji University, Kolhapur. It has been a nurturing ground for pharmaceutical professionals with its objective of providing the best possible pharmaceutical education.

Considering all this situation and adding national holidays in the total days, the audit process was carried out in three phases. For preparation of audit, the earlier data was compared with the present. At first, all the secondary data required for the study was collected from various sources, like concerned departments. A broad reference work was carried out to clear the idea of Energy Auditing. Different case studies and methodologies were studied and the following methodology was adopted for present audit. The methodology of present study is based on onsite visits, the personal observations and questionnaires survey tool. Initially, based on data requirement, sets of questionnaires were prepared. The surveyors then visited all the departments of the college and the questionnaires were filled. The generated data is subsequently gathered through various sections of college and used for further analysis. From the outcome of the overall study, a final report is prepared.

- Energy Auditing Process
- Planning
- Choosing audit team
- Inspecting site/ Collection of data
- Analyzing results of audit
- Evaluating audit

2.2 Survey by Questionnaire:

Baseline data for Energy Audit report preparation was collected by questionnaire survey method. Questionnaires prepared to conduct the Energy Audit in the college campus is based on the guidelines, rules, acts and formats prepared by Ministry of Environment, Forest and Climate Change, New Delhi, Central Pollution Control Board and other statutory organizations. Most of the guidelines and formats are based on broad aspects and some of the issues or formats were not applicable for college campus. Therefore, using these guidelines and formats, combinations, modifications and restructuring was done and sets of questionnaires were prepared for energy audit. All the questionnaires comprise of group of modules. The first module is related to the general information of the concerned department, which broadly includes name of the department, month and year, total number of students and employees, visitors of the department, average working days and office timings etc. The next module is related to the present consumption of resources energy. There are possibilities of loss of resources like water, energy due to improper maintenances and assessment of this kind of probability is necessary in Energy Audit. One separate module is based on the questions related to this aspect. Another module is related to maintaining records, like records energy bill, equipment warranty specification, etc. For better convenience of the surveyor, some statistics like, basic energy consumption characteristics for electrical equipment etc. was provided with the questionnaires itself.

2.3. Onsite visit and observations:

R. L. Tawde foundation's Sarojini College of Pharmacy, Kolhapur has vast built up area comprising of various departments, administrative building, teachers and staff quarters, student hostels, sports complex and health centre. All these amenities have different kind of infrastructure as per their requirement. All these buildings were visited by the surveyors and the present condition is checked with the help of the questionnaires. Personal observations were made during the onsite visit. All the amenities were clubbed in as per their similarities and differences, which makes the survey and further analysis easier. For the data compilation purpose the Administrative building, Departments and support services were clubbed into 3

Blocks and given coding as Building Block A, Building Block B, Building Block C the details of the Blocks are as follows:

Table No. 2.1 Details of each block including the various departments.

Sr. No.	Name of the Building Block	Code
1.	Administrative and Facilities Block	Building Block A
2.	All Departments	Building Block B
3.	Support Services	Building Block C

After collection of secondary data, the reviews related to each environmental factor were taken by the energy audit team. The data was tabulated, analyzed and graphs were prepared using computer. Depending upon the observations and data collected, interpretations were made. The lacunas and good practices were documented. The Energy Management Plan (EMP) was prepared for the next academic year in order to have better environmental sensitization. Finally, all the information was compiled in the form of energy Audit Report.

2.4 Data analysis and final report preparation:

A proper analysis and presentation of data produced from work is a vital element. In case of Energy Audit, the filled questionnaires of the survey from each group, were tabulated as per their modules, in Excel spreadsheets. The tabulated data is then used for further analysis. For better understanding of the results and to avoid complications, averages and percentages of the tables were calculated. Graphical representation of these results was made to give a quick idea of the status. Interpretation of the overall outcomes was made which incorporates all the primary and secondary data, references and interrelations within. Final report preparation was done using this interpretation.

Chapter III

Observation and Result

3. Electricity and energy audit:

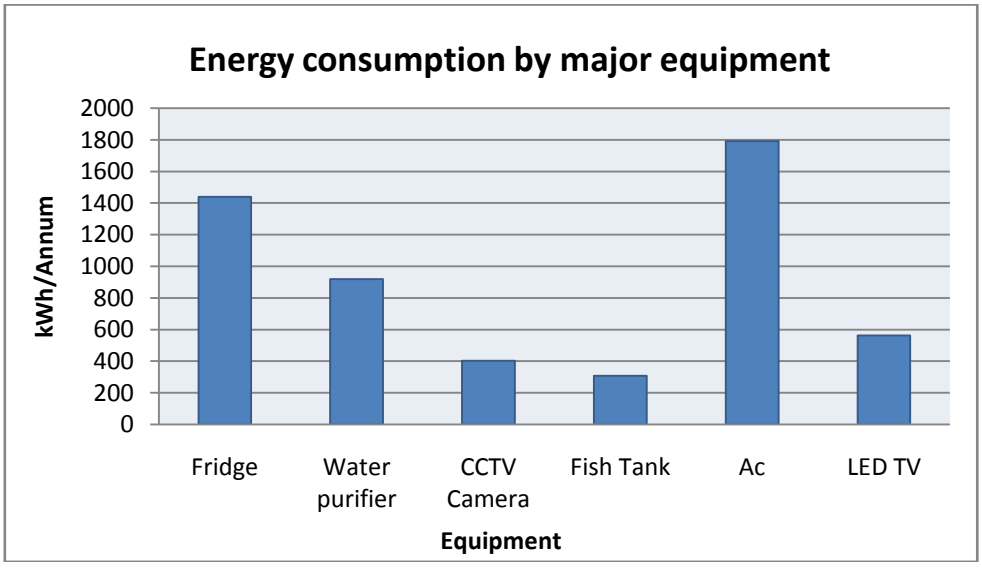
An energy source utilized by all the departments, support services of R. L. Tawde foundation's Sarojini College of Pharmacy campus includes use of electricity and liquid petroleum. Major use of the energy is at office, laboratories, and support services for lighting, transportation, and instruments. Electricity is supplied to the college campus by Maharashtra State Electricity Board.

3.1 Energy consumption at Building A:

Building Block A includes Office, Principle office, IQAC section, Cash counter, Board room, Ante Chamber, Exam section. The calculations are based on the data provided by the college and actual observations taken at the site. The collected data shows all departments in the college have maximum number of major energy consuming equipments and energy consumption is 5,425.6 kWh/ Annum.

Table No.3.1: Energy consumed per annum by major instruments in Building A

Sr. No.	Equipment	Number	kWh/Annum
1	Fridge	1	1,440
2	Water purifier	2	920
3	CCTV Camera	8	403.2
4	Fish Tank	1	307.2
5	Ac	4	1,792
6	LED TV	1	563.2
	Total	**17**	**5,425.6**



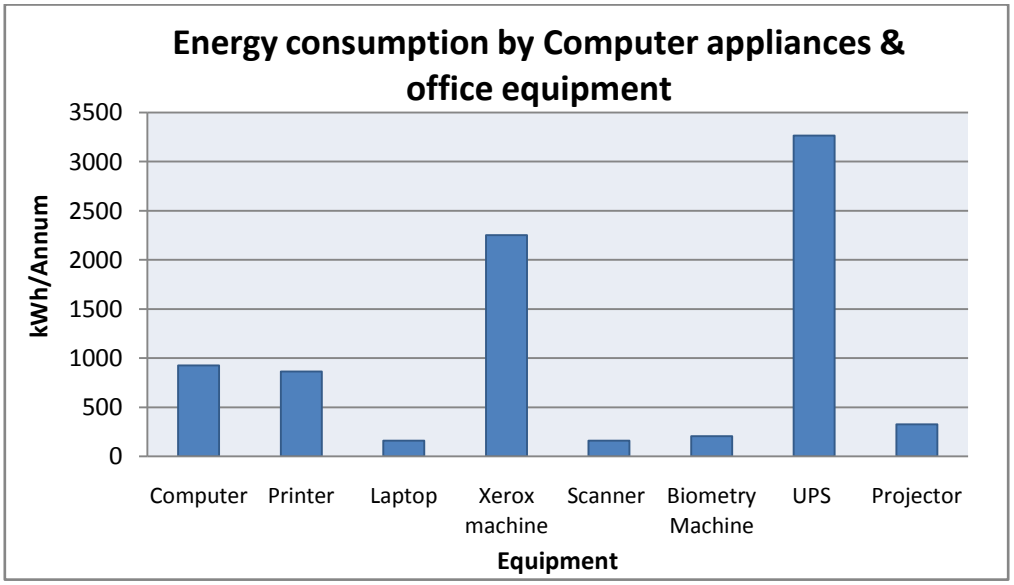
Graph No.3.1: Energy consumed per annum by major instruments in Building A

The major energy-consuming equipment throughout the administrative buildings uses 4,862.4 kWh/Annum of power annually. Since there are four additional Air conditioner, which consume more energy than any other equipment and, as a result, using the most energy at 1,792 kWh/Annum. Moreover, in the assessments it was found that there are 1 Refrigerator overall, which consumes energy i.e 1,440 kWh/Annum. Motor uses 920 kWh/Annum, Fridge 10,281.6 kWh/Annum, Water purifiers use 8,211 kWh/ Annum, CCTV cameras use 403.2 kWh/Annum, LED TV 563.2 kWh/Annum, respectively. (Graph No. 3.1)

Similarly, Computer, printers, and laptops used for Computer appliances. Therefore, office equipment were also analysed for the calculations of electricity consumption.

Table No. 3.2: Computer appliances & office equipment their energy consumption (kWh/Annum) at Building A

Sr. No.	Equipment	Number	kWh/Annum
1	Computer	11	924
2	Printer	6	864
3	Laptop	4	161.28
4	Xerox machine	2	2,252.8
5	Scanner	1	160
6	Biometry Machine	1	204.8
7	UPS	6	3,264
8	Projector	2	326.4
	Total	**33**	**8,157.28**



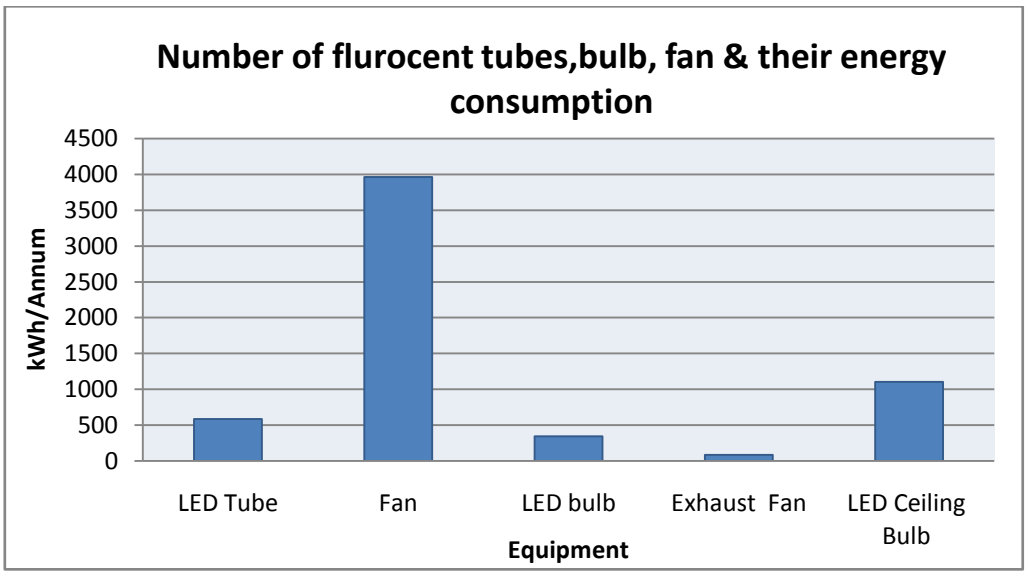
Graph No. 3.2: Computer appliances & office equipment and their energy consumption (kWh/ Annum) at Building A

Every department's computer equipments uses 8,157.28 kWh of electricity annually. As there are (6) more UPS in the category of computer appliances than Xerox machines, printers, Smart boards, LCD projectors, laptops, and biometric machines, UPS use more energy (6) 3,264 kWh each year. Followed by Xerox Machine (2) 2,252.8 kWh/Annum, Computer (11) 924 kWh/Annum, Printers (6) 864 kWh/Annum, Projector 326.4 kWh/Annum, Biometry machine 204.8 kWh/Annum, Laptop 161.28 kWh/Annum, Scanner 160 kWh/Annum, respectively. (Graph No. 3.2)

Similarly, to analyze the electricity consumption, lights and fans were also considered.

Table No. 3.3: Number of fluorescent tubes, bulbs and fans and their energy consumption (kWh/ Annum) at Building A

Sr. No.	Equipments	Number	kWh/Annum
1	LED Tube	38	583.68
2	Fan	59	3,964.8
3	LED bulb	12	345.6
4	Exhaust Fan	2	87.04
5	LED Ceiling Bulb	18	1,105.92
	Total	**129**	**6,087.04**



Graph No.3.3: Number of fluorescent Tubes, bulbs and fans and their energy Consumption (kWh/ Annum) at Building A

The total number of Ceiling fan 59 and their electricity consumption is 3,964.8 kWh/Annum. In the building A total number of LED Ceiling Bulb 18 and their energy consumption 1,105.92kWh/Annum, LED Tube 583.68 kWh/Annum, LED bulb and is 12 and their electricity consumption is i.e. 345.6 kWh/annum, Exhaust fan 87.04 kWh/Annum, respectively (Graph No.3.3).

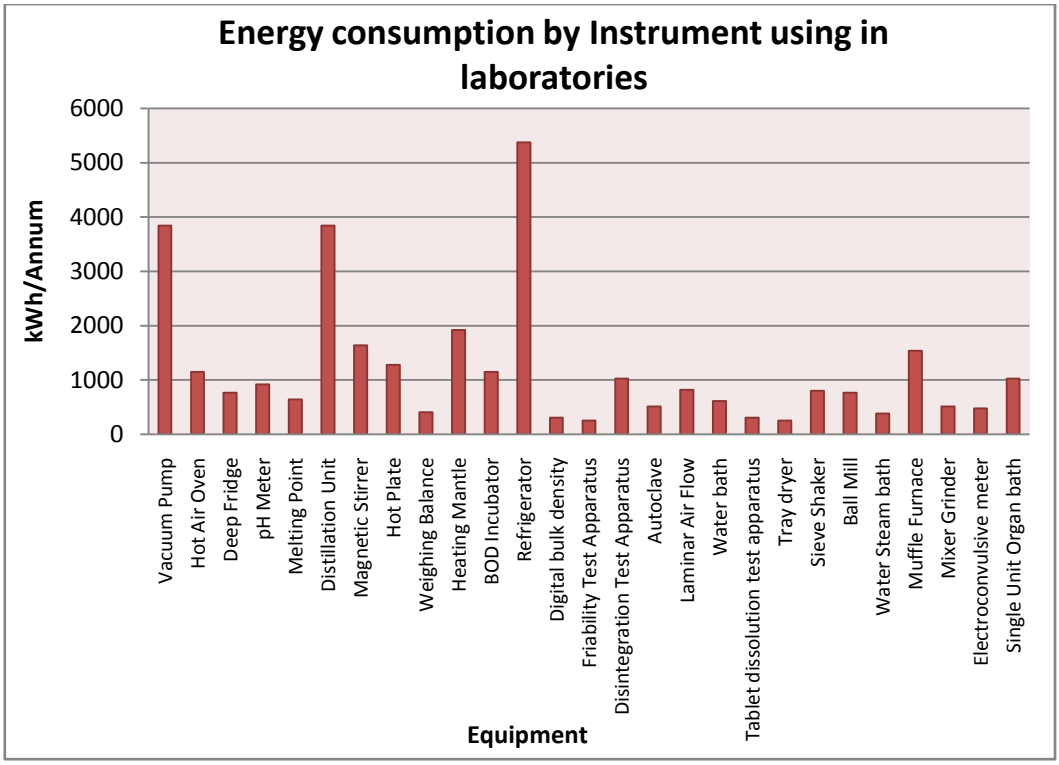
3.2 Energy Consumption at Building B:

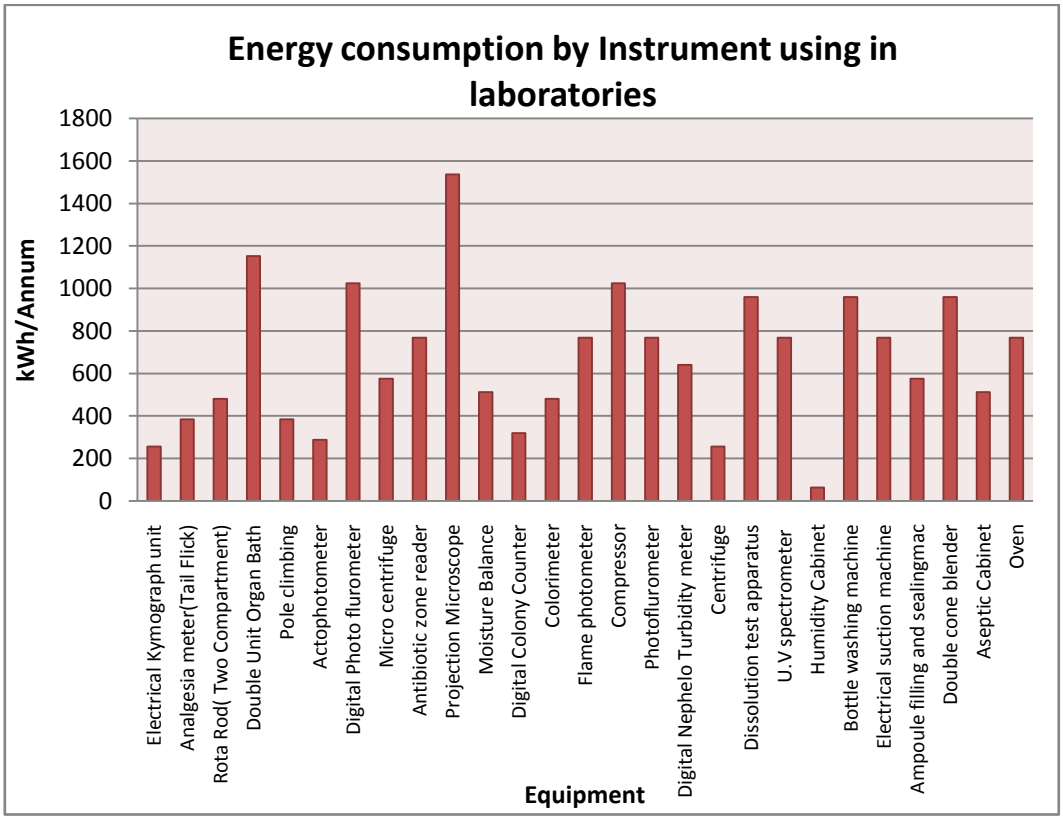
It includes Degree and diploma all the department and laboratories like chemistry, Pharmaceutics, Pharmacology, Pharmacognosy etc. The collected data shows that the building B has maximum number of major energy consuming equipments and energy consumption is 50,489.6 kWh/Annum.

Table No.3.4: Energy consumed per annum by major instruments at Building B

Sr. No.	Equipment	Number	kWh/Annum
1	Vacuum Pump	3	3,840
2	Hot Air Oven	3	1,152
3	Deep Fridge	1	768
4	pH Meter	3	921.6
5	Melting Point	1	640
6	Distillation Unit	4	3,840
7	Magnetic Stirrer	4	1,638.4
8	Hot Plate	2	1,280
9	Weighing Balance	5	409.6
10	Heating Mantle	3	1,920
11	BOD Incubator	1	1,152
12	Refrigerator	2	5,376
13	Digital bulk density	1	307.2
14	Friability Test Apparatus	1	256
15	Disintegration Test Apparatus	1	1,024
16	Autoclave	1	512
17	Laminar Air Flow	1	819.2
18	Water bath	2	614.4
19	Tablet dissolution test apparatus	1	307.2
20	Tray dryer	1	256
21	Sieve Shaker	1	800
22	Ball Mill	1	768
23	Water Steam bath	1	384
24	Muffle Furnace	1	1,536
25	Mixer Grinder	1	512

26	Electroconvulsive meter	1	480
27	Single Unit Organ bath	1	1,024
28	Electrical Kymograph unit	1	256
29	Analgesia meter(Tail Flick)	1	384
30	Rota Rod(Two Compartment)	1	480
31	Double Unit Organ Bath	2	1,152
32	Pole climbing	1	384
33	Actophotometer	1	288
34	Digital Photo flurometer	1	1,024
35	Micro centrifuge	1	576
36	Antibiotic zone reader	1	768
37	Projection Microscope	2	1,536
38	Moisture Balance	1	512
39	Digital Colony Counter	1	320
40	Colorimeter	1	480
41	Flame photometer	1	768
42	Compressor	1	1,024
43	Photoflurometer	1	768
44	Digital Nephelo Turbidity meter	1	640
45	Centrifuge	1	256
46	Dissolution test apparatus	1	960
47	U.V spectrometer	1	768
48	Humidity Cabinet	1	64
49	Bottle washing machine	1	960
50	Electrical suction machine	1	768
51	Ampoule filling and sealingmac	1	576
52	Double cone blender	1	960
53	Aseptic Cabinet	1	512
54	Oven	1	768
	Total	**77**	**50,489.6**





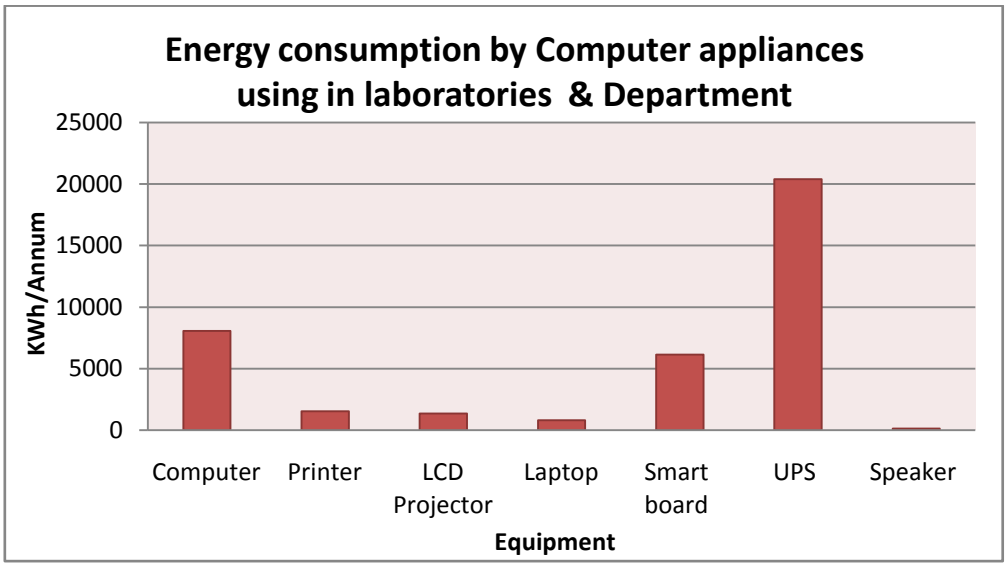
Graph No 3.4: Energy consumed per annum by major instruments at Building B

The total number of major energy consuming equipments at building B is 77 and energy consumption is 50,489.6 kWh/Annum. Number of Refrigerator is 2 at building B but the energy consumption is highest i.e. 5,376 kWh/ Annum. As major energy consuming

equipments, number of Distillation unit is 4 also the energy consumed by major energy consuming equipments is also maximum i.e. 3,840 kWh/Annum. Followed by Vacuum Pump 3,840 kWh/Annum, Heating Mantle 1,920 kWh/Annum, Magnetic stirrer 1,638.4 kWh/annum, Muffle Furnace, Projection Microscope i.e. 1,536 kWh/Annum, Hot plate 1,280 kWh/Annum, Double Unit Organ, Hot Oven, BOD Incubator consumption i.e. 1,152 kWh/Annum, Disintegration Test Apparatus, Single Unit Organ Bath, Digital photo flurometer, Compressor consumption range is 1,024 kWh/Annum, Dissolution test, Bottle Washing, Double Cone blender consumption range is 960 kWh/Annum, etc., respectively (Graph No3.4). Similarly, to analyze the electricity consumption of office equipments computers, printers, laptops were also considered.

Table No.3.5: Computer appliances & office equipment their energy consumption (kWh/Annum) at Building B

Sr. No.	Equipment	Number	kWh/Annum
1	Computer	48	8,064
2	Printer	8	1,536
3	LCD Projector	5	1,360
4	Laptop	12	806.4
5	Smart board	8	6,144
6	UPS	30	20,400
7	Speaker	14	139.77
	Total	**125**	**38,450.18**

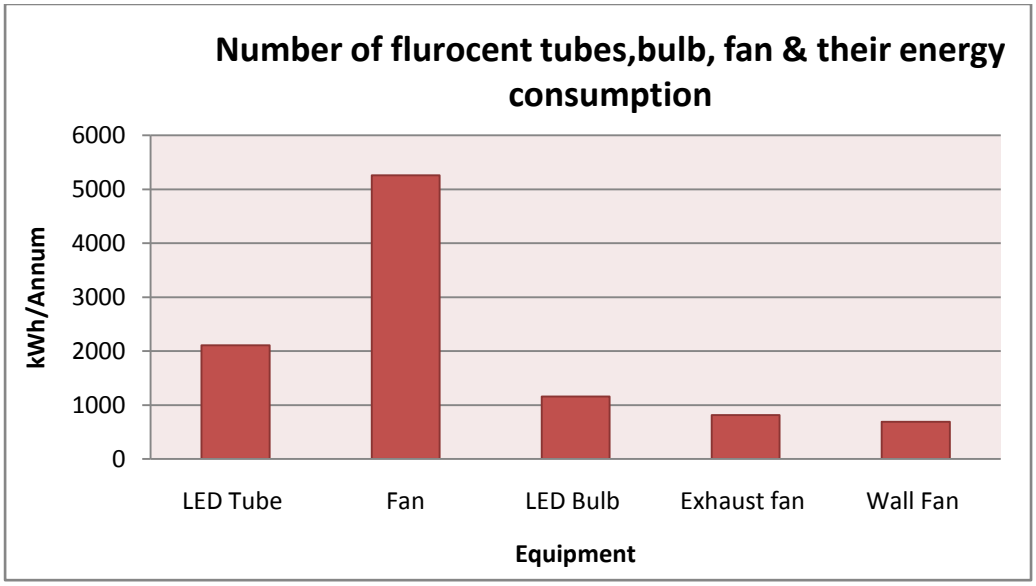


Graph No3.5: Computer appliances & office equipment their energy consumption (kWh/Annum) at Building B

The total annual energy usage of the major appliances at the laboratories is 38,450.176 kWh. There are 30 UPS throughout all departments, including classrooms and laboratories, and they use the most energy 20,400 kWh annually. As significant energy-consuming devices, there are 48 computers, and they all use a maximum of 8,064 kWh per year in terms of energy consumption. Smart Board 6,144 kWh/Annum, printer 1536 kWh/Annum, LCD Projector 1360 KWh/Annum, Laptop 806.4 KWh/Annum, Speaker 139.776 kWh/Annum etc. are the subsequently items in order of annual energy consumption (Graph No.3.5). Similarly, to analyze the electricity consumption of office equipments computers, printers, laptops were also considered.

Table No. 3.6: Number of Fluorescent Tubes, Bulbs and Fans and Their Energy Consumption (kWh/Annum) at Building B

Sr. No.	Equipments	Number	kWh/Annum
1	LED Tube	61	2,108.16
2	Fan	73	5,256
3	LED Bulb	43	1,155.84
4	Exhaust fan	15	816
5	Wall Fan	12	691.2
	Total	**204**	**10,027.2**



Graph No.3.6: Number of fluorescent tubes, bulbs and fans and their energy consumption (kWh/ Annum) at Building B

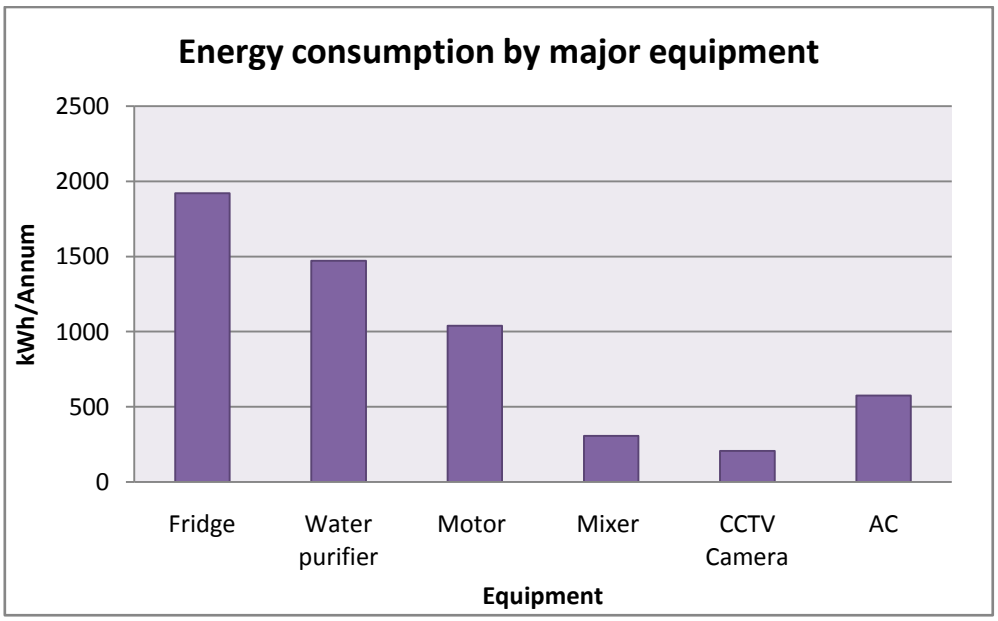
The total number of Fan is 73 and their electricity consumption is 5,256 kWh/Annum. In the building B total number of LED Tube 2,108.16 kWh/Annum, LED bulb and is 43 and their electricity consumption is i.e. 1,155.84 kWh/Annum, LED Ceiling bulb 5,529.6 kWh/Annum, LED Light 4,732.8 kWh/Annum, LED Bulb 3,478.2 kWh/Annum, Exhaust fan 816 kWh/Annum, Wall Fan 691.2 kWh/Annum, respectively (Graph No.3.6).

3.3 Energy consumption at Building C:

A support service includes –Library, Gymkhana, Ladies & Boys room, Central store, Seminar Hall, Pantry, Sick room, Record room, Campus, NSS etc. The collected data shows the Support services have maximum number of major energy consuming equipments and energy consumption is. 5,521.02 kWh/ Annum.

Table No.3.7: Energy consumed per Annum by major instruments at Building C

Sr. No.	Equipment	Number	kWh/Annum
1	Fridge	1	1,920
2	Water purifier	1	1,472
3	Motor	1	1,040
4	Mixer	2	307.2
5	CCTV Camera	4	205.82
6	AC	1	576
	Total	**10**	**5,521.02**

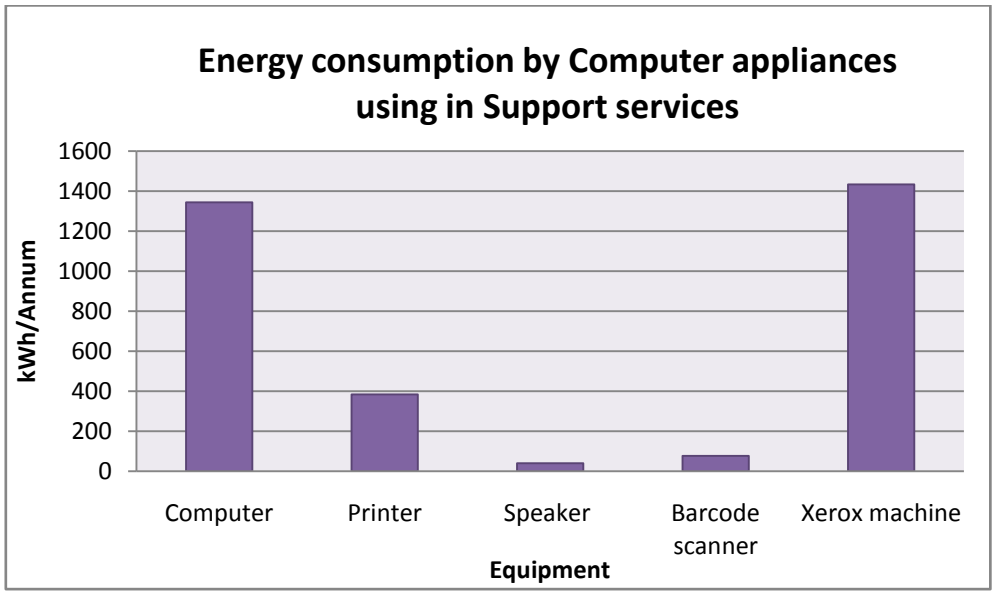


Graph No.3.7: Energy consumed per Annum by major instruments at Building C

The major energy consuming equipments at Support services consume energy 5,521.024 kWh/Annum. The energy consumption is for Fridge 1,920 kWh/Annum. Followed by Water Purifier 1,472 kWh/Annum, Motor 1,040 kWh/Annum, AC 576 kWh/Annum, Mixer 307.2 kWh/Annum, CCTV 205.824 kWh/Annum respectively (Graph No.3.7). Similarly, to analyze the electricity consumption of office equipments computers, printers, laptops were also considered from support services.

Table No 3.8: Energy consumption by Computer appliances using in Support services (kWh/Annum) at Building C

Sr. No.	Equipment	Number	kWh/Annum
1	Computer	8	1,344
2	Printer	2	384
3	Speaker	4	39.93
4	Barcode scanner	1	76.8
5	Xerox machine	1	1,433.6
	Total	**16**	**3,278.33**



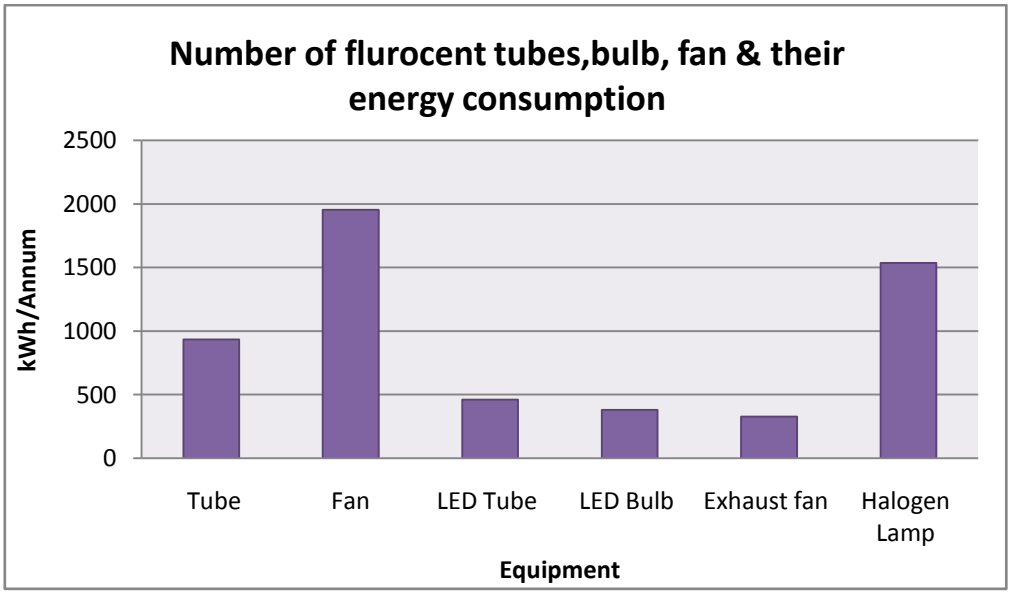
Graph No. 3.8: Energy consumption by Computer appliances using in Support services (kWh/Annum) at Building C

Computer appliances at Support Services consume energy 3,278.33 kWh/Annum. The number of Xerox machine is 1 highest as compared to computers, Printers, and scanner. The energy consumed by Xerox Machine is also maximum i.e. (1) 1,433.6 kWh/Annum, followed by Computer (18) 6,048 kWh/Annum, Printer (2) 384 kWh/Annum, Barcode Scanner (1)

76.8 kWh/ Annum, Speaker (4) 39.93 kWh/ Annum respectively. (Graph No. 3.8). Similarly, to analyze the electricity consumption, lights and fans were also considered.

Table No. 3.9: Number of fluorescent tubes, bulbs and fans and their energy Consumption (kWh/ Annum) at Building C

Sr. No.	Equipments	Number	kWh/Annum
1	Tube	54	933.12
2	Fan	37	1,953.6
3	LED Tube	30	460.8
4	LED Bulb	18	380.16
5	Exhaust fan	6	326.4
6	Halogen Lamp	4	1,536
	Total	**149**	**5,590.08**



Graph No.3.9: Number of fluorescent Tubes, bulbs and fans and their energy consumption (kWh/ Annum) at support services

The support services buildings are where lightning and fans use the most energy. There are 54 Tube in all support services department etc., they use 933.12 kWh of electricity per year. The total number of Fan used in the support services and their annual electricity consumption were Fan (37) 1,953.6 kWh/Annum, Halogen (4) 1,536 kWh/ Annum Tube 933.12 kWh/Annum, LED Tube 460.8 kWh/Annum, LED Bulb 380.16 kWh/Annum, Exhaust fan 326.4 kWh/ Annum, respectively. (Graph No. 3.9)

4. LPG Use in Laboratories & Support Services:

Almost three billion people use liquefied petroleum gas (LPG), a clean-burning and effective cooking fuel that is also referred to as propane, butane, bottled gas, or cooking gas in various other nations. It has long been an aspirational fuel choice for many urban and rural poor. Due to its non renewability, LPG is disliked by some in the development sector. However, there is a global LPG excess since it is an unavoidable by-product of the extraction and refining of oil and natural gas. At oil and gas production facilities, some of the excess is vented or flared, wasting this priceless fuel resource and spewing carbon back into the environment. It makes sense to use it for clean cooking. The LPG cylinders are used for cooking purpose and laboratories purpose at the laboratories, Pantry.

Table No.4.1 LPG Use in Laboratories & Support Services

Sr. No.	Laboratories & Support Services	No of Cylinder kg	kg/Annum
1	Laboratories	3	58.5
2	Pantry	2	39
	Total	**5**	**97.5**

The LPG is used in Support services i.e. Pantry and laboratories. In the Pantry, LPG is used as a fuel for cooking. The overall total 5 LPG cylinders in all were required, and their annual usage is 97.5 kg/Annum. Also LPG gas use in the Labourites for practical purpose was 58.5 kg/Annum and Pantry 39 kg/ Annum respectively.

5. Key Observations:

- The total energy consumption of college is 1,32,642.33 kWh/Annum
- Highest consumption of energy is by Laboratory equipments and support services i.e. 50,489.6 kWh/Annum.
- The energy consumption of Laboratory equipments is more than office equipments and support services.
- Installation of sensor based electrification items like fans, lights, etc. can save electricity.
- Installation of solar panels to every terrace of building will be useful in conserving the natural resources.
- Unnecessary use of lights, fans and computers at some places when no one is using.

Electric Equipment in the R. L. Tawde foundation's Sarojini College of Pharmacy, Campus

Weighing Balance

Magnetic Stirrer

Friability Test Apparatus

Oven

Sieve Shaker

Distillation test Apparatus

Double Cone Blender

Jar Test Apparatus

Electric Suction Machine

Tablet Coating Pan

Chapter IV

Summary and Conclusion

Summary:

Energy Audit is one of the important tools to check the balance of natural resources and its judicial use. Energy auditing is the process of identifying and determining whether institutional practices which are eco-friendly and sustainable. It is a process of regular identification, quantification, documenting, reporting and monitoring of environmentally important components in a specified area.

The Department of Environmental Science, Shivaji University, Kolhapur has conducted an "Energy Audit" of R. L. Tawde foundation's Sarojini College of Pharmacy, Kolhapur in the academic year 2022-23. The main objective to carry out energy audit is to check the Energy Audit practices followed by college and to conduct a well defined audit report to understand whether the college is on the track of sustainable development.

After completing the audit procedure of college for Energy Audit practices, there are following conclusions, recommendations and Energy Management Plan (EMP) which can be followed by college in future for keeping campus environment friendly.

Conclusion:

From the Energy Audit, following are some of the conclusions which can be taken for improvement in the campus.

1. Installation of solar panels provides ample amount of electricity. Such solar modules should be installed wherever possible in the campus.

2. Use of LED lamps and Tube Lights is minimum and is to be encouraged.

3. Laboratories equipment is consuming more energy in the departments. The replacement of old equipment can be beneficial for solving this issue.

4. The replacement of florescent tube can be beneficial for solving electricity consumption issue.

Recommendations:

Following are some of the key recommendation for improving campus environment:

1. An environmental policy document has to be prepared with all the recommendations and current practice carried by college.

2. The college should develop internal procedures to ensure its compliances with environmental legislation and responsibility should be fixed to carry out it in practice.

3. Electrification of street lights by solar power should be encouraged.

4. Installation of sensor based electrification items like fans, lights, etc. can save electricity.

5. Installation of solar panels and rain water harvesting system to every terrace of building will be useful in conserving the natural resources.

6. Regular checkups and maintenance of wire, and Electricity meter system should be done by engineering section to reduce over use, short circuit.

7. Science laboratories and support services using large amount of energy consumption; the system should develop energy conservation practices.

Chapter V

Energy Management Plan (EMP):

By understanding the dynamics of present situation of resource utilization and current Energy Audit practices, the Department of Environmental Science has prepared an 'Energy Management Plan' for the R. L. Tawde foundation's Sarojini College of Pharmacy, Kolhapur. This plan will reveal the strengths and weaknesses and suggests remedies to develop Energy Audit campus. The EMP also gives suggestion for the priority of work to carry out.

Energy Management Plan

Sector	Strengths	Weakness	Suggestions	Priority
1. Electricity	Different types of the instrument is available	• Insufficient use of solar energy for electricity generation. • Unnecessary use of lights, fans and computers at some places when no one is using. • Sometimes ignorance by the staff and students wastes electricity in class rooms.	• Electrification of street lights by solar power. • Installation of sensor based electrification for fans, lights, etc. Use of solar pumps for water tanks. • Use of electricity efficient equipments for laboratory and office use. • Installation of solar panels on the top of every building can reduce the use of conventional energy. • General awareness about electricity saving among all the staff, students and non teaching staff should be enhanced.	Medium