Energy Audit

Year 2023-24

Energy Audit

Rashtriya Sahakari Shikshan Prasarak Mandal Ltd., Chalisgaon Sanstha's

Nanasaheb Yashvantrao Narayanrao Chavan

Arts, Science & Commerce College

Chalisgaon, Dist - Jalgaon

CONTENTS

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- Honourable Secretary Abasaheb Prin. Balasaheb Vishwasrao Chavan
- Honourable Director Board Members of the college
- Prin. Dr. S. R. Jadhav
- IQAC Members
- Energy Audit coordinator
- Teaching & Supporting Staff of College

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C.V. M. Agone

(Dr. Vikram Agone)

Founder & Chairman

Vikram GeoInfo Tech

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Report by: Lead Auditor

(Dr. Vikram Agone)

Founder & Chairman

Vikram GeoInfo Tech

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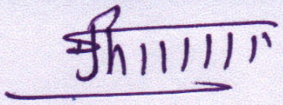
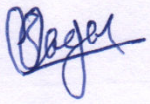
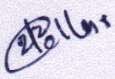
ENERGY AUDIT ASSESSMENT TEAM

Internal Auditor

NAME	POSITION	SIGNATURE
Prin. Dr. S. R. Jadhav	Principal & Chairman	
Dr. U. R. Magar	Vice-Principal	
Dr. G. D. Deshmukh	IQAC Coordinator & Vice-Principal	
Dr. G. B. Shelke	Member	
Dr. N. P. Golhar	Member	

External Auditor

NAME	POSITION	QUALIFICATION
Dr. Vikram Madhukar Agone	Lead Auditor	Ph.D. FRGS (UK)

INTRODUCTION

R.S.S.P. Mandal Ltd., Chalisgaon Sanstha's Nanasaheb Yashvantrao Narayanrao Chavan Arts, Science & Commerce College Chalisgaon, Dist - Jalgaon aims at creating awareness about energy conservation awareness. In an era where energy conservation and sustainability have become paramount, energy audits have emerged as a vital tool for individuals, businesses, and governments to assess, optimize, and reduce energy consumption. Energy is the lifeblood of modern society, powering our homes, industries, and economies. However, the indiscriminate use of energy resources has led to environmental concerns, rising costs, and a growing need for responsible energy management. Energy audits offer a systematic approach to address these challenges by evaluating energy usage patterns, identifying inefficiencies, and proposing actionable solutions to enhance energy performance.

An energy audit is a comprehensive assessment of an organization's or individual's energy consumption, focusing on both the supply and demand sides of energy utilization. It involves a detailed examination of energy systems, processes, and infrastructure to understand how energy is used and where improvements can be made.

Excessive energy consumption contributes to greenhouse gas emissions, climate change, and resource depletion. Energy audits help mitigate these impacts by reducing energy waste and optimizing resource utilization. Energy costs represent a significant portion of operating expenses for businesses and households. Energy audits can uncover cost-saving opportunities, making energy management a financially sound strategy. Many jurisdictions have implemented energy efficiency standards and mandates. Energy audits assist organizations in meeting these requirements and avoiding penalties. In a world increasingly focused on sustainability and responsible resource management, energy audits play a pivotal role in achieving these objectives. By uncovering energy inefficiencies, reducing costs, and lessening environmental impacts, energy audits empower individuals, businesses, and governments to make informed decisions and take meaningful steps towards a more sustainable and energy-efficient future.

One of the primary purposes of an energy audit is to identify opportunities for reducing energy consumption and, subsequently, energy costs. Educational institutions often have tight budgets, and energy expenses can be a significant portion of their operating costs. By identifying energy

efficiency measures, the institution can lower its utility bills and allocate more resources to educational programs and services.

Educational institutes have a responsibility to promote sustainability and environmental stewardship. Energy audits help identify ways to reduce energy consumption, lower greenhouse gas emissions, and minimize the institute's overall environmental footprint. This aligns with the institution's commitment to sustainability and can serve as an example for students and the community.

Educational institutes often have extensive facilities and equipment. Energy audits help in assessing the condition and efficiency of these assets, including HVAC systems, lighting, and electrical equipment. This information can inform maintenance and replacement strategies, ensuring that resources are used efficiently.

the purpose of an energy audit in an educational institute is multifaceted. It encompasses cost reduction, environmental responsibility, educational opportunities, regulatory compliance, asset management, and overall improvement in the institution's financial stability and sustainability efforts. Conducting energy audits aligns with the educational institution's mission to provide quality education while being socially and environmentally responsible.

The primary goal of an energy audit done by ***R.S.S.P. Mandal Ltd., Chalisgaon Sanstha's Nanasaheb Yashvantrao Narayanrao Chavan Arts, Science & Commerce College Chalisgaon, Dist - Jalgaon*** is to assess and analyze the energy consumption and utilization of a system, facility, or organization with the aim of identifying opportunities to improve energy efficiency, reduce energy costs, and minimize environmental impacts.

It helps in recognizing the necessity for colleges to figure around the academic years **2023-24** for energy conservation. Thus, the Energy audit forms the baseline survey to decide on the **energy consumption policy**.

ENERGY AUDIT

An energy audit is a survey of a building or process to determine how much energy is being used and to identify ways to reduce energy consumption. An energy audit is an inspection, survey, and analysis of energy flows for energy conservation in a building, process, or system. It is an assessment of the current energy use of a facility and a proposal for measures to reduce energy consumption. The results of an energy audit are typically presented in a report that includes recommendations for energy efficiency improvements. The report may also include estimates of the cost savings and environmental benefits of the recommended improvements.

The purpose of an energy audit is to identify the sources and uses of energy, measure the energy consumption and efficiency, and recommend ways to reduce energy waste and improve energy savings. An energy audit can be conducted at different levels of detail and scope, depending on the objectives and resources of the auditee. Some of the benefits of an energy audit include:

- Lowering energy bills and operating costs
- Enhancing environmental performance and reducing greenhouse gas emissions
- Improving occupant comfort and productivity
- Increasing asset value and marketability
- Complying with regulatory requirements and standards

In this context it becomes essential to adopt the system of the energy efficient Campus for the college which will lead to sustainable development and at the same time decrease a sizable amount of atmospheric pollution from the environment, conserve energy and many more. The National Assessment and Accreditation Council, New Delhi (NAAC) has made it compulsory that all Higher Educational Institutions should submit an annual Energy Audit Report. Moreover, it is part of the Corporate Social Responsibility of Higher Educational Institutions to ensure that they contribute towards the reduction of global warming through energy uses reduction measures. The energy audit Report aims at summarising the college's contribution and its activeness in creating awareness and consciousness in practically applying environmentally friendly measures towards an institute in A.Y. **2023-24**

ENVIRONMENTAL SETTING OF THE COLLEGE

The college has a sprawling pollution-free campus on the central part of Chalisgaon city. Chalisgaon is a city and taluka in Jalgaon district of Nashik Division, Maharashtra, and It is located on state Highway NH 211, NH 753J and Central Railway. The Tittur River flows through the city. Chalisgaon city has been situated at 356 m MSL altitude. Chalisgaon has a tropical climate with hot and humid summers and mild winters. The average temperature ranges from 27°C to 40°C in the summer and 12°C to 20°C in the winter. The city receives an average rainfall of 700 mm per year, most of which falls during the monsoon season (June to September). Chalisgaon is located at the foot hill of Ajanta Satmala Mountain range. The vegetation in Chalisgaon is mainly tropical deciduous forest. The city is home to a variety of trees and plants.

The college campus is spread over 4.038 acres (1.63 hectare) which include about 1.52-acre (0.61 hectare) sports ground. College is easily accessible by road for the rural area which is 25 km away. Although the campus is located near the residential area, the presence of a green belt considerably reduced noise pollution and provided fresh air on the campus. The College campus area has an academic building, library, parking, canteen and sports ground.

OVERVIEW OF INSTITUTE

Nanasaheb Yashwantrao Narayanrao Chavan Arts, Science and Commerce College is run by Rashtriya Sahakari Shikshan Prasarak Mandal Ltd., Chalisgaon (Jalgaon) Sanstha's. Established in 1953 in the form of a hostel the Institute now has 1 Senior College, 5 Junior Colleges (+ 2 Level), 21 Secondary Schools, 2 Primary Schools, 1 Ashramshala (residential school), 1 School for Blind Students, 5 Pre-Primary Schools, 5 hostels, 1 MCVC Unit and 1 Cooperative Consumer Stores.

At present about 25, 000 students are learning in all these schools, junior colleges, ashramshala and senior college. The Office-bearers of the Institute represent various fields like medicine, law, education, agriculture and business. The R. S. S. P. Mandal is run by visionary and committed Office-bearers and resultantly this is one of the well-known educational institutes in this region.

Nanasaheb Yashvantrao Narayanrao Chavan Arts, Science & Commerce College, Chalisgaon is run by Rashtriya Sahakari Shikshan Prasarak Mandal Ltd. Chalisgaon Dist. Jalgaon. The College was established in June 1984 and is affiliated to the North Maharashtra University, Jalgaon. The College is Grant-in-aid, affiliated and co-education system. The College was first accredited in January 2004 and was awarded B+ by the NAAC.

In the Second cycle of NAAC Reaccreditation our institute excelled and achieved "A" grade with CGPA 3.10, in 2012. Similarly, in 2013 North Maharashtra University, Jalgaon bestowed upon us 'Best College Award' in the University. In Academic Audit conducted by the University we were again given 'A' grade.

The college started with B. A, B. Com and B.Sc. During the course of time moved upward by adding various graduate, post-graduate and doctoral courses. To be in tune with the time of professionalism we also offer undergraduate programmes like B.C.A. and B.B.M. and PG course M.B.M.

The need of the hour is 'skill-based courses and this institute has rightly initiated the course like 10-Certificate, 06-Diploma, 06-Advanced Diploma Courses as Career Oriented Courses and One P. G. Diploma Course. M. Phil, and Ph. D. activities by the recognized guides are available on the campus of the College.

Every year our students secure ranks in university merit list some are gold medallists. Highly qualified staff along with academic growth of students complement by co-curricular and extra-curricular activities to nurture all round personality of our students.

Our students represent University at various levels in sports. We are always at 1st or 2nd position among the '10 Best Colleges in the University'. Our students are recipients of gold, silver and bronze medals at various events in university level cultural event: Yuvarang. Our respected Principal has been awarded "Best Centre In-charge Award" (Karya Gaurav Puraskar) by Yashwantrao Chavan Maharashtra Open University, Nashik.

The college has been recognized under 2(f) and 12 (b) by the UGC. The campus area of the college is 14284 sq. mts. And Women's hostel 1184.19 sq. mts. The college stands in a multi-storied, majestic building with various facilities. More than two thousand and four hundred students and studying in the college.

There is Library building with NRC for students and teachers, Playground and well-equipped Gymnasium. There is Canteen and Health Centre on the campus.

To enhance the potential of students in writing, compiling annual magazine 'Rashtriyata' is published. Some departments compile wall papers on certain subjects. In the competitive world and to prepare for competitive examination with the philanthropic contribution by our Ex-Principal we have been conducting State Level General Knowledge Quiz Competition every year.

The College also has a Study Centre of Yashwantrao Chavan Maharashtra Open University, Nasik. The Centre offers B. A., B. Com., M. A. and M. Com. Courses. The strength of students at the Centre almost equals to that of the strength of our regular courses.

Through this Centre we provide opportunity of learning to those who cannot attend regular college. Our respected Principal has been awarded 'Best Centre In-charge Award' (Karya Gaurav Puraskar) by Yashwantrao Chavan Maharashtra Open University, Nashik.

The faculties in our college are competent and committed and they upgrade the knowledge of their subjects by participating in state, national and international conferences and seminars. There are 21 Ph. D. holders and 6 are pursuing Ph. D.

Our faculty members also engage in Research projects. Most of the faculty members have published their Research articles in state, national, international level and online journals with impact factors. They are also authors of some books.

VISION

Imparting instruction in social sciences, humanities; business, commerce and management; basic and applied sciences with humanitarian, national and global outlook.

MISSION

Knowledge that liberates

AIMS AND OBJECTIVE

R.S.S.P. Mandal Ltd., Chalisgaon Sanstha's Nanasaheb Yashvantrao Narayanrao Chavan Arts, Science & Commerce College Chalisgaon, Dist - Jalgaon conducted an Energy auditing survey for the year 2023-24. The primary aim of an energy audit is to determine ways to reduce energy consumption per unit of product output or to lower operating costs. It serves to identify all the energy streams in a facility and quantifies energy usage according to its discrete functions. The following were the objectives:

- A baseline survey to recognize the real status of energy consumption.
- One of the main objectives is to identify where and how energy is being used in a facility. This includes understanding the energy consumption patterns and the efficiency of energy use.
- Energy audits aim to find opportunities to reduce energy usage without negatively impacting the operations. This could be through improved efficiency, process changes, or equipment upgrades.
- By identifying areas of energy waste and potential improvements, energy audits can help reduce operating costs.
- Energy audits can also help reduce the environmental impact of a facility by identifying ways to decrease energy consumption, which in turn reduces greenhouse gas emissions.
- The information gathered during an energy audit can be used to develop a comprehensive energy management plan, which includes strategies for ongoing energy efficiency and cost savings.
- Increasing and spreading the awareness for energy conservation and sustainable use of resources amongst the students, teaching and non-teaching staff members.
- Improving environmental standards of the institute.
- Financial savings through a reduction in energy use.

DATABASE AND METHODOLOGY

The present study is based on visits to the college, personal observations, and a primary database that was collected using sets of questionnaires and other survey tools.

- **Database**: The database refers to the collection of relevant data and information that are used to analyse the energy performance of a facility. The database may include:
    - Historical energy consumption and cost data
    - Energy bills and tariffs
    - Facility layout and floor plans
    - Equipment inventory and specifications
    - Operating schedules and conditions
    - Benchmarking data and industry standards
- **Methodology**: The methodology refers to the systematic approach and techniques that are used to conduct the energy audit. The methodology may include:
    - Defining the audit objectives and scope
    - Forming the audit team and assigning roles and responsibilities
    - Conducting a preliminary walk-through survey
    - Collecting and verifying data from various sources
    - Measuring and monitoring key energy parameters
    - Performing energy balance and analysis
    - Identifying energy saving opportunities and calculating savings potential
    - Evaluating the technical and economic feasibility of energy conservation measures
    - Preparing and presenting the audit report and recommendations

ANALYSIS OF THE DATABASE

The database has been prepared for statistical analysis for the energy audit using Minitab and IBM SPSS statistical software. The surveys from each group were tabulated in MS Excel spreadsheets. The tabulated data were further analyzed through statistical analysis and computing. For a better understanding of the results and to avoid complications, averages and percentages of the tables were taken. A graphical representation of these results was made to give a summarized picture of the status. The outcome was interpreted with the overall consequences, conclusion and plausible solutions or steps for them.

Energy Audit Report

ENERGY AUDIT

As per the Energy Conservation Act, 2001, Energy Audit is defined as "the verification, monitoring and analysis of the use of energy as well as submission of technical report containing recommendations for improving energy efficiency with cost-benefit analysis and an action plan to reduce energy consumption". Effective management of energy-consuming systems can lead to significant cost and energy savings as well as increased comfort, lower maintenance costs, and extended equipment life. A successful energy management program begins with a thorough energy audit. The energy audit evaluates the efficiency of all building and process systems that use energy.

Energy use is an important aspect of campus sustainability and thus requires no explanation for its inclusion in the assessment. An old incandescent bulb uses approximately 60W to 100W while an energy-efficient light emitting diode (LED) uses only less than 10 W. Energy auditing deals with the conservation and methods to reduce its consumption related to environmental degradation. It is therefore essential that any environmentally responsible institution examine its energy use practices.

One electricity meter is provided for the entire campus. There is **total energy consumption** for the college has been **211.472 kWh/day** for the A.Y. 2023-24. Laboratory equipment's have been **63.29 kwh/day** energy consumption, while other appliances have **148.176 kWh/day** energy consumption. The major difference in Energy consumption of various departments is due to the usage of various electronic and electrical equipment. Data are shown in Tables below for a comparison of no. of electrical appliances and energy consumption (kwh) per day in each Department/ Sections. The difference in no. of electrical appliances and energy consumption (kwh) used is reflected in their respective energy consumption. The emissions per unit of electricity in India are estimated to be in the range of 0.91 to 0.95 kg/kWh, in this way **college contribute 196.668 kg per day of CO_2 emission** to the atmosphere by using electrical energy for the A.Y. 2023-24 respectively.

The data highlights some notable findings.

The Principal's Office has a modest array of appliances, with two tube lights, two CFL bulbs, two fans, and two computers, indicating a simple configuration for communication and administrative work. The principal's workspace is made comfortable by the air conditioner (1), but the one photocopier (1) suggests that document duplication is occasionally necessary.

A significant number of tube lights (17) and fans (14), which are necessary to provide sufficient lighting and ventilation for studying, are installed in the library. The institution has a moderate amount of computers (7) and printers (1), which suggests that both faculty and students have access to digital resources and printing facilities. Further facilitating document reproduction and digitization—which is necessary for academic research and the distribution of study materials—are the presence of scanners (3) and photocopiers (3).

The Administrative Office is furnished with necessary equipment, such as computers (10), fans (9), and tube lights (15), to facilitate communication and administrative tasks within the organization. The number of printers (9) and scanners (4) indicates the necessity of digital resource management and document handling for administrative tasks.

The department of computer science has a sizable number of computers (23), in addition to other related devices such as fans (4), printers (3), scanners (2), and tube lights (8). This suggests that the department places a high priority on computer-based learning and research, and that it has plenty of resources for both peripherals and hardware. The department of information technology is equipped with a sizable number of computers (18) as well as printers (2) and scanners (1). This demonstrates an emphasis on digital technology and IT infrastructure, which are crucial for information technology education and research. BCA Lab (Bachelor of Computer Applications) lab possesses a significant number of computers (20), along with other related equipment like tube lights (6) and fans (6), supporting practical learning and experimentation in computer science and programming. The presence of printers (1) suggests a need for document printing and reproduction within this lab.

The Multipurpose Hall is mainly used for parties and events, as seen by the fans (20) and tube lights (14). This section appears to be focused on non-digital events or physical activities, as evidenced by the lack of computers or other electronic devices. Since the playground is an outdoor recreation area rather than a place for learning or administration, it naturally lacks electrical appliances. However, it does have six flood lamps, which reflect the playground's

purpose as a place for sports and physical activities. The appliances in the YCMU section are mixed and include four tube lights, two fans, four computers, two printers, and two scanners. These items suggest that the space is multipurpose and is probably used for student activities and academic purposes. The fact that there are two photocopiers in this area suggests that document distribution and duplication are necessary.

The sport room has a modest amount of equipment, such as computers (1), fans (2), and tube lights (4), suggesting a simple arrangement for handling administrative duties or keeping an eye on sporting events. The photocopier (1) indicates that there may be a need for periodic document duplication in this area. The gymnasium provides adequate lighting and ventilation for physical training with a substantial number of tube lights (12) and fans (9). This section is focused on exercise equipment and physical activities, as evidenced by the lack of computers or other electronics.

The botany department has a wide range of appliances, such as fans (1), computers (1), CFL bulbs (8), tube lights (18), and many more research-related tools that help with both academic research and departmental administrative duties. The fact that there are printers (1) and scanners (1) suggests that digital resource management and document handling are necessary for botanical research. The botany department is equipped with a wide range of research tools, including centrifugal pumps, mixers, water baths, incubators, autoclaves, spectrophotometers, calibrators, and Fame photometers.

To support its academic and administrative endeavors, the zoology department is outfitted with appliances like computers (1), CFL bulbs (2), and tube lights (15). It appears that document distribution and duplication are necessary in this area based on the photocopier (1). Research Lab for Zoology: Equipped with a basic selection of equipment, such as one tube light, two CFL bulbs, two fans, and one computer, the lab offers a favorable setting for conducting scientific experiments and analyzing data within the department. The Zoology Research Lab facilities include a single hot plate, an incubator, a centrifugal pump, a spectrophotometer, an oven, a stirrer with a hot plate, a tissue embedding center, a slide staining machine, a distillation plant, a BOD incubator, cooling plants, a bio-spectrometer, and a light microscope. The microbiology department is equipped with a variety of equipment to support both academic research and administrative duties. This equipment includes computer(s), fans(5), CFL bulbs(2), water baths, autoclaves, ovens, stirrers with hot plates, and laminators. It appears that document distribution and duplication are necessary in this area based on the photocopier (1).

Electronics has significant number of computers (12) and related equipment like tube lights (10), CFL bulbs (5), and fans (6), CRO and Function generator. The electronics department emphasizes hands-on learning and research in electronic systems and devices. The presence of a photocopier (1) suggests a need for document duplication and distribution within this area. The physics department is equipped with a diverse array of appliances including tube lights (16), CFL bulbs (6), fans (10), and computers (3), CRO, Function generator, Stirrer with hot plate and Water bath supporting both theoretical studies and practical experimentation within the field of physics. The presence of printers (3) suggests a need for document handling and reproduction within this area.

Psychology department with a mix of appliances including tube lights (3), CFL bulbs (2), fans (2), and computers (1), the psychology department provides a conducive environment for academic research and counselling activities. The presence of scanners (2) and photocopiers (1) facilitates document management and duplication within this area.

The IQAC (Internal Quality Assurance Cell) office possesses a diverse array of appliances including tube lights (7), fans (4), computers (4), printers (2), and scanners (2), supporting quality assurance and academic accreditation activities within the institution. The presence of photocopiers (2) suggests a need for document duplication and distribution within this administrative office.

Conference Hall Equipped with appliances like tube lights (6), fans (2), and an air conditioner (1), the conference hall provides a comfortable and well-lit environment for academic conferences and meetings. The absence of computers or other electronic devices indicates a focus on presentations and discussions rather than digital activities within this space.

The staff room is equipped with appliances such as tube lights (9) and fans (12), providing a comfortable and well-lit workspace for faculty and staff members. The absence of computers or other electronic devices suggests a focus on administrative tasks and faculty interactions within this area. Ladies Room section possesses appliances like tube lights (5) and fans (6), ensuring a comfortable environment for female faculty and staff members. The absence of computers or other electronic devices indicates a focus on restroom facilities rather than academic or administrative activities within this space.

English department Equipped with appliances like tube lights (4), CFL bulbs (3), fans (3), and computers (2), the English department provides a conducive environment for academic

research and language studies. The presence of a photocopier (1) suggests a need for document duplication and distribution within this area.

The chemistry department is equipped with a diverse array of appliances including tube lights (20), CFL bulbs (4), fans (2), and computers (1), supporting both theoretical studies and practical experimentation within the field of chemistry. The presence of printers (1) suggests a need for document handling and reproduction within this area.

The geography department prioritizes digital mapping and spatial analysis in its academic curriculum. It has a sizable number of computers (12) and related equipment, such as tube lights (10), CFL bulbs (4), and fans (6). The photocopier (1) indicates that document distribution and duplication are necessary in this area.

Statistics department Equipped with a significant number of computers (18) and related equipment like tube lights (2), fans (1), and printers (1), the statistics department emphasizes data analysis and mathematical modelling in its academic curriculum. The presence of a photocopier (1) suggests a need for document duplication and distribution within this area.

The mathematics department is equipped with a modest array of appliances including tube lights (1), CFL bulbs (1), fans (1), and computers (1), and one projector supporting both theoretical studies and practical problem-solving activities within the field of mathematics. The presence of a printer (1) suggests a need for document printing and reproduction within this area.

The provided table (2) presents the energy consumption data for various departments or sections within the institution, measured in kilowatt-hours (kWh) for different types of electrical appliances. This data is crucial for conducting an energy audit to assess the energy usage patterns and identify opportunities for energy efficiency improvements. Upon analysing the data, several key findings emerge:

The table (2) shows the energy consumption of various departments and sections of a building. The consumption is categorized by different appliances. For example, the library department uses 2.72 kWh of tube lights, 0.24 kWh of fans, 6.3 kWh of computers, 5.6 kWh of printers, 0.3 kWh of projectors, and 6.6 kWh of inverters. The computer lab consumes the most energy at 27.6 kWh, followed by the administrative office at 12 kWh and the library at 6.3 kWh. This is likely because computer labs typically have many computers that are running for long periods of time. Administrative offices may also have a number of computers and other

electronic devices in use. Libraries, on the other hand, may have fewer computers but a higher use of lights. The Computer Lab has the highest overall consumption of 69.6 kWh. This is likely because it has a high number of computers (27.6 kWh) and printers (21.6 kWh). The library also has a high overall consumption of 6.6 kWh, likely due to the high number of tube lights (2.72 kWh).

Variation in Energy Consumption: The amount of energy consumed varies significantly between departments or sections. The presence of numerous appliances, including computers, air conditioners, and photocopiers, results in departments such as the "Library," "Administrative Office," "Computer," and "Psychology" exhibiting relatively higher energy consumption.

Identifying High Energy Consumers: The information identifies areas or departments with high energy consumption, like the "Administrative Office" and the "Computer" department, where air conditioning and computers account for a sizable portion of energy use. To lower overall energy consumption and operating costs, this shows possible locations for energy-saving measures to be put into place.

Opportunities for Efficiency Improvements: Opportunities for increasing departmental efficiency are found by the energy audit. Departments such as the "Multipurpose Hall," "Play Ground," and "Sport Room," for example, exhibit negligible or no energy consumption, indicating that these spaces could benefit from the implementation of energy-efficient lighting solutions or energy optimization.

Impact of Equipment Usage: The data also underscores the impact of equipment usage on energy consumption. Departments like "Microbiology" and "Psychology" show higher energy consumption due to the continuous operation of equipment such as computers and air conditioners, indicating the need for optimizing equipment usage schedules or upgrading to energy-efficient models.

Importance of Behavioral Changes: Beyond equipment upgrades and infrastructure improvements, the data also underscores the importance of promoting energy-conscious behavior among faculty, staff, and students. Educating stakeholders about energy-saving practices and encouraging simple actions like turning off lights and equipment when not in use can contribute significantly to overall energy conservation efforts.

The amount of energy used by various departments varies noticeably. The presence of multiple electrical appliances, including computers, air conditioners, and photocopiers, makes departments like the "Computer," "Administrative Office," and "Library" stand out as significant energy consumers. On the other hand, spaces like the "Sport Room," "Multipurpose Hall," and "Play Ground" use less energy because they rely less on electrical equipment. The information highlights the major influence of particular appliances on total energy consumption. For example, in many departments, computers and air conditioners are the main sources of energy consumption. It is imperative to take into account appliance efficiency and usage patterns when evaluating energy consumption and pinpointing areas for optimization, as this emphasizes.

The table (3) shows the energy consumption of various laboratory equipment in kWh. It categorizes the equipment by type and the number of each type of equipment present in the lab. The Autoclave consumes the most energy at 90 kWh. Autoclaves are used for sterilization and typically use a lot of energy to heat up and maintain high pressure. Stirrers with hot plates consume the second most energy at 8 kWh, likely because they are used for long periods to heat and stir solutions. Ovens and Incubators also consume a relatively high amount of energy at 4 kWh each. This is because they need to maintain a constant temperature for extended periods.

Table 1 Department-wise number of electrical appliances A.Y. 2023-24

Department/Section	*Tube Light*	*CFL*	*Fan*	*Computer*	*Printers*	*A.C.*	*Projectors*	*Scanner*	*Photocopiers (Xerox)*	*Inverter*
Library	17	3	14	7	1	0	0	0	3	0
Principal's office	2	2	2	2	0	1	0	0	0	1
Administrative office	15	0	9	10	9	0	0	0	0	1
Computer	8	0	4	23	3	2	0	0	0	1
Information Technology	5	0	3	18	2	0	1	0	0	0
Multipurpose Hall	14	0	20	0	0	0	0	0	0	0
Play Ground	0	0	0	0	0	0	0	0	0	0
YCMU	4	0	2	4	2	0	0	0	2	0
Sport Room	4	0	2	1	1	0	0	0	0	0
Jim	12	0	9	0	0	0	0	0	0	0
Botany	18	8	1	1	1	1	0	0	0	0
Zoology	15	2	0	1	1	0	0	1	0	0
Zoology Research Lab	1	2	2	1	1	0	0	1	0	0
Microbiology	4	2	5	1	0	1	0	0	0	1
Electronics	10	5	6	12	0	0	1	0	0	0
Physics	16	6	0	10	3	0	0	0	0	1
Psychology	3	2	2	1	1	0	2	0	0	1
IQAC office	7	0	4	4	2	2	1	0	0	0
Conference Hall	6	0	2	0	0	1	1	0	0	0
BCA Lab	6	0	6	20	1	0	0	0	0	0
Staff Room	9	0	12	0	0	0	0	0	0	0
Ladies Room	5	0	6	0	0	0	0	0	0	0
English	4	0	3	2	1	0	1	0	0	0
Chemistry	20		4	2	1	0	0	0	0	0
Geography	10	4	6	12	2	0	1	0	0	0
Statistic	2	0	2	18	1	0	0	1	0	0
Mathematics	1	1	0	1	1	0	1	0	0	0
Total	218	37	126	151	34	8	9	3	5	6

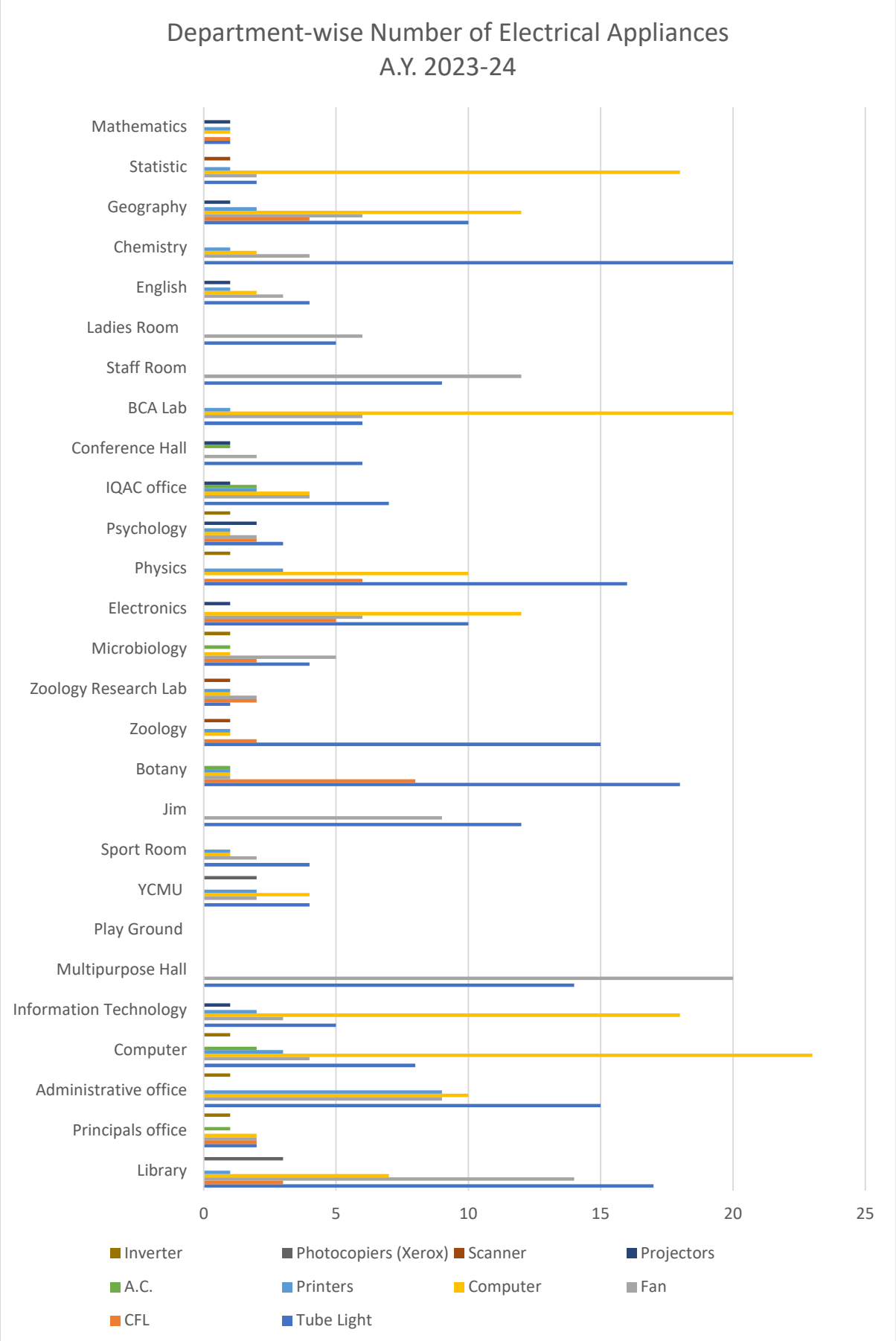


Figure 1 Department-wise Number of Electrical Appliances A.Y. 2023-24

Table 2 Department-wise Energy Consumption per day (kwh) A.Y. 2023-24

Department/Section	Tube Light	CFL	Fan	Computer	Printers	A.C.	Projectors	Scanner	Photocopiers (Xerox)	Inverter
Library	1.36	0.12	2.1	2.8	0.03	0	0	0	3.3	0
Principal's office	0.16	0.08	0.3	0.8	0	1.5	0	0	0	3.48
Administrative office	1.2	0	1.35	6	0.27	0	0	0	0	3.48
Computer	0.8	0	1.5	23	0.09	9	0.8	0	0	3.48
Information Technology	0.5	0	1.125	18	0.06	0	0.8	0	0	0
Multipurpose Hall	0.056	0	0.3	0	0	0	0	0	0	0
Play Ground	0	0	0	0	0	0	0	0	0	0
YCMU	0.016	0	0.15	0.8	0.06	0	0	0	2.2	0
Sport Room	0.016	0	0.03	0.1	0	0	0	0	0	0
Jim	0.24	0	0.675	0	0	0	0	0	0	0
Botany	0.72	0.16	0.075	0.2	0.03	0.75	0	0	0	0
Zoology	0.6	0.04	0	0.2	0.03	0	0	0.0006	0	0
Zoology Research Lab	0.04	0.04	0.15	0.2	0.03	0	0	0.0006	0	0
Microbiology	0.16	0.04	0.375	0.2	0	0.75	0	0	0	3.48
Electronics	0.4	0.1	0.45	2.4	0	0	0.16	0	0	0
Physics	0.64	0.12	0	2	0.09	0	0	0	0	3.48
Psychology	0.12	0.04	0.15	0.2	0.03	0	0.16	0	0	3.48
NAAC office	0.028	0	0.06	0.8	0.6	1.5	0.08	0	0	0
Conference Hall	0.024	0	0.03	0	0	0	0.08	0	0	0
BCA Lab	0.48	0	1.8	16	0	0	0	0	0	0
Staff Room	0.54	0	0.9	0	0	0	0	0	0	0
Ladies Room	0.3	0	0.45	0	0	0	0	0	0	0
English	0.16	0	0.225	0.4	0.03	0	0.08	0	0	0
Chemistry	0.8	0	0.3	0.4	0.03	0	0	0	0	0
Geography	0.4	0.08	0.45	2.4	0.06	0	0.04	0	0	0
Statistic	0.08	0	0.15	3.6	0.03	0	0	0.0006	0	0
Mathematics	0.04	0.02	0	0.2	0.03	0	0.08	0	0	0
Total	9.88	0.84	13.095	80.7	1.5	13.5	2.28	0.0018	5.5	20.88

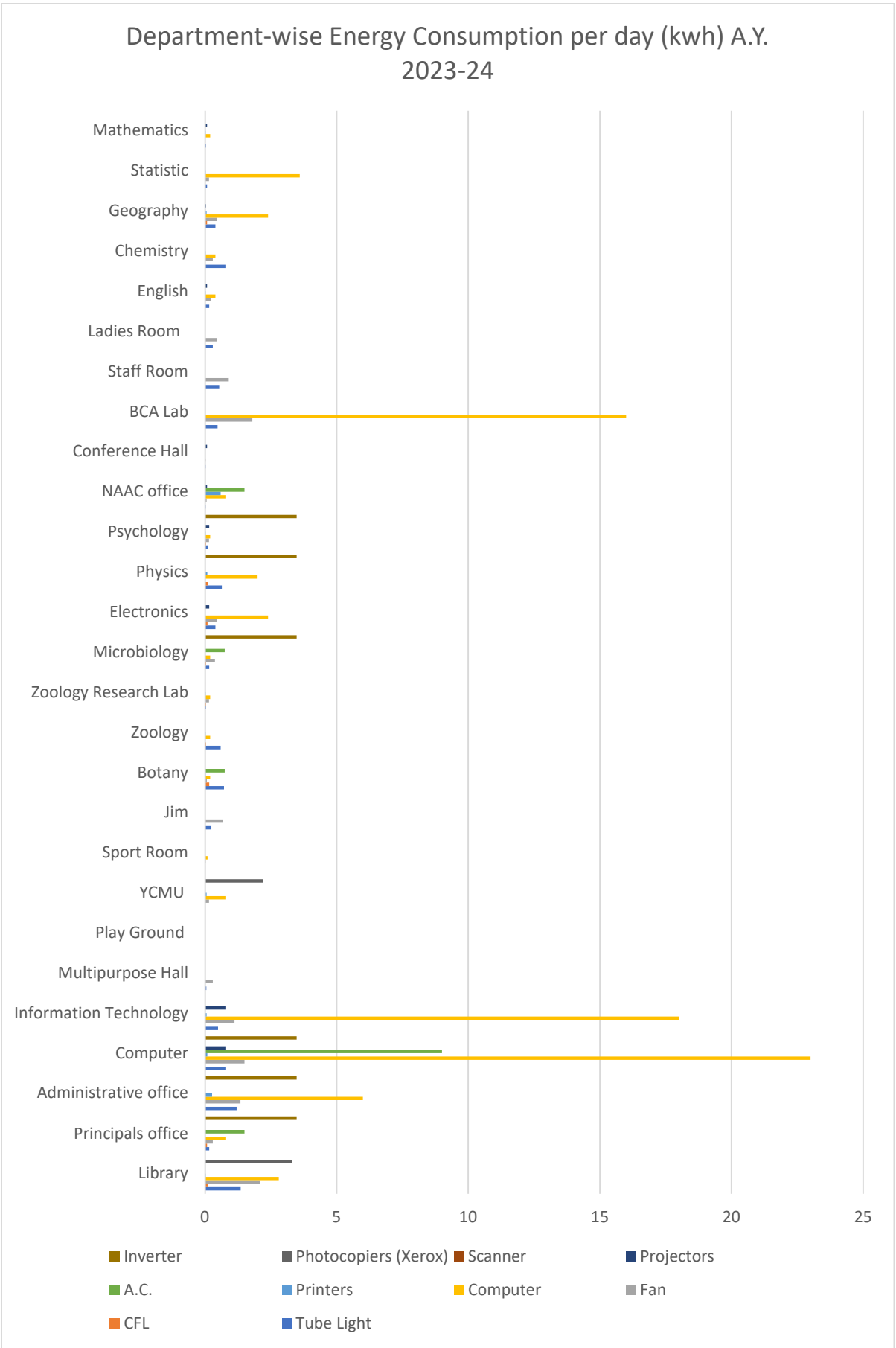


Figure 2 Department-wise Energy Consumption per day (kwh) A.Y. 2023-24

Table 3 List of instruments and its energy consumption

Laboratory equipment's	*Number of equipment's*	*Energy consumption (kWh)*
Water Filter	1	0.0125
Flood lamp	6	3
TV	2	0.5
Mixture	1	0.1
Hot Plates	4	2.4
Water bath	6	3
Incubator	5	0.25
Autoclave	4	18
Centrifugal pump	2	0.14
Spectrometer	3	0.375
Bio-spectrometer	1	0.125
Calorimeter	1	0.5
Fame photometer	1	0.5
Hot Plates	2	2
Oven	4	4
Stirrer with hot Plate	8	8
Tissue embedding centre	1	0.3
Slide staining Machine	1	8.5
Distillation Plant	1	0.05
BOD incubator	1	0.675
Cooling plants	1	0.4
Light Microscope	1	0.05
Laminator air flow	2	0.3
CRO	10	5
Function generator	10	0.0002
Power Supply	25	1.5
pH meter	5	0.005
Slide Projector	1	0.0115
Earth Globe	2	0.001
CCTV	10	3.6

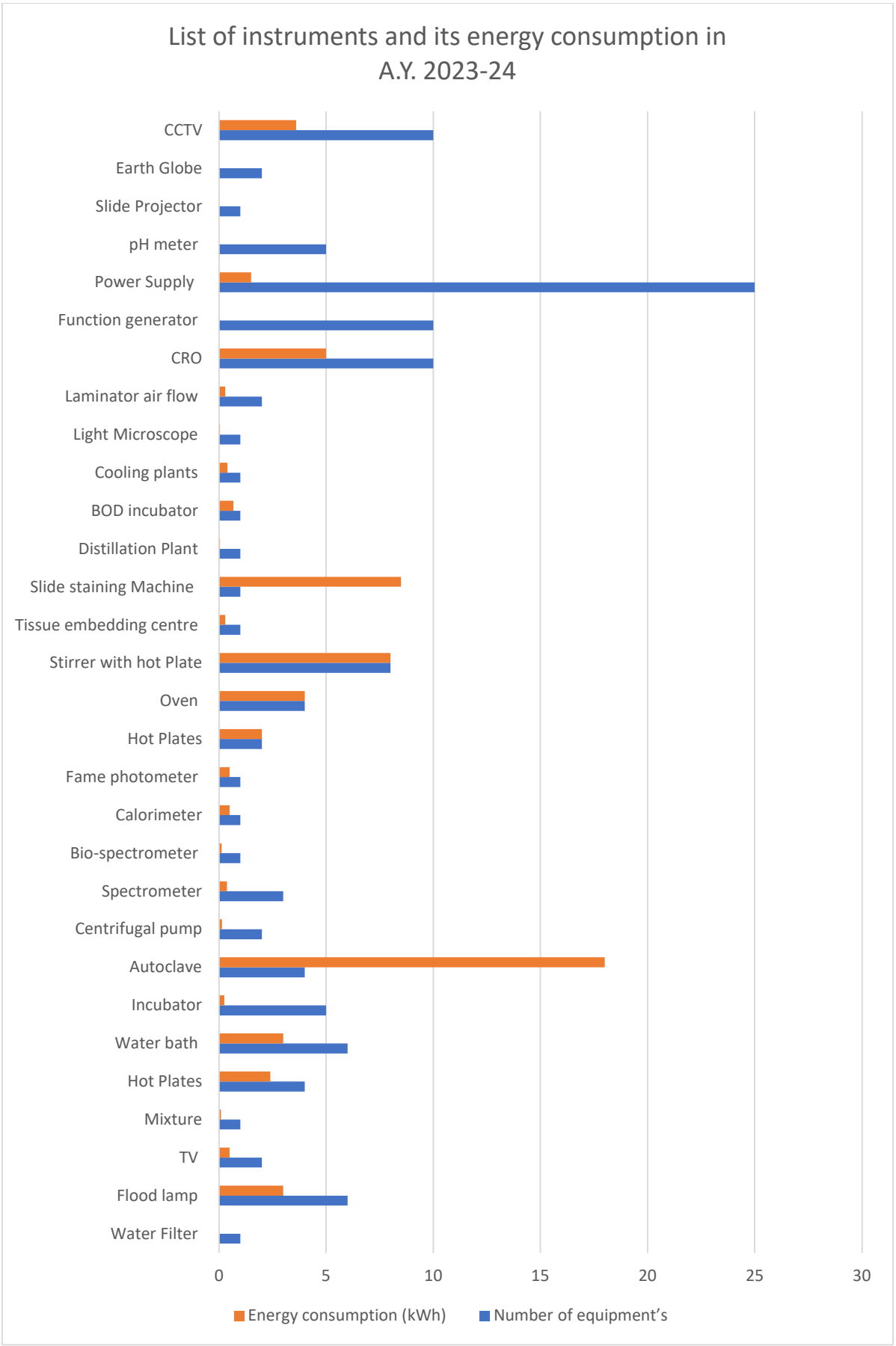


Figure 3 List of instruments and its energy consumption

Table 4 Details of Energy import and export from MSEDCL

Month	*Energy Consumption*	*Unit Produced by Renewable Source*	*Unit Balance*	*Unit Required From MSEB*	*Total Unit Save*
August 2023	998	452	0	546	452
September 2023	868	765	0	103	765
October 2023	986	830	0	156	830
November 2023	1031	1101	70	0	70
December 2023	1262	1318	56	0	56
January 2024	1209	1211	2	0	2
February 2024	1039	1132	93	0	93
March 2024	1321	1321	0	0	0
April 2024	1460	1442	-18	0	18
May 2024	782	837	55	0	55
June 2024	1523	1355	0	168	1355
July 2024	488	529	0	41	488

Total energy consumption from 1 August 2023 to 31 July 2024 = 12967 units

Total Unit Produced by Solar Panel from 1 August 2022 to 31 July 2023 = 12293 units

Energy Import to the MSEB = 932 units

Energy Export = 258 units

The college's total energy consumption for the period of August 1, 2023 to July 31, 2024 was 12967 units. The solar panels generated 12293 units during the same period. The college imported 932 units from MSEB and exported 258 units.

CONCLUSION

The key findings of the energy audit conducted at Rashtriya Sahakari Shikshan Prasarak Mandal Ltd., Chalisgaon Sanstha's Nanasaheb Yashvantrao Narayanrao Chavan Arts, Science & Commerce College are as follows:

1. Significant differences in energy consumption between the college's various departments and sections were found during the audit. The "Computer," "Administrative Office," and "Library" departments were identified as high energy users because of the abundance of electrical devices they had, including photocopiers, air conditioners, and computers. Conversely, spaces such as the "Sport Room," "Play Ground," and "Multipurpose Hall" showed very little energy use.

2. The audit made clear how much of an impact some appliances have on total energy use. Several departments found that the main sources of energy consumption were air conditioners and computers. This finding highlighted the significance of taking usage patterns and appliance efficiency into account when evaluating energy consumption.

3. The audit also looked at how much energy different lab equipment used. The highest energy consumption was discovered in autoclaves, which used 90 kWh, and stirrers with hot plates, which used 8 kWh. The requirement to maintain consistent temperatures for prolonged periods of time led to a relatively high energy consumption in ovens and incubators.

4. The audit underlined the value of encouraging faculty, staff, and students to behave in an energy-conscious manner in addition to investing in new equipment and upgraded infrastructure. Uncomplicated measures such as shutting off lights and appliances when not in use have been found to be important contributors to overall energy conservation initiatives.

These findings provide valuable insights into the college's energy usage patterns, highlighting areas of high energy consumption and opportunities for efficiency improvements. By implementing targeted strategies such as equipment upgrades, behavioral changes, and renewable energy integration, the college can work towards achieving its energy conservation goals while reducing operational costs and environmental impact. The college was able to generate a significant portion (12293 W) of its energy consumption through solar panels. There

was a net export of energy (258 units) to MSEB, indicating that the college produced more energy than it consumed.

In conclusion, the energy audit conducted at Rashtriya Sahakari Shikshan Prasarak Mandal Ltd., Chalisgaon Sanstha's Nanasaheb Yashvantrao Narayanrao Chavan Arts, Science & Commerce College has provided valuable insights into the college's energy consumption patterns and environmental impact. The audit uncovered notable disparities in the amount of energy used by various departments, with certain appliances—such as air conditioners and computers—emerging as the main energy consumers. The audit also emphasized the significance of encouraging stakeholders to adopt energy-conscious behavior and found chances for energy conservation through equipment upgrades and behavioral modifications. The college can improve its energy efficiency, lower operating expenses, and lessen its environmental impact by putting the audit report's recommendations into practice. These recommendations include maximizing appliance efficiency, encouraging energy-saving behaviors, and taking renewable energy options into consideration. All things considered, the energy audit is an invaluable resource that the college can use to advance sustainable initiatives, coordinate with environmental stewardship objectives, and encourage ethical energy management techniques. The college can make a positive impact on the environment and contribute to a more sustainable future by implementing the audit's recommendations and findings to transform the campus into one that is more environmentally conscious and energy-efficient.

RECOMMENDATIONS

- Tubes lights and bulbs: Despite being less energy-efficient than CFLs or LEDs, most departments still use tubes and bulbs for lighting. An important way to cut down on energy use is to switch out tubes and bulbs for CFLs or LEDs.
- Ceiling fans: In most departments, ceiling fans are the biggest energy users. Up to 50% less energy can be used by installing energy-efficient ceiling fans.
- Computers and monitors: Another significant energy user is a computer or monitor. Energy consumption can be decreased by encouraging users to turn off their computers and monitors when not in use.
- Printers and copiers: Additionally, copiers and printers can use a lot of energy. Duplex printing and copying can contribute to lower energy and paper usage.
- Projectors: Projectors can be energy-intensive. Using projectors in eco-mode can help to reduce energy consumption.
- Air conditioners: Air conditioners use a lot of energy. One way to cut down on energy use is to set thermostats to a higher temperature in the summer and a lower temperature in the winter.
- Lighting controls: Installing lighting controls, such as occupancy sensors and timers, can help to ensure that lights are only turned on when they are needed.
- Power management software: Putting computers in sleep mode when not in use through the installation of power management software can help reduce energy consumption.
- The college needs to keep funding and maintaining its solar energy system. Looking into more energy-saving options could help decrease dependency on imported energy and boost exports of energy.

REFERENCES

- The Environment [Protection] Act – 1986 (Amended 1991) & Rules-1986 (Amended 2010)
- The Petroleum Act: 1934 – The Petroleum Rules: 2002
- The Central Motor Vehicle Act: 1988 (Amended 2011) and The Central Motor Vehicle Rules:1989 (Amended in 2005)
- Energy Conservation Act 2010.
- The Air [Prevention & Control Of Pollution] Act – 1981 (Amended 1987) The Air (Prevention & Control of Pollution) Rules – 1982
- Electrical Act 2003 (Amended 2001) / Rules 1956 (Amended 2006)
- The Hazardous Waste (Management and Handling and Trans-boundary Movement) Rules, 2008 (Amended 2016)
- The Batteries (Management and Handling) Rules, 2001 (Amended 2010)
- Relevant Indian Standard Code practices
- Internal Records of the Campus, (A.Y.2023-24)

Energy Audit

Year 2022-23

Energy Audit

Rashtriya Sahakari Shikshan Prasarak Mandal Ltd., Chalisgaon Sanstha's

Nanasaheb Yashvantrao Narayanrao Chavan

Arts, Science & Commerce College

Chalisgaon, Dist - Jalgaon

CONTENTS

ACKNOWLEDGEMENT

Vikram GeoInfo Tech thanks the management of ***R.S.S.P. Mandal Ltd., Chalisgaon Sanstha's Nanasaheb Yashvantrao Narayanrao Chavan Arts, Science & Commerce College Chalisgaon, Dist - Jalgaon*** for assigning this important work of Energy Audit. Vikram GeoInfo Tech appreciates the cooperation in the completion of the study. Our special thanks are due to:

- Honourable Chairman, Bapusaheb Dr. Vinayak Yashwantrao Chavan
- Honourable Vice Chairwoman Taisaheb Pushpa Sadashiv Bhosale
- Honourable Secretary Abasaheb Prin. Balasaheb Vishwasrao Chavan
- Honourable Director Board Members of the college
- Prin. Dr. S. R. Jadhav
- IQAC Members
- Energy Audit coordinator
- Teaching & Supporting Staff of College

For giving us the necessary inputs to carry out this very vital exercise of Energy Audit. We are also thankful to other staff members who were actively involved while collecting the data and conducting field measurements.

C.V. M. Agone

(Dr. Vikram Agone)

Founder & Chairman

Vikram GeoInfo Tech

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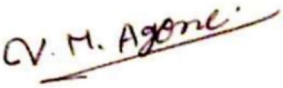
Report by: Lead Auditor



(Dr. Vikram Agone)

Founder & Chairman

Vikram GeoInfo Tech

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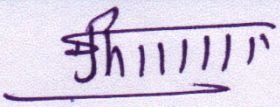
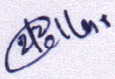
ENERGY AUDIT ASSESSMENT TEAM

Internal Auditor

NAME	POSITION	SIGNATURE
Prin. Dr. S. R. Jadhav	Principal & Chairman	
Dr. U. R. Magar	Vice-Principal	
Dr. G. D. Deshmukh	IQAC Coordinator & Vice-Principal	
Dr. G. B. Shelke	Member	
Dr. N. P. Golhar	Member	

External Auditor

NAME	POSITION	QUALIFICATION
Dr. Vikram Madhukar Agone	Lead Auditor	Ph.D. FRGS (UK)

INTRODUCTION

R.S.S.P. Mandal Ltd., Chalisgaon Sanstha's Nanasaheb Yashvantrao Narayanrao Chavan Arts, Science & Commerce College Chalisgaon, Dist - Jalgaon aims at creating awareness about energy conservation awareness. In an era where energy conservation and sustainability have become paramount, energy audits have emerged as a vital tool for individuals, businesses, and governments to assess, optimize, and reduce energy consumption. Energy is the lifeblood of modern society, powering our homes, industries, and economies. However, the indiscriminate use of energy resources has led to environmental concerns, rising costs, and a growing need for responsible energy management. Energy audits offer a systematic approach to address these challenges by evaluating energy usage patterns, identifying inefficiencies, and proposing actionable solutions to enhance energy performance.

An energy audit is a comprehensive assessment of an organization's or individual's energy consumption, focusing on both the supply and demand sides of energy utilization. It involves a detailed examination of energy systems, processes, and infrastructure to understand how energy is used and where improvements can be made.

Excessive energy consumption contributes to greenhouse gas emissions, climate change, and resource depletion. Energy audits help mitigate these impacts by reducing energy waste and optimizing resource utilization. Energy costs represent a significant portion of operating expenses for businesses and households. Energy audits can uncover cost-saving opportunities, making energy management a financially sound strategy. Many jurisdictions have implemented energy efficiency standards and mandates. Energy audits assist organizations in meeting these requirements and avoiding penalties. In a world increasingly focused on sustainability and responsible resource management, energy audits play a pivotal role in achieving these objectives. By uncovering energy inefficiencies, reducing costs, and lessening environmental impacts, energy audits empower individuals, businesses, and governments to make informed decisions and take meaningful steps towards a more sustainable and energy-efficient future.

One of the primary purposes of an energy audit is to identify opportunities for reducing energy consumption and, subsequently, energy costs. Educational institutions often have tight budgets, and energy expenses can be a significant portion of their operating costs. By identifying energy

efficiency measures, the institution can lower its utility bills and allocate more resources to educational programs and services.

Educational institutes have a responsibility to promote sustainability and environmental stewardship. Energy audits help identify ways to reduce energy consumption, lower greenhouse gas emissions, and minimize the institute's overall environmental footprint. This aligns with the institution's commitment to sustainability and can serve as an example for students and the community.

Educational institutes often have extensive facilities and equipment. Energy audits help in assessing the condition and efficiency of these assets, including HVAC systems, lighting, and electrical equipment. This information can inform maintenance and replacement strategies, ensuring that resources are used efficiently.

the purpose of an energy audit in an educational institute is multifaceted. It encompasses cost reduction, environmental responsibility, educational opportunities, regulatory compliance, asset management, and overall improvement in the institution's financial stability and sustainability efforts. Conducting energy audits aligns with the educational institution's mission to provide quality education while being socially and environmentally responsible.

The primary goal of an energy audit done by ***R.S.S.P. Mandal Ltd., Chalisgaon Sanstha's Nanasaheb Yashvantrao Narayanrao Chavan Arts, Science & Commerce College Chalisgaon, Dist - Jalgaon*** is to assess and analyze the energy consumption and utilization of a system, facility, or organization with the aim of identifying opportunities to improve energy efficiency, reduce energy costs, and minimize environmental impacts.

It helps in recognizing the necessity for colleges to figure around the academic years **2022-23** for energy conservation. Thus, the Energy audit forms the baseline survey to decide on the **energy consumption policy**.

ENERGY AUDIT

An energy audit is a survey of a building or process to determine how much energy is being used and to identify ways to reduce energy consumption. An energy audit is an inspection, survey, and analysis of energy flows for energy conservation in a building, process, or system. It is an assessment of the current energy use of a facility and a proposal for measures to reduce energy consumption. The results of an energy audit are typically presented in a report that includes recommendations for energy efficiency improvements. The report may also include estimates of the cost savings and environmental benefits of the recommended improvements.

The purpose of an energy audit is to identify the sources and uses of energy, measure the energy consumption and efficiency, and recommend ways to reduce energy waste and improve energy savings. An energy audit can be conducted at different levels of detail and scope, depending on the objectives and resources of the auditee. Some of the benefits of an energy audit include:

- Lowering energy bills and operating costs
- Enhancing environmental performance and reducing greenhouse gas emissions
- Improving occupant comfort and productivity
- Increasing asset value and marketability
- Complying with regulatory requirements and standards

In this context it becomes essential to adopt the system of the energy efficient Campus for the college which will lead to sustainable development and at the same time decrease a sizable amount of atmospheric pollution from the environment, conserve energy and many more. The National Assessment and Accreditation Council, New Delhi (NAAC) has made it compulsory that all Higher Educational Institutions should submit an annual Energy Audit Report. Moreover, it is part of the Corporate Social Responsibility of Higher Educational Institutions to ensure that they contribute towards the reduction of global warming through energy uses reduction measures. The energy audit Report aims at summarising the college's contribution and its activeness in creating awareness and consciousness in practically applying environmentally friendly measures towards an institute in A.Y. **2022-23**

ENVIRONMENTAL SETTING OF THE COLLEGE

The college has a sprawling pollution-free campus on the central part of Chalisgaon city. Chalisgaon is a city and taluka in Jalgaon district of Nashik Division, Maharashtra, and It is located on state Highway NH 211, NH 753J and Central Railway. The Tittur River flows through the city. Chalisgaon city has been situated at 356 m MSL altitude. Chalisgaon has a tropical climate with hot and humid summers and mild winters. The average temperature ranges from 27°C to 40°C in the summer and 12°C to 20°C in the winter. The city receives an average rainfall of 700 mm per year, most of which falls during the monsoon season (June to September). Chalisgaon is located at the foot hill of Ajanta Satmala Mountain range. The vegetation in Chalisgaon is mainly tropical deciduous forest. The city is home to a variety of trees and plants.

The college campus is spread over 4.038 acres (1.63 hectare) which include about 1.52-acre (0.61 hectare) sports ground. College is easily accessible by road for the rural area which is 25 km away. Although the campus is located near the residential area, the presence of a green belt considerably reduced noise pollution and provided fresh air on the campus. The College campus area has an academic building, library, parking, canteen and sports ground.

OVERVIEW OF INSTITUTE

Nanasaheb Yashwantrao Narayanrao Chavan Arts, Science and Commerce College is run by Rashtriya Sahakari Shikshan Prasarak Mandal Ltd., Chalisgaon (Jalgaon) Sanstha's. Established in 1953 in the form of a hostel the Institute now has 1 Senior College, 5 Junior Colleges (+ 2 Level), 21 Secondary Schools, 2 Primary Schools, 1 Ashramshala (residential school), 1 School for Blind Students, 5 Pre-Primary Schools, 5 hostels, 1 MCVC Unit and 1 Cooperative Consumer Stores.

At present about 25, 000 students are learning in all these schools, junior colleges, ashramshala and senior college. The Office-bearers of the Institute represent various fields like medicine, law, education, agriculture and business. The R. S. S. P. Mandal is run by visionary and committed Office-bearers and resultantly this is one of the well-known educational institutes in this region.

Nanasaheb Yashvantrao Narayanrao Chavan Arts, Science & Commerce College, Chalisgaon is run by Rashtriya Sahakari Shikshan Prasarak Mandal Ltd. Chalisgaon Dist. Jalgaon. The College was established in June 1984 and is affiliated to the North Maharashtra University, Jalgaon. The College is Grant-in-aid, affiliated and co-education system. The College was first accredited in January 2004 and was awarded B+ by the NAAC.

In the Second cycle of NAAC Reaccreditation our institute excelled and achieved "A" grade with CGPA 3.10, in 2012. Similarly, in 2013 North Maharashtra University, Jalgaon bestowed upon us 'Best College Award' in the University. In Academic Audit conducted by the University we were again given 'A' grade.

The college started with B. A, B. Com and B.Sc. During the course of time moved upward by adding various graduate, post-graduate and doctoral courses. To be in tune with the time of professionalism we also offer undergraduate programmes like B.C.A. and B.B.M. and PG course M.B.M.

The need of the hour is 'skill-based courses and this institute has rightly initiated the course like 10-Certificate, 06-Diploma, 06-Advanced Diploma Courses as Career Oriented Courses and One P. G. Diploma Course. M. Phil, and Ph. D. activities by the recognized guides are available on the campus of the College.

Every year our students secure ranks in university merit list some are gold medallists. Highly qualified staff along with academic growth of students complement by co-curricular and extra-curricular activities to nurture all round personality of our students.

Our students represent University at various levels in sports. We are always at 1st or 2nd position among the '10 Best Colleges in the University'. Our students are recipients of gold, silver and bronze medals at various events in university level cultural event: Yuvarang. Our respected Principal has been awarded "Best Centre In-charge Award" (Karya Gaurav Puraskar) by Yashwantrao Chavan Maharashtra Open University, Nashik.

The college has been recognized under 2(f) and 12 (b) by the UGC. The campus area of the college is 14284 sq. mts. And Women's hostel 1184.19 sq. mts. The college stands in a multi-storied, majestic building with various facilities. More than two thousand and four hundred students and studying in the college.

There is Library building with NRC for students and teachers, Playground and well-equipped Gymnasium. There is Canteen and Health Centre on the campus.

To enhance the potential of students in writing, compiling annual magazine 'Rashtriyata' is published. Some departments compile wall papers on certain subjects. In the competitive world and to prepare for competitive examination with the philanthropic contribution by our Ex-Principal we have been conducting State Level General Knowledge Quiz Competition every year.

The College also has a Study Centre of Yashwantrao Chavan Maharashtra Open University, Nasik. The Centre offers B. A., B. Com., M. A. and M. Com. Courses. The strength of students at the Centre almost equals to that of the strength of our regular courses.

Through this Centre we provide opportunity of learning to those who cannot attend regular college. Our respected Principal has been awarded 'Best Centre In-charge Award' (Karya Gaurav Puraskar) by Yashwantrao Chavan Maharashtra Open University, Nashik.

The faculties in our college are competent and committed and they upgrade the knowledge of their subjects by participating in state, national and international conferences and seminars. There are 21 Ph. D. holders and 6 are pursuing Ph. D.

Our faculty members also engage in Research projects. Most of the faculty members have published their Research articles in state, national, international level and online journals with impact factors. They are also authors of some books.

VISION

Imparting instruction in social sciences, humanities; business, commerce and management; basic and applied sciences with humanitarian, national and global outlook.

MISSION

Knowledge that liberates

AIMS AND OBJECTIVE

R.S.S.P. Mandal Ltd., Chalisgaon Sanstha's Nanasaheb Yashvantrao Narayanrao Chavan Arts, Science & Commerce College Chalisgaon, Dist - Jalgaon conducted an Energy auditing survey for the year 2022-23. The primary aim of an energy audit is to determine ways to reduce energy consumption per unit of product output or to lower operating costs. It serves to identify all the energy streams in a facility and quantifies energy usage according to its discrete functions. The following were the objectives:

- A baseline survey to recognize the real status of energy consumption.
- One of the main objectives is to identify where and how energy is being used in a facility. This includes understanding the energy consumption patterns and the efficiency of energy use.
- Energy audits aim to find opportunities to reduce energy usage without negatively impacting the operations. This could be through improved efficiency, process changes, or equipment upgrades.
- By identifying areas of energy waste and potential improvements, energy audits can help reduce operating costs.
- Energy audits can also help reduce the environmental impact of a facility by identifying ways to decrease energy consumption, which in turn reduces greenhouse gas emissions.
- The information gathered during an energy audit can be used to develop a comprehensive energy management plan, which includes strategies for ongoing energy efficiency and cost savings.
- Increasing and spreading the awareness for energy conservation and sustainable use of resources amongst the students, teaching and non-teaching staff members.
- Improving environmental standards of the institute.
- Financial savings through a reduction in energy use.

DATABASE AND METHODOLOGY

The present study is based on visits to the college, personal observations, and a primary database that was collected using sets of questionnaires and other survey tools.

- **Database**: The database refers to the collection of relevant data and information that are used to analyse the energy performance of a facility. The database may include:
    - Historical energy consumption and cost data
    - Energy bills and tariffs
    - Facility layout and floor plans
    - Equipment inventory and specifications
    - Operating schedules and conditions
    - Benchmarking data and industry standards
- **Methodology**: The methodology refers to the systematic approach and techniques that are used to conduct the energy audit. The methodology may include:
    - Defining the audit objectives and scope
    - Forming the audit team and assigning roles and responsibilities
    - Conducting a preliminary walk-through survey
    - Collecting and verifying data from various sources
    - Measuring and monitoring key energy parameters
    - Performing energy balance and analysis
    - Identifying energy saving opportunities and calculating savings potential
    - Evaluating the technical and economic feasibility of energy conservation measures
    - Preparing and presenting the audit report and recommendations

ANALYSIS OF THE DATABASE

The database has been prepared for statistical analysis for the energy audit using Minitab and IBM SPSS statistical software. The surveys from each group were tabulated in MS Excel spreadsheets. The tabulated data were further analyzed through statistical analysis and computing. For a better understanding of the results and to avoid complications, averages and percentages of the tables were taken. A graphical representation of these results was made to give a summarized picture of the status. The outcome was interpreted with the overall consequences, conclusion and plausible solutions or steps for them.

Energy Audit Report

ENERGY AUDIT

As per the Energy Conservation Act, 2001, Energy Audit is defined as "the verification, monitoring and analysis of the use of energy as well as submission of technical report containing recommendations for improving energy efficiency with cost-benefit analysis and an action plan to reduce energy consumption". Effective management of energy-consuming systems can lead to significant cost and energy savings as well as increased comfort, lower maintenance costs, and extended equipment life. A successful energy management program begins with a thorough energy audit. The energy audit evaluates the efficiency of all building and process systems that use energy.

Energy use is an important aspect of campus sustainability and thus requires no explanation for its inclusion in the assessment. An old incandescent bulb uses approximately 60W to 100W while an energy-efficient light emitting diode (LED) uses only less than 10 W. Energy auditing deals with the conservation and methods to reduce its consumption related to environmental degradation. It is therefore essential that any environmentally responsible institution examine its energy use practices.

One electricity meter is provided for the entire campus. There is **total energy consumption** for the college has been **191.907 kWh/day** for the A.Y. 2022-23. Laboratory equipment's have been **63.295 kwh/day** energy consumption, while other appliances have **128.611 kWh/day** energy consumption. The major difference in Energy consumption of various departments is due to the usage of various electronic and electrical equipment. Data are shown in Tables below for a comparison of no. of electrical appliances and energy consumption (kwh) per day in each Department/ Sections. The difference in no. of electrical appliances and energy consumption (kwh) used is reflected in their respective energy consumption. The emissions per unit of electricity in India are estimated to be in the range of 0.91 to 0.95 kg/kWh, in this way **college contribute 178.473 kg per day of CO_2 emission** to the atmosphere by using electrical energy for the A.Y. 2022-23 respectively.

The data highlights some notable findings.

The library is equipped with a substantial number of tube lights (17) and fans (14), essential for providing adequate lighting and ventilation conducive to studying. It also possesses a moderate number of computers (7) and printers (1), indicating access to digital resources and printing facilities for students and faculty. The presence of scanners (3) and photocopiers (3) further facilitates document reproduction and digitization, essential for academic research and study material distribution.

Principal's Office has a modest array of appliances, including tube lights (2), CFL bulbs (2), fans (2), and computers (2), suggesting a basic setup for administrative tasks and communication. The presence of an air conditioner (1) highlights the comfort factor in the principal's workspace, while the single photocopier (1) indicates a need for occasional document duplication.

Administrative Office is equipped with essential appliances like tube lights (15), fans (9), and computers (10), supporting administrative functions and communication within the institution. The presence of printers (9) and scanners (4) reflects a need for document handling and digital resource management in administrative tasks.

Computer Science department has a significant number of computers (23), along with other related equipment like tube lights (8), fans (4), printers (3), and scanners (2). This indicates a strong emphasis on computer-based learning and research within the department, supported by ample resources for both hardware and peripherals.

Information Technology department possesses a considerable number of computers (18) and related equipment like printers (2) and scanners (1). This reflects a focus on IT infrastructure and digital technology, essential for teaching and research in the field of information technology.

Multipurpose Hall primarily accommodates gatherings and events, as indicated by the presence of tube lights (14) and fans (20). The absence of computers or other electronic devices suggests a focus on physical activities or non-digital events within this section.

Play Ground as an outdoor recreational area, the playground understandably lacks electrical appliances, it has 6 flood lamps reflecting its nature as a space for physical activities and sports rather than academic or administrative functions.

YCMU section possesses a mix of appliances including tube lights (4), fans (2), computers (4), printers (2), and scanners (2), indicating a multifunctional space likely used for academic purposes and student activities. The presence of photocopiers (2) suggests a need for document duplication and distribution within this area.

The sport room is equipped with a moderate number of appliances including tube lights (4), fans (2), and computers (1), indicating a basic setup for administrative tasks or monitoring of sports-related activities. The presence of a photocopier (1) suggests a need for occasional document duplication within this space.

With a significant number of tube lights (12) and fans (9), the gymnasium ensures proper illumination and ventilation for physical workouts. The absence of computers or other electronic devices indicates a focus on exercise equipment and physical activities within this section.

The botany department possesses a diverse array of appliances including tube lights (18), CFL bulbs (8), fans (1), and computers (1), and many other research related instrument supporting both academic research and administrative tasks within the department. The presence of printers (1) and scanners (1) indicates a need for document handling and digital resource management in botanical research. Botany department owns a diverse array of appliances for research purpose like Mixture, Water bath, Incubator, Autoclave, Centrifugal pump, Spectrometer, Calorimeter and Fame photometer.

Zoology department equipped with appliances such as tube lights (15), CFL bulbs (2), and computers (1), supporting academic and administrative activities within the department. The presence of a photocopier (1) suggests a need for document duplication and distribution within this area. Zoology Research Lab with a modest array of appliances including tube lights (1), CFL bulbs (2), fans (2), and computers (1), the zoology research lab provides a conducive environment for scientific experimentation and data analysis within the department. Zoology Research Lab have single Hot Plates, Incubator, Centrifugal pump, Spectrometer, Oven, Stirrer with hot Plate, Tissue embedding center, Slide staining Machine, Distillation Plant, BOD incubator, Cooling plants, Bio-spectrometer and Light Microscope.

Microbiology department possesses a mix of appliances including tube lights (4), CFL bulbs (2), fans (5), and computers (1), Water bath, Incubator, Autoclave, Oven, Stirrer with hot plate, Laminator air flow supporting both academic research and administrative tasks within the

microbiology department. The presence of a photocopier (1) suggests a need for document duplication and distribution within this area.

Electronics has significant number of computers (12) and related equipment like tube lights (10), CFL bulbs (5), and fans (6), CRO and Function generator. The electronics department emphasizes hands-on learning and research in electronic systems and devices. The presence of a photocopier (1) suggests a need for document duplication and distribution within this area.

The physics department is equipped with a diverse array of appliances including tube lights (16), CFL bulbs (6), fans (10), and computers (3), CRO, Function generator, Stirrer with hot plate and Water bath supporting both theoretical studies and practical experimentation within the field of physics. The presence of printers (3) suggests a need for document handling and reproduction within this area.

Psychology department with a mix of appliances including tube lights (3), CFL bulbs (2), fans (2), and computers (1), the psychology department provides a conducive environment for academic research and counselling activities. The presence of scanners (2) and photocopiers (1) facilitates document management and duplication within this area.

The IQAC (Internal Quality Assurance Cell) office possesses a diverse array of appliances including tube lights (7), fans (4), computers (4), printers (2), and scanners (2), supporting quality assurance and academic accreditation activities within the institution. The presence of photocopiers (2) suggests a need for document duplication and distribution within this administrative office.

Conference Hall Equipped with appliances like tube lights (6), fans (2), and an air conditioner (1), the conference hall provides a comfortable and well-lit environment for academic conferences and meetings. The absence of computers or other electronic devices indicates a focus on presentations and discussions rather than digital activities within this space.

BCA Lab (Bachelor of Computer Applications) lab possesses a significant number of computers (20), along with other related equipment like tube lights (6) and fans (6), supporting practical learning and experimentation in computer science and programming. The presence of printers (1) suggests a need for document printing and reproduction within this lab.

The staff room is equipped with appliances such as tube lights (9) and fans (12), providing a comfortable and well-lit workspace for faculty and staff members. The absence of computers

or other electronic devices suggests a focus on administrative tasks and faculty interactions within this area.

Ladies Room section possesses appliances like tube lights (5) and fans (6), ensuring a comfortable environment for female faculty and staff members. The absence of computers or other electronic devices indicates a focus on restroom facilities rather than academic or administrative activities within this space.

English department Equipped with appliances like tube lights (4), CFL bulbs (3), fans (3), and computers (2), the English department provides a conducive environment for academic research and language studies. The presence of a photocopier (1) suggests a need for document duplication and distribution within this area.

The chemistry department is equipped with a diverse array of appliances including tube lights (20), CFL bulbs (4), fans (2), and computers (1), supporting both theoretical studies and practical experimentation within the field of chemistry. The presence of printers (1) suggests a need for document handling and reproduction within this area.

Geography department with a significant number of computers (12) and related equipment like tube lights (10), CFL bulbs (4), and fans (6), the geography department emphasizes digital mapping and spatial analysis in its academic curriculum. The presence of a photocopier (1) suggests a need for document duplication and distribution within this area.

Statistics department Equipped with a significant number of computers (18) and related equipment like tube lights (2), fans (1), and printers (1), the statistics department emphasizes data analysis and mathematical modelling in its academic curriculum. The presence of a photocopier (1) suggests a need for document duplication and distribution within this area.

The mathematics department is equipped with a modest array of appliances including tube lights (1), CFL bulbs (1), fans (1), and computers (1), and one projector supporting both theoretical studies and practical problem-solving activities within the field of mathematics. The presence of a printer (1) suggests a need for document printing and reproduction within this area.

The provided table (2) presents the energy consumption data for various departments or sections within the institution, measured in kilowatt-hours (kWh) for different types of electrical appliances. This data is crucial for conducting an energy audit to assess the energy

usage patterns and identify opportunities for energy efficiency improvements. Upon analysing the data, several key findings emerge:

The table (2) shows the energy consumption of various departments and sections of a building. The consumption is categorized by different appliances. For example, the library department uses 2.72 kWh of tube lights, 0.24 kWh of fans, 6.3 kWh of computers, 5.6 kWh of printers, 0.3 kWh of projectors, and 6.6 kWh of inverters. The computer lab consumes the most energy at 27.6 kWh, followed by the administrative office at 12 kWh and the library at 6.3 kWh. This is likely because computer labs typically have many computers that are running for long periods of time. Administrative offices may also have a number of computers and other electronic devices in use. Libraries, on the other hand, may have fewer computers but a higher use of lights. The Computer Lab has the highest overall consumption of 69.6 kWh. This is likely because it has a high number of computers (27.6 kWh) and printers (21.6 kWh). The library also has a high overall consumption of 6.6 kWh, likely due to the high number of tube lights (2.72 kWh).

Variation in Energy Consumption: There is a significant variation in energy consumption across different departments or sections. For example, departments like the "Library," "Administrative Office," "Computer," and "Psychology" exhibit relatively higher energy consumption due to the presence of multiple appliances such as computers, air conditioners, and photocopiers.

Identifying High Energy Consumers: The data highlights departments or sections that are high energy consumers, such as the "Computer" department and the "Administrative Office," where computers and air conditioners contribute significantly to energy usage. This indicates potential areas for implementing energy-saving measures to reduce overall energy consumption and operational costs.

Opportunities for Efficiency Improvements: The energy audit reveals opportunities for efficiency improvements in certain departments. For instance, departments like the "Multipurpose Hall," "Play Ground," and "Sport Room" show minimal or no energy consumption, suggesting the potential for implementing energy-efficient lighting solutions or optimizing energy usage in these areas.

Impact of Equipment Usage: The data also underscores the impact of equipment usage on energy consumption. Departments like "Microbiology" and "Psychology" show higher energy

consumption due to the continuous operation of equipment such as computers and air conditioners, indicating the need for optimizing equipment usage schedules or upgrading to energy-efficient models.

Importance of Behavioral Changes: Beyond equipment upgrades and infrastructure improvements, the data also underscores the importance of promoting energy-conscious behavior among faculty, staff, and students. Educating stakeholders about energy-saving practices and encouraging simple actions like turning off lights and equipment when not in use can contribute significantly to overall energy conservation efforts.

There is a notable discrepancy in energy consumption among different departments. Departments such as the "Computer" department, "Administrative Office," and "Library" stand out as significant energy consumers due to the presence of numerous electrical appliances like computers, air conditioners, and photocopiers. Conversely, areas like the "Multipurpose Hall," "Play Ground," and "Sport Room" exhibit minimal energy consumption, reflecting their lower dependency on electrical equipment. The data underscores the significant impact of specific appliances on overall energy usage. For instance, computers and air conditioners emerge as primary contributors to energy consumption in several departments. This highlights the importance of considering appliance efficiency and usage patterns when assessing energy consumption and identifying opportunities for optimization.

In conclusion, the energy audit report based on the provided table offers valuable insights into the institution's energy usage patterns, highlighting areas of high energy consumption and opportunities for efficiency improvements. By implementing targeted strategies such as equipment upgrades, behavioral changes, and renewable energy integration, the institution can work towards achieving its energy conservation goals while reducing operational costs and environmental impact.

The table (3) shows the energy consumption of various laboratory equipment in kWh. It categorizes the equipment by type and the number of each type of equipment present in the lab. The Autoclave consumes the most energy at 90 kWh. Autoclaves are used for sterilization and typically use a lot of energy to heat up and maintain high pressure. Stirrers with hot plates consume the second most energy at 8 kWh, likely because they are used for long periods to heat and stir solutions. Ovens and Incubators also consume a relatively high amount of energy at 4 kWh each. This is because they need to maintain a constant temperature for extended periods.

Table 1 Department-wise number of electrical appliances A.Y. 2022-23

Department/Section	*Tube Light*	*CFL*	*Fan*	*Computer*	*Printers*	*A.C.*	*Projectors*	*Scanner*	*Photocopiers (Xerox)*	*Inverter*
Library	17	3	14	7	1	0	0	0	3	0
Principal's office	2	2	2	2	0	1	0	0	0	1
Administrative office	15	0	9	10	9	0	0	0	0	1
Computer	8	0	4	23	3	2	0	0	0	1
Information Technology	5	0	3	18	2	0	1	0	0	0
Multipurpose Hall	14	0	20	0	0	0	0	0	0	0
Play Ground	0	0	0	0	0	0	0	0	0	0
YCMU	4	0	2	4	2	0	0	0	2	0
Sport Room	4	0	2	1	1	0	0	0	0	0
Jim	12	0	9	0	0	0	0	0	0	0
Botany	18	8	1	1	1	1	0	0	0	0
Zoology	15	2	0	1	1	0	0	1	0	0
Zoology Research Lab	1	2	2	1	1	0	0	1	0	0
Microbiology	4	2	5	1	0	1	0	0	0	1
Electronics	10	5	6	12	0	0	1	0	0	0
Physics	16	6	0	10	3	0	0	0	0	1
Psychology	3	2	2	1	1	0	2	0	0	1
IQAC office	7	0	4	4	2	2	1	0	0	0
Conference Hall	6	0	2	0	0	1	1	0	0	0
BCA Lab	6	0	6	20	1	0	0	0	0	0
Staff Room	9	0	12	0	0	0	0	0	0	0
Ladies Room	5	0	6	0	0	0	0	0	0	0
English	4	0	3	2	1	0	1	0	0	0
Chemistry	20		4	2	1	0	0	0	0	0
Geography	10	4	6	12	2	0	1	0	0	0
Statistic	2	0	2	18	1	0	0	1	0	0
Mathematics	1	1	0	1	1	0	1	0	0	0
Total	218	37	126	151	34	8	9	3	5	6

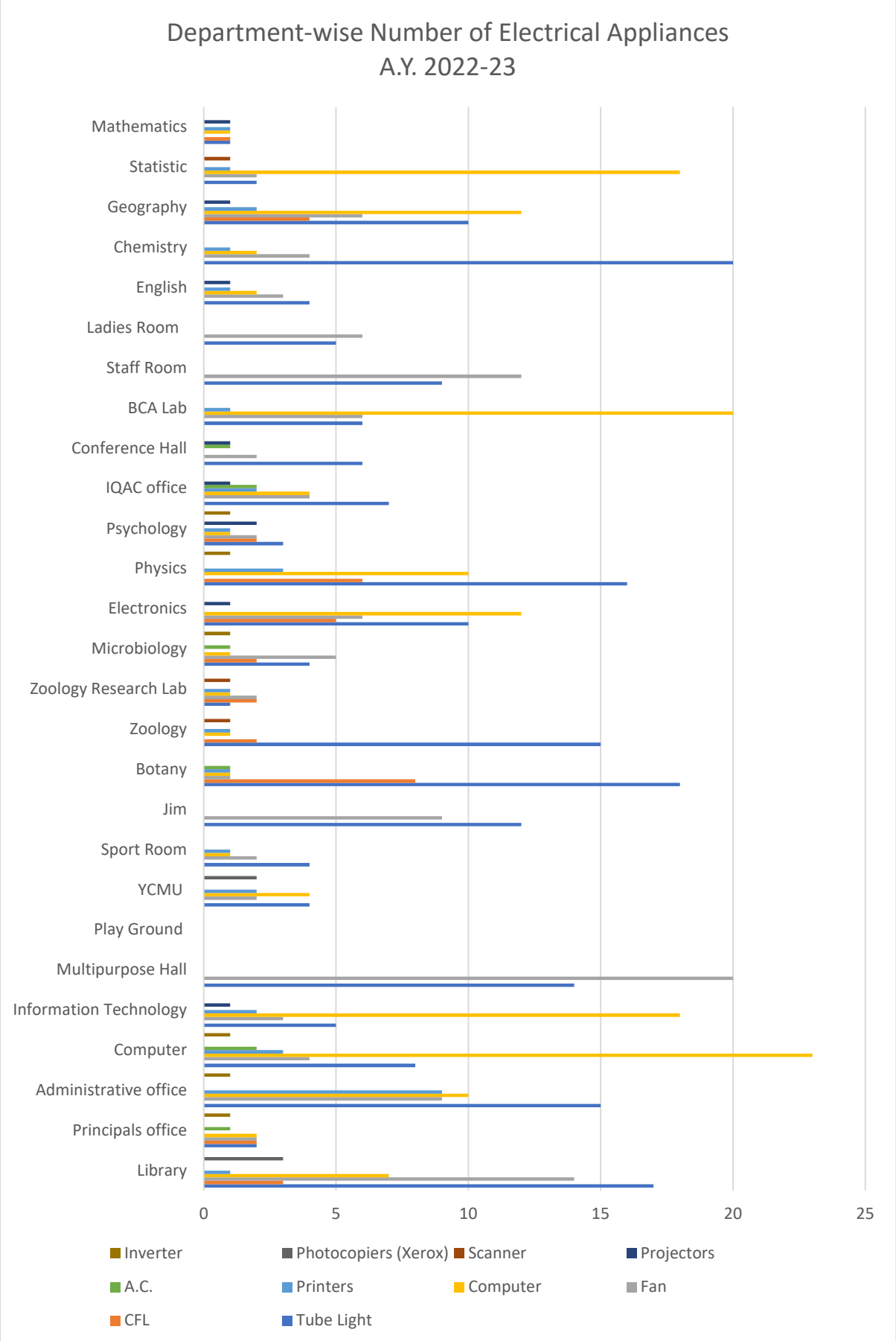


Figure 1 Department-wise Number of Electrical Appliances A.Y. 2022-23

Table 2 Department-wise Energy Consumption per day (kwh) A.Y. 2022-23

Department/Section	Tube Light	CFL	Fan	Computer	Printers	A.C.	Projectors	Scanner	Photocopiers (Xerox)	Inverter
Library	1.36	0.12	2.1	2.8	0.03	0	0	0	3.3	0
Principal's office	0.16	0.08	0.3	0.8	0	1.5	0	0	0	3.48
Administrative office	1.2	0	1.35	6	0.27	0	0	0	0	3.48
Computer	0.48	0	0.6	18.4	0.09	6	0	0	0	3.48
Information Technology	0.3	0	0.45	14.4	0.06	0	0.8	0	0	0
Multipurpose Hall	0.056	0	0.3	0	0	0	0	0	0	0
Play Ground	0	0	0	0	0	0	0	0	0	0
YCMU	0.016	0	0.15	0.8	0.06	0	0	0	2.2	0
Sport Room	0.016	0	0.03	0.1	0	0	0	0	0	0
Jim	0.24	0	0.675	0	0	0	0	0	0	0
Botany	0.72	0.16	0.075	0.2	0.03	0.75	0	0	0	0
Zoology	0.6	0.04	0	0.2	0.03	0	0	0.0006	0	0
Zoology Research Lab	0.04	0.04	0.15	0.2	0.03	0	0	0.0006	0	0
Microbiology	0.16	0.04	0.375	0.2	0	0.75	0	0	0	3.48
Electronics	0.4	0.1	0.45	2.4	0	0	0.16	0	0	0
Physics	0.64	0.12	0	2	0.09	0	0	0	0	3.48
Psychology	0.12	0.04	0.15	0.2	0.03	0	0.16	0	0	3.48
NAAC office	0.028	0	0.06	0.8	0.6	1.5	0.08	0	0	0
Conference Hall	0.024	0	0.03	0	0	0	0.08	0	0	0
BCA Lab	0.36	0	0.45	12	0	0	0	0	0	0
Staff Room	0.54	0	0.9	0	0	0	0	0	0	0
Ladies Room	0.3	0	0.45	0	0	0	0	0	0	0
English	0.16	0	0.225	0.4	0.03	0	0.08	0	0	0
Chemistry	0.8	0	0.3	0.4	0.03	0	0	0	0	0
Geography	0.4	0.08	0.45	2.4	0.06	0	0.04	0	0	0
Statistic	0.08	0	0.15	3.6	0.03	0	0	0.0006	0	0
Mathematics	0.04	0.02	0	0.2	0.03	0	0.08	0	0	0
Total	9.24	0.84	10.17	68.5	1.5	10.5	1.48	0.0018	5.5	20.88

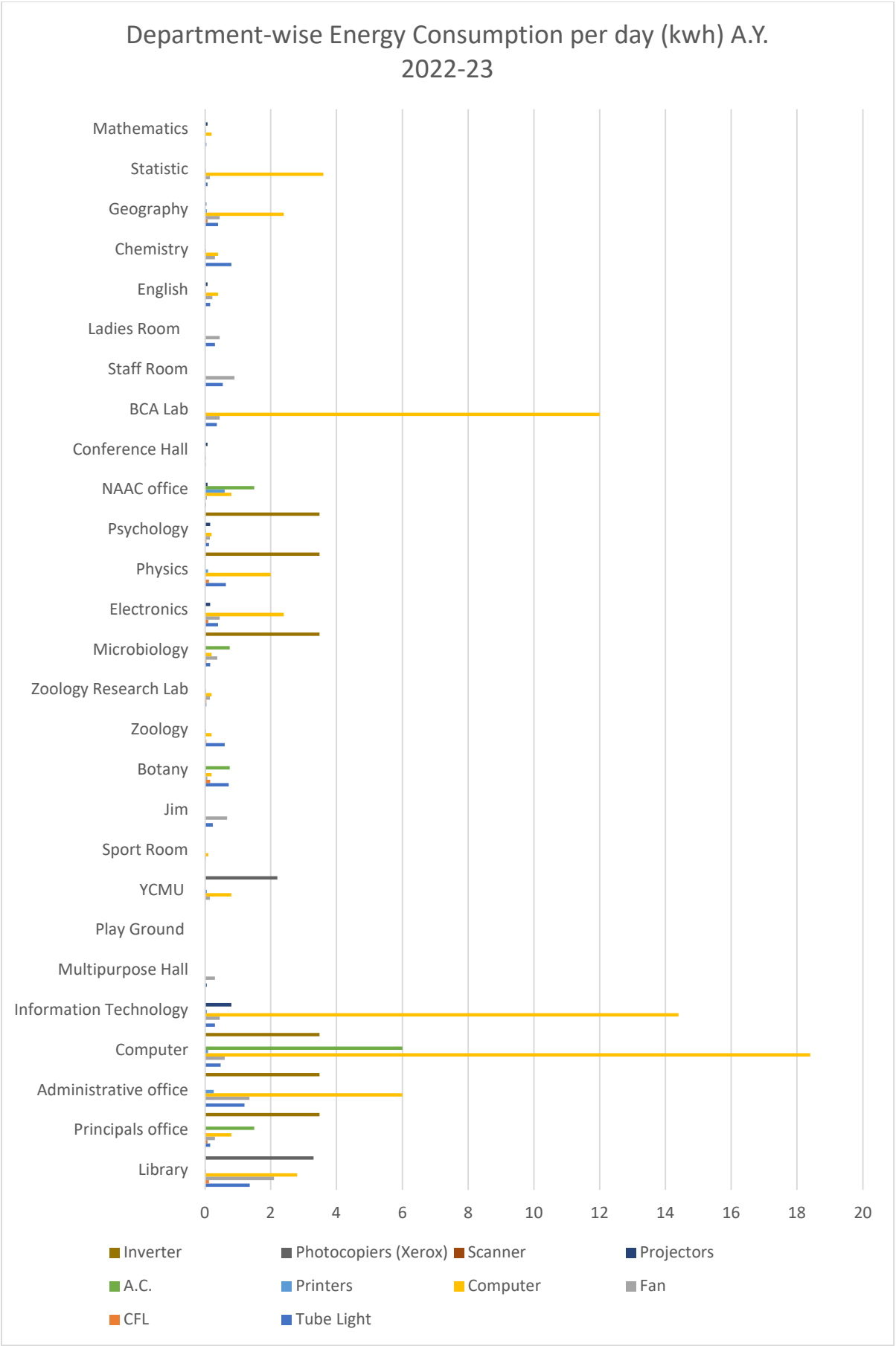


Figure 2 Department-wise Energy Consumption per day (kwh) A.Y. 2022-23

Table 3 List of instruments and its energy consumption

Laboratory equipment's	*Number of equipment's*	*Energy consumption (kWh)*
Water Filter	1	0.0125
Flood lamp	6	3
TV	2	0.5
Mixture	1	0.1
Hot Plates	4	2.4
Water bath	6	3
Incubator	5	0.25
Autoclave	4	18
Centrifugal pump	2	0.14
Spectrometer	3	0.375
Bio-spectrometer	1	0.125
Calorimeter	1	0.5
Fame photometer	1	0.5
Hot Plates	2	2
Oven	4	4
Stirrer with hot Plate	8	8
Tissue embedding centre	1	0.3
Slide staining Machine	1	8.5
Distillation Plant	1	0.05
BOD incubator	1	0.675
Cooling plants	1	0.4
Light Microscope	1	0.05
Laminator air flow	2	0.3
CRO	10	5
Function generator	10	0.0002
Power Supply	25	1.5
pH meter	5	0.005
Slide Projector	1	0.0115
Earth Globe	2	0.001
CCTV	10	3.6

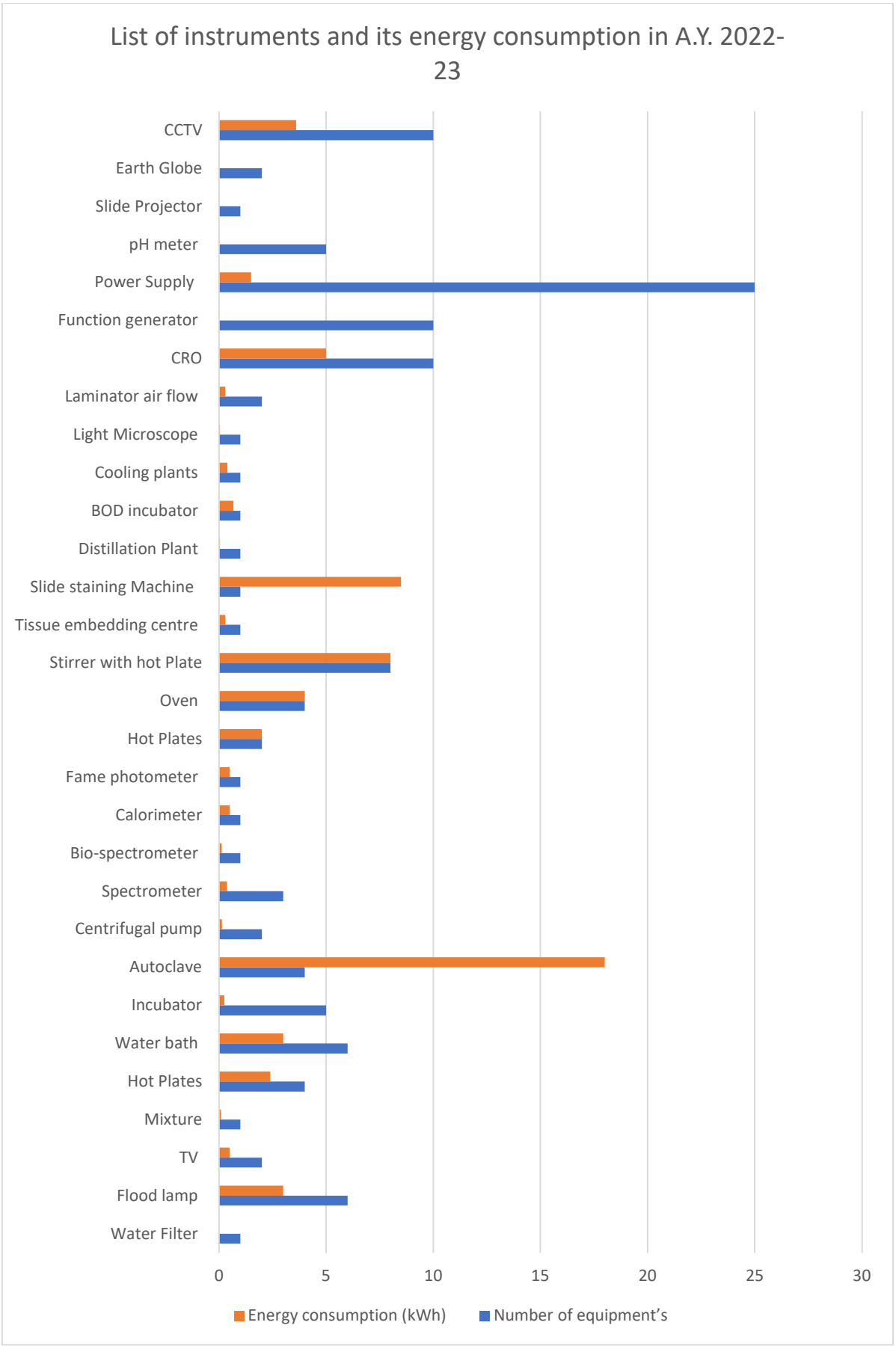


Figure 3 List of instruments and its energy consumption

Table 4 Details of Energy import and export from MSEDCL

Month	*Energy Consumption*	*Unit Produced by Renewable Source*	*Unit Balance*	*Unit Required From MSEB*	*Total Unit Save*
August 2022	987	477	0	396	-396
September 2022	845	778	0	67	-67
October 2022	954	840	0	114	-114
November 2022	1023	1112	89	0	89
December 2022	1256	1321	65	0	65
January 2023	1198	1214	16	0	16
February 2023	1045	1134	89	0	89
March 2023	1300	1323	23	0	23
April 2023	1400	1450	50	0	50
May 2023	776	847	71	0	24
June 2023	1513	1365	0	148	-148
July 2023	448	539	0	91	-91

Total energy consumption from 1 August 2022 to 31 July 2023 = 12745 units

Total Unit Produced by Solar Panel from 1 August 2022 to 31 July 2023 = 12400 units

Energy Import to the MSEB = 816 units

Energy Export per month = 458 units

The college's total energy consumption for the period of August 1, 2022 to July 31, 2023 was 12745 units. The solar panels generated 12400 units during the same period. The college imported 816 units from MSEB and exported 458 units.

CONCLUSION

The key findings of the energy audit conducted at Rashtriya Sahakari Shikshan Prasarak Mandal Ltd., Chalisgaon Sanstha's Nanasaheb Yashvantrao Narayanrao Chavan Arts, Science & Commerce College are as follows:

1. Variation in Energy Consumption: The audit identified significant variations in energy consumption among different departments and sections of the college. Departments such as the "Computer" department, "Administrative Office," and "Library" were noted as significant energy consumers due to the presence of numerous electrical appliances like computers, air conditioners, and photocopiers. In contrast, areas like the "Multipurpose Hall," "Play Ground," and "Sport Room" exhibited minimal energy consumption.

2. Impact of Specific Appliances: The audit highlighted the significant impact of specific appliances on overall energy usage. Computers and air conditioners were identified as primary contributors to energy consumption in several departments, emphasizing the importance of considering appliance efficiency and usage patterns when assessing energy consumption.

3. Laboratory Equipment Energy Consumption: The audit also analyzed the energy consumption of various laboratory equipment. Autoclaves were found to consume the most energy at 90 kWh, followed by stirrers with hot plates at 8 kWh. Ovens and incubators also consumed a relatively high amount of energy due to the need to maintain constant temperatures for extended periods.

4. Importance of Behavioral Changes: In addition to equipment upgrades and infrastructure improvements, the audit emphasized the importance of promoting energy-conscious behavior among faculty, staff, and students. Simple actions like turning off lights and equipment when not in use were identified as significant contributors to overall energy conservation efforts.

These findings provide valuable insights into the college's energy usage patterns, highlighting areas of high energy consumption and opportunities for efficiency improvements. By implementing targeted strategies such as equipment upgrades, behavioral changes, and renewable energy integration, the college can work towards achieving its energy conservation goals while reducing operational costs and environmental impact. The college was able to generate a significant portion (12400 W out of 12745 W) of its energy consumption through

solar panels. There was a net export of energy (458 W per month on average) to MSEB, indicating that the college produced more energy than it consumed.

In conclusion, the energy audit conducted at Rashtriya Sahakari Shikshan Prasarak Mandal Ltd., Chalisgaon Sanstha's Nanasaheb Yashvantrao Narayanrao Chavan Arts, Science & Commerce College has provided valuable insights into the college's energy consumption patterns and environmental impact. The audit revealed significant variations in energy usage among different departments, with specific appliances like computers and air conditioners emerging as primary contributors to energy consumption. Furthermore, the audit highlighted the importance of promoting energy-conscious behavior among stakeholders and identified opportunities for energy conservation through equipment upgrades and behavioral changes. By implementing the recommendations outlined in the audit report, including optimizing appliance efficiency, promoting energy-saving practices, and considering renewable energy options, the college can enhance its energy efficiency, reduce operational costs, and minimize its environmental footprint. Overall, the energy audit serves as a crucial tool for the college to enhance its sustainability efforts, align with environmental stewardship goals, and promote responsible energy management practices. By leveraging the findings and recommendations of the audit, the college can move towards a more energy-efficient and environmentally conscious campus, contributing to a greener and more sustainable future.

RECOMMENDATIONS

- Tubes lights and bulbs: The majority of departments are still using tubes lights and bulbs, which are less energy-efficient than CFLs or LEDs. Replacing tubes lights and bulbs with CFLs or LEDs can significantly reduce energy consumption.
- Ceiling fans: Ceiling fans are the largest energy consumer in most departments. Installing energy-efficient ceiling fans can reduce energy consumption by up to 50%.
- Computers and monitors: Computers and monitors are also major energy consumers. Encouraging users to turn off their computers and monitors when they are not in use can help to reduce energy consumption.
- Printers and copiers: Printers and copiers can also consume a significant amount of energy. Using duplex printing and copying can help to reduce paper consumption and energy use.
- Projectors: Projectors can be energy-intensive. Using projectors in eco-mode can help to reduce energy consumption.
- Air conditioners: Air conditioners are major energy consumers. Setting thermostats to a higher temperature in the summer and a lower temperature in the winter can help to reduce energy consumption.
- Lighting controls: Installing lighting controls, such as occupancy sensors and timers, can help to ensure that lights are only turned on when they are needed.
- Power management software: Installing power management software on computers can help to reduce energy consumption by putting computers into sleep mode when they are not in use.
- The college should continue to invest in and maintain its solar panel system. Exploring additional energy-saving measures could further reduce reliance on imported energy and increase exported energy.

REFERENCES

- The Environment [Protection] Act – 1986 (Amended 1991) & Rules-1986 (Amended 2010)
- The Petroleum Act: 1934 – The Petroleum Rules: 2002
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- Energy Conservation Act 2010.
- The Air [Prevention & Control Of Pollution] Act – 1981 (Amended 1987) The Air (Prevention & Control of Pollution) Rules – 1982
- Electrical Act 2003 (Amended 2001) / Rules 1956 (Amended 2006)
- The Hazardous Waste (Management and Handling and Trans-boundary Movement) Rules, 2008 (Amended 2016)
- The Batteries (Management and Handling) Rules, 2001 (Amended 2010)
- Relevant Indian Standard Code practices
- Internal Records of the Campus, (A.Y.2022-23)

Energy Audit

Year 2021-22

Energy Audit

Rashtriya Sahakari Shikshan Prasarak Mandal Ltd., Chalisgaon Sanstha's

Nanasaheb Yashvantrao Narayanrao Chavan

Arts, Science & Commerce College

Chalisgaon, Dist - Jalgaon

CONTENTS

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- Honourable Vice Chairwoman Taisaheb Pushpa Sadashiv Bhosale
- Honourable Secretary Abasaheb Prin. Balasaheb Vishwasrao Chavan
- Honourable Director Board Members of the college
- Prin. Dr. S. R. Jadhav
- IQAC Members
- Energy Audit coordinator
- Teaching & Supporting Staff of College

For giving us the necessary inputs to carry out this very vital exercise of Energy Audit. We are also thankful to other staff members who were actively involved while collecting the data and conducting field measurements.

C.V. M. Agone

(Dr. Vikram Agone)

Founder & Chairman

Vikram Geoinfo Tech

Vikram Geoinfo Tech

Revealing Earth Information

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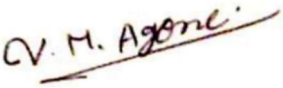
Report by: Lead Auditor



(Dr. Vikram Agone)

Founder & Chairman

Vikram Geoinfo Tech

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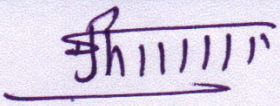
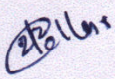
ENERGY AUDIT ASSESSMENT TEAM

Internal Auditor

NAME	POSITION	SIGNATURE
Prin. Dr. S. R. Jadhav	Principal & Chairman	
Dr. U. R. Magar	Vice-Principal	
Dr. G. D. Deshmukh	IQAC Coordinator & Vice-Principal	
Dr. G. B. Shelke	Member	
Dr. N. P. Golhar	Member	

External Auditor

NAME	POSITION	QUALIFICATION
Dr. Vikram Madhukar Agone	Lead Auditor	Ph.D. FRGS (UK)

INTRODUCTION

R.S.S.P. Mandal Ltd., Chalisgaon Sanstha's Nanasaheb Yashvantrao Narayanrao Chavan Arts, Science & Commerce College Chalisgaon, Dist - Jalgaon aims at creating awareness about energy conservation awareness. In an era where energy conservation and sustainability have become paramount, energy audits have emerged as a vital tool for individuals, businesses, and governments to assess, optimize, and reduce energy consumption. Energy is the lifeblood of modern society, powering our homes, industries, and economies. However, the indiscriminate use of energy resources has led to environmental concerns, rising costs, and a growing need for responsible energy management. Energy audits offer a systematic approach to address these challenges by evaluating energy usage patterns, identifying inefficiencies, and proposing actionable solutions to enhance energy performance.

An energy audit is a comprehensive assessment of an organization's or individual's energy consumption, focusing on both the supply and demand sides of energy utilization. It involves a detailed examination of energy systems, processes, and infrastructure to understand how energy is used and where improvements can be made.

Excessive energy consumption contributes to greenhouse gas emissions, climate change, and resource depletion. Energy audits help mitigate these impacts by reducing energy waste and optimizing resource utilization. Energy costs represent a significant portion of operating expenses for businesses and households. Energy audits can uncover cost-saving opportunities, making energy management a financially sound strategy. Many jurisdictions have implemented energy efficiency standards and mandates. Energy audits assist organizations in meeting these requirements and avoiding penalties. In a world increasingly focused on sustainability and responsible resource management, energy audits play a pivotal role in achieving these objectives. By uncovering energy inefficiencies, reducing costs, and lessening environmental impacts, energy audits empower individuals, businesses, and governments to make informed decisions and take meaningful steps towards a more sustainable and energy-efficient future.

One of the primary purposes of an energy audit is to identify opportunities for reducing energy consumption and, subsequently, energy costs. Educational institutions often have tight budgets, and energy expenses can be a significant portion of their operating costs. By identifying energy

efficiency measures, the institution can lower its utility bills and allocate more resources to educational programs and services.

Educational institutes have a responsibility to promote sustainability and environmental stewardship. Energy audits help identify ways to reduce energy consumption, lower greenhouse gas emissions, and minimize the institute's overall environmental footprint. This aligns with the institution's commitment to sustainability and can serve as an example for students and the community.

Educational institutes often have extensive facilities and equipment. Energy audits help in assessing the condition and efficiency of these assets, including HVAC systems, lighting, and electrical equipment. This information can inform maintenance and replacement strategies, ensuring that resources are used efficiently.

the purpose of an energy audit in an educational institute is multifaceted. It encompasses cost reduction, environmental responsibility, educational opportunities, regulatory compliance, asset management, and overall improvement in the institution's financial stability and sustainability efforts. Conducting energy audits aligns with the educational institution's mission to provide quality education while being socially and environmentally responsible.

The primary goal of an energy audit done by ***R.S.S.P. Mandal Ltd., Chalisgaon Sanstha's Nanasaheb Yashvantrao Narayanrao Chavan Arts, Science & Commerce College Chalisgaon, Dist - Jalgaon*** is to assess and analyze the energy consumption and utilization of a system, facility, or organization with the aim of identifying opportunities to improve energy efficiency, reduce energy costs, and minimize environmental impacts.

It helps in recognizing the necessity for colleges to figure around the academic years **2021-22** for energy conservation. Thus, the Energy audit forms the baseline survey to decide on the **energy consumption policy**.

ENERGY AUDIT

An energy audit is a survey of a building or process to determine how much energy is being used and to identify ways to reduce energy consumption. An energy audit is an inspection, survey, and analysis of energy flows for energy conservation in a building, process, or system. It is an assessment of the current energy use of a facility and a proposal for measures to reduce energy consumption. The results of an energy audit are typically presented in a report that includes recommendations for energy efficiency improvements. The report may also include estimates of the cost savings and environmental benefits of the recommended improvements.

The purpose of an energy audit is to identify the sources and uses of energy, measure the energy consumption and efficiency, and recommend ways to reduce energy waste and improve energy savings. An energy audit can be conducted at different levels of detail and scope, depending on the objectives and resources of the auditee. Some of the benefits of an energy audit include:

- Lowering energy bills and operating costs
- Enhancing environmental performance and reducing greenhouse gas emissions
- Improving occupant comfort and productivity
- Increasing asset value and marketability
- Complying with regulatory requirements and standards

In this context it becomes essential to adopt the system of the energy efficient Campus for the college which will lead to sustainable development and at the same time decrease a sizable amount of atmospheric pollution from the environment, conserve energy and many more. The National Assessment and Accreditation Council, New Delhi (NAAC) has made it compulsory that all Higher Educational Institutions should submit an annual Energy Audit Report. Moreover, it is part of the Corporate Social Responsibility of Higher Educational Institutions to ensure that they contribute towards the reduction of global warming through energy uses reduction measures. The energy audit Report aims at summarising the college's contribution and its activeness in creating awareness and consciousness in practically applying environmentally friendly measures towards an institute in A.Y. **2021-22**

ENVIRONMENTAL SETTING OF THE COLLEGE

The college has a sprawling pollution-free campus on the central part of Chalisgaon city. Chalisgaon is a city and taluka in Jalgaon district of Nashik Division, Maharashtra, and It is located on state Highway NH 211, NH 753J and Central Railway. The Tittur River flows through the city. Chalisgaon city has been situated at 356 m MSL altitude. Chalisgaon has a tropical climate with hot and humid summers and mild winters. The average temperature ranges from 27°C to 40°C in the summer and 12°C to 20°C in the winter. The city receives an average rainfall of 700 mm per year, most of which falls during the monsoon season (June to September). Chalisgaon is located at the foot hill of Ajanta Satmala Mountain range. The vegetation in Chalisgaon is mainly tropical deciduous forest. The city is home to a variety of trees and plants.

The college campus is spread over 4.038 acres (1.63 hectare) which include about 1.52-acre (0.61 hectare) sports ground. College is easily accessible by road for the rural area which is 25 km away. Although the campus is located near the residential area, the presence of a green belt considerably reduced noise pollution and provided fresh air on the campus. The College campus area has an academic building, library, parking, canteen and sports ground.

OVERVIEW OF INSTITUTE

Nanasaheb Yashwantrao Narayanrao Chavan Arts, Science and Commerce College is run by Rashtriya Sahakari Shikshan Prasarak Mandal Ltd., Chalisgaon (Jalgaon) Sanstha's. Established in 1953 in the form of a hostel the Institute now has 1 Senior College, 5 Junior Colleges (+ 2 Level), 21 Secondary Schools, 2 Primary Schools, 1 Ashramshala (residential school), 1 School for Blind Students, 5 Pre-Primary Schools, 5 hostels, 1 MCVC Unit and 1 Cooperative Consumer Stores.

At present about 25, 000 students are learning in all these schools, junior colleges, ashramshala and senior college. The Office-bearers of the Institute represent various fields like medicine, law, education, agriculture and business. The R. S. S. P. Mandal is run by visionary and committed Office-bearers and resultantly this is one of the well-known educational institutes in this region.

Nanasaheb Yashvantrao Narayanrao Chavan Arts, Science & Commerce College, Chalisgaon is run by Rashtriya Sahakari Shikshan Prasarak Mandal Ltd. Chalisgaon Dist. Jalgaon. The College was established in June 1984 and is affiliated to the North Maharashtra University, Jalgaon. The College is Grant-in-aid, affiliated and co-education system. The College was first accredited in January 2004 and was awarded B+ by the NAAC.

In the Second cycle of NAAC Reaccreditation our institute excelled and achieved "A" grade with CGPA 3.10, in 2012. Similarly, in 2013 North Maharashtra University, Jalgaon bestowed upon us 'Best College Award' in the University. In Academic Audit conducted by the University we were again given 'A' grade.

The college started with B. A, B. Com and B.Sc. During the course of time moved upward by adding various graduate, post-graduate and doctoral courses. To be in tune with the time of professionalism we also offer undergraduate programmes like B.C.A. and B.B.M. and PG course M.B.M.

The need of the hour is 'skill-based courses and this institute has rightly initiated the course like 10-Certificate, 06-Diploma, 06-Advanced Diploma Courses as Career Oriented Courses and One P. G. Diploma Course. M. Phil, and Ph. D. activities by the recognized guides are available on the campus of the College.

Every year our students secure ranks in university merit list some are gold medallists. Highly qualified staff along with academic growth of students complement by co-curricular and extra-curricular activities to nurture all round personality of our students.

Our students represent University at various levels in sports. We are always at 1st or 2nd position among the '10 Best Colleges in the University'. Our students are recipients of gold, silver and bronze medals at various events in university level cultural event: Yuvarang. Our respected Principal has been awarded "Best Centre In-charge Award" (Karya Gaurav Puraskar) by Yashwantrao Chavan Maharashtra Open University, Nashik.

The college has been recognized under 2(f) and 12 (b) by the UGC. The campus area of the college is 14284 sq. mts. And Women's hostel 1184.19 sq. mts. The college stands in a multi-storied, majestic building with various facilities. More than two thousand and four hundred students and studying in the college.

There is Library building with NRC for students and teachers, Playground and well-equipped Gymnasium. There is Canteen and Health Centre on the campus.

To enhance the potential of students in writing, compiling annual magazine 'Rashtriyata' is published. Some departments compile wall papers on certain subjects. In the competitive world and to prepare for competitive examination with the philanthropic contribution by our Ex-Principal we have been conducting State Level General Knowledge Quiz Competition every year.

The College also has a Study Centre of Yashwantrao Chavan Maharashtra Open University, Nasik. The Centre offers B. A., B. Com., M. A. and M. Com. Courses. The strength of students at the Centre almost equals to that of the strength of our regular courses.

Through this Centre we provide opportunity of learning to those who cannot attend regular college. Our respected Principal has been awarded 'Best Centre In-charge Award' (Karya Gaurav Puraskar) by Yashwantrao Chavan Maharashtra Open University, Nashik.

The faculties in our college are competent and committed and they upgrade the knowledge of their subjects by participating in state, national and international conferences and seminars. There are 21 Ph. D. holders and 6 are pursuing Ph. D.

Our faculty members also engage in Research projects. Most of the faculty members have published their Research articles in state, national, international level and online journals with impact factors. They are also authors of some books.

VISION

Imparting instruction in social sciences, humanities; business, commerce and management; basic and applied sciences with humanitarian, national and global outlook.

MISSION

Knowledge that liberates

AIMS AND OBJECTIVE

R.S.S.P. Mandal Ltd., Chalisgaon Sanstha's Nanasaheb Yashvantrao Narayanrao Chavan Arts, Science & Commerce College Chalisgaon, Dist - Jalgaon conducted an Energy auditing survey for the year 2021-22. The primary aim of an energy audit is to determine ways to reduce energy consumption per unit of product output or to lower operating costs. It serves to identify all the energy streams in a facility and quantifies energy usage according to its discrete functions. The following were the objectives:

- A baseline survey to recognize the real status of energy consumption.
- One of the main objectives is to identify where and how energy is being used in a facility. This includes understanding the energy consumption patterns and the efficiency of energy use.
- Energy audits aim to find opportunities to reduce energy usage without negatively impacting the operations. This could be through improved efficiency, process changes, or equipment upgrades.
- By identifying areas of energy waste and potential improvements, energy audits can help reduce operating costs.
- Energy audits can also help reduce the environmental impact of a facility by identifying ways to decrease energy consumption, which in turn reduces greenhouse gas emissions.
- The information gathered during an energy audit can be used to develop a comprehensive energy management plan, which includes strategies for ongoing energy efficiency and cost savings.
- Increasing and spreading the awareness for energy conservation and sustainable use of resources amongst the students, teaching and non-teaching staff members.
- Improving environmental standards of the institute.
- Financial savings through a reduction in energy use.

DATABASE AND METHODOLOGY

The present study is based on visits to the college, personal observations, and a primary database that was collected using sets of questionnaires and other survey tools.

- **Database**: The database refers to the collection of relevant data and information that are used to analyse the energy performance of a facility. The database may include:
    - Historical energy consumption and cost data
    - Energy bills and tariffs
    - Facility layout and floor plans
    - Equipment inventory and specifications
    - Operating schedules and conditions
    - Benchmarking data and industry standards
- **Methodology**: The methodology refers to the systematic approach and techniques that are used to conduct the energy audit. The methodology may include:
    - Defining the audit objectives and scope
    - Forming the audit team and assigning roles and responsibilities
    - Conducting a preliminary walk-through survey
    - Collecting and verifying data from various sources
    - Measuring and monitoring key energy parameters
    - Performing energy balance and analysis
    - Identifying energy saving opportunities and calculating savings potential
    - Evaluating the technical and economic feasibility of energy conservation measures
    - Preparing and presenting the audit report and recommendations

ANALYSIS OF THE DATABASE

The database has been prepared for statistical analysis for the energy audit using Minitab and IBM SPSS statistical software. The surveys from each group were tabulated in MS Excel spreadsheets. The tabulated data were further analyzed through statistical analysis and computing. For a better understanding of the results and to avoid complications, averages and percentages of the tables were taken. A graphical representation of these results was made to give a summarized picture of the status. The outcome was interpreted with the overall consequences, conclusion and plausible solutions or steps for them.

Energy Audit Report

ENERGY AUDIT

As per the Energy Conservation Act, 2001, Energy Audit is defined as "the verification, monitoring and analysis of the use of energy as well as submission of technical report containing recommendations for improving energy efficiency with cost-benefit analysis and an action plan to reduce energy consumption". Effective management of energy-consuming systems can lead to significant cost and energy savings as well as increased comfort, lower maintenance costs, and extended equipment life. A successful energy management program begins with a thorough energy audit. The energy audit evaluates the efficiency of all building and process systems that use energy.

Energy use is an important aspect of campus sustainability and thus requires no explanation for its inclusion in the assessment. An old incandescent bulb uses approximately 60W to 100W while an energy-efficient light emitting diode (LED) uses only less than 10 W. Energy auditing deals with the conservation and methods to reduce its consumption related to environmental degradation. It is therefore essential that any environmentally responsible institution examine its energy use practices.

One electricity meter is provided for the entire campus. There is **energy consumption** for the college has been **191.907 kWh/day** for the A.Y. 2021-22. The total energy consumption of the college over A.Y. 2021-22 is **11,373.536 kWh**. Laboratory equipment's have been **63.295 kwh/day** energy consumption, while other appliances have **128.611 kWh/day** energy consumption. The major difference in Energy consumption of various departments is due to the usage of various electronic and electrical equipment. Data are shown in Tables below for a comparison of no. of electrical appliances and energy consumption (kwh) per day in each Department/ Sections. The difference in no. of electrical appliances and energy consumption (kwh) used is reflected in their respective energy consumption. The emissions per unit of electricity in India are estimated to be in the range of 0.91 to 0.95 kg/kWh, in this way Total energy produce by Non-renewable energy sources has been 914 w, in this way college contribute **54.28 kg of CO_2 emission** to the atmosphere by using electrical energy for the A.Y. 2021-22.

The data highlights some notable findings. The library has a good number of tube lights (17) and fans (14), which are necessary to provide sufficient ventilation and lighting for studying. Additionally, it has a reasonable number of computers (7) and printers (1), indicating that teachers and students have access to digital resources and printing facilities. The availability of photocopiers (3) and scanners (3) makes it even easier to reproduce and digitize documents, which is crucial for study materials and scholarly research. The Principal's Office has a modest array of appliances, with two tube lights, two CFL bulbs, two fans, and two computers, indicating a simple configuration for communication and administrative work. The principal's workspace is made comfortable by the air conditioner (1), but the one photocopier (1) suggests that document duplication is occasionally necessary. The Administrative Office is furnished with necessary equipment, such as computers (10), fans (9), and tube lights (15), to facilitate communication and administrative tasks within the organization. The number of printers (9) and scanners (4) indicates the necessity of digital resource management and document handling for administrative tasks. The department of computer science has a sizable number of computers (23), in addition to other relevant devices such as fans (4), printers (3), scanners (2), and tube lights (8). This suggests that the department places a high priority on computer-based learning and research, and that it has plenty of resources for both peripherals and hardware. The department of information technology is equipped with a sizable number of computers (18) as well as printers (2) and scanners (1). This demonstrates an emphasis on digital technology and IT infrastructure, which are crucial for information technology education and research.

Multipurpose Hall primarily accommodates gatherings and events, as indicated by the presence of tube lights (14) and fans (20). The absence of computers or other electronic devices suggests a focus on physical activities or non-digital events within this section. Play Ground as an outdoor recreational area, the playground understandably lacks electrical appliances, it has 6 flood lamps reflecting its nature as a space for physical activities and sports rather than academic or administrative functions. YCMU section possesses a mix of appliances including tube lights (4), fans (2), computers (4), printers (2), and scanners (2), indicating a multifunctional space likely used for academic purposes and student activities. The presence of photocopiers (2) suggests a need for document duplication and distribution within this area.

The modest number of appliances in the sport room—four tube lights, two fans, and one computer—indicates a simple configuration for handling administrative duties or keeping an eye on sporting events. The photocopier (1) indicates that there may occasionally be a need for

duplicate documents in this area. The gymnasium has a lot of tube lights (12) and fans (9), so it has enough lighting and ventilation for intense exercise. This section is focused on physical activities and exercise equipment, as evidenced by the lack of computers or other electronic devices. The botany department has a wide range of appliances, such as fans (1), computers (1), CFL bulbs (8), tube lights (18), and many more research-related tools that help with both academic research and departmental administrative duties. The fact that there are printers (1) and scanners (1) suggests that digital resource management and document handling are necessary for botanical research. The botany department is equipped with a wide range of research tools, including centrifugal pumps, mixers, water baths, incubators, autoclaves, spectrophotometers, calibrators, and Fame photometers.

The zoology department has equipment to support its administrative and academic functions, including computers (1), fluorescent lights (15), and CFL bulbs (2). The photocopier (1) in this area suggests that document distribution and duplication are necessary. The department's zoology research lab offers a suitable setting for scientific experimentation and data analysis thanks to its modest array of appliances, which includes computers (1), fans (2), CFL bulbs (2), and tube lights (1). Single hot plates, an incubator, a centrifugal pump, a spectrophotometer, an oven, a stirrer with a hot plate, a tissue embedding center, a slide staining machine, a distillation plant, a BOD incubator, cooling plants, a bio-spectrometer, and a light microscope are all contained in the Zoology Research Lab. The equipment in the microbiology department is diverse and includes a water bath, incubator, autoclave, oven, stirrer with hot plate, laminator air flow, computers (1), fans (5), and tube lights (4) for academic research as well as administrative duties. The photocopier (1) in this area suggests that document distribution and duplication are necessary.

Electronics has significant number of computers (12) and related equipment like tube lights (10), CFL bulbs (5), and fans (6), CRO and Function generator. The electronics department emphasizes hands-on learning and research in electronic systems and devices. The presence of a photocopier (1) suggests a need for document duplication and distribution within this area. The physics department is equipped with a diverse array of appliances including tube lights (16), CFL bulbs (6), fans (10), and computers (3), CRO, Function generator, Stirrer with hot plate and Water bath supporting both theoretical studies and practical experimentation within the field of physics. The presence of printers (3) suggests a need for document handling and reproduction within this area. Psychology department with a mix of appliances including tube lights (3), CFL bulbs (2), fans (2), and computers (1), the psychology department provides a

conducive environment for academic research and counselling activities. The presence of scanners (2) and photocopiers (1) facilitates document management and duplication within this area.

In order to support the institution's efforts in academic accreditation and quality assurance, the IQAC (Internal Quality Assurance Cell) office is equipped with a wide range of appliances, including fans (4), computers (4), printers (2), and scanners (2). The fact that this administrative office has two photocopiers indicates that there is a need for document distribution and replication. Meetings and conferences for academic purposes can be held in the conference hall, which is furnished with appliances such as fans (2), air conditioning (1), and tube lights (6). In this space, discussions and presentations are prioritized over digital activities as evidenced by the lack of computers or other electronic devices. A sizable number of computers (20), along with additional relevant tools like fans (6) and tube lights (6), are present in the Bachelor of Computer Applications (BCA) lab, facilitating hands-on learning and experimentation in computer science and programming. A need for document printing and reproduction in this lab is indicated by the existence of printers (1).

The staff room has appliances like fans (12) and tube lights (9) to give faculty and staff members a cozy and well-lit workstation. The lack of computers or other electronic equipment in this space suggests that administrative duties and faculty interactions are the main priorities. The Ladies Room section has equipment such as fans (6) and tube lights (5) to provide a comfortable environment for female faculty and staff. The lack of computers or other electronics suggests that restrooms are prioritized over administrative or scholarly activities in this area. The English department has the necessary equipment, including computers (2), fans (3), CFL bulbs (3), and tube lights (4), to create a comfortable atmosphere for language learning and scholarly research. The photocopier (1) indicates that document distribution and duplication are necessary in this area.

The chemistry department is equipped with a diverse array of appliances including tube lights (20), CFL bulbs (4), fans (2), and computers (1), supporting both theoretical studies and practical experimentation within the field of chemistry. The presence of printers (1) suggests a need for document handling and reproduction within this area. Geography department with a significant number of computers (12) and related equipment like tube lights (10), CFL bulbs (4), and fans (6), the geography department emphasizes digital mapping and spatial analysis in its academic curriculum. The presence of a photocopier (1) suggests a need for document

duplication and distribution within this area. Statistics department Equipped with a significant number of computers (18) and related equipment like tube lights (2), fans (1), and printers (1), the statistics department emphasizes data analysis and mathematical modelling in its academic curriculum. The presence of a photocopier (1) suggests a need for document duplication and distribution within this area. The mathematics department is equipped with a modest array of appliances including tube lights (1), CFL bulbs (1), fans (1), and computers (1), and one projector supporting both theoretical studies and practical problem-solving activities within the field of mathematics. The presence of a printer (1) suggests a need for document printing and reproduction within this area.

The provided table (2) presents the energy consumption data for various departments or sections within the institution, measured in kilowatt-hours (kWh) for different types of electrical appliances. This data is crucial for conducting an energy audit to assess the energy usage patterns and identify opportunities for energy efficiency improvements. Upon analysing the data, several key findings emerge:

The table (2) shows the energy consumption of various departments and sections of a building. The consumption is categorized by different appliances. For example, the library department uses 2.72 kWh of tube lights, 0.24 kWh of fans, 6.3 kWh of computers, 5.6 kWh of printers, 0.3 kWh of projectors, and 6.6 kWh of inverters. The computer lab consumes the most energy at 27.6 kWh, followed by the administrative office at 12 kWh and the library at 6.3 kWh. This is likely because computer labs typically have many computers that are running for long periods of time. Administrative offices may also have a number of computers and other electronic devices in use. Libraries, on the other hand, may have fewer computers but a higher use of lights. The Computer Lab has the highest overall consumption of 69.6 kWh. This is likely because it has a high number of computers (27.6 kWh) and printers (21.6 kWh). The library also has a high overall consumption of 6.6 kWh, likely due to the high number of tube lights (2.72 kWh).

Variation in Energy Consumption: There is a significant variation in energy consumption across different departments or sections. For example, departments like the "Library," "Administrative Office," "Computer," and "Psychology" exhibit relatively higher energy consumption due to the presence of multiple appliances such as computers, air conditioners, and photocopiers. Identifying High Energy Consumers: The data highlights departments or sections that are high energy consumers, such as the "Computer" department and the

"Administrative Office," where computers and air conditioners contribute significantly to energy usage. This indicates potential areas for implementing energy-saving measures to reduce overall energy consumption and operational costs. Opportunities for Efficiency Improvements: The energy audit reveals opportunities for efficiency improvements in certain departments. For instance, departments like the "Multipurpose Hall," "Play Ground," and "Sport Room" show minimal or no energy consumption, suggesting the potential for implementing energy-efficient lighting solutions or optimizing energy usage in these areas.

The impact of equipment usage on energy consumption is also highlighted by the data. Because computers and air conditioners run constantly in departments like "Psychology" and "Microbiology," these units use more energy than others. This suggests that energy-efficient models should be replaced or equipment usage schedules should be optimized. The data highlights the significance of encouraging faculty, staff, and students to adopt energy-conscious behaviors in addition to investing in equipment upgrades and infrastructure improvements. An important way to support overall energy conservation efforts is to educate stakeholders about energy-saving techniques and to promote easy actions like turning off lights and appliances when not in use.

The amount of energy used by various departments varies noticeably. The presence of multiple electrical appliances, including computers, air conditioners, and photocopiers, makes departments like the "Computer," "Administrative Office," and "Library" stand out as significant energy consumers. On the other hand, spaces like the "Sport Room," "Multipurpose Hall," and "Play Ground" use less energy because they rely less on electrical equipment. The information highlights the major influence of particular appliances on total energy consumption. For example, in many departments, computers and air conditioners are the main sources of energy consumption. It is imperative to take into account appliance efficiency and usage patterns when evaluating energy consumption and pinpointing areas for optimization, as this emphasizes.

Table 1 Department-wise number of electrical appliances A.Y. 2021-22

Department/Section	*Tube Light*	*CFL*	*Fan*	*Computer*	*Printers*	*A.C.*	*Projectors*	*Scanner*	*Photocopiers (Xerox)*	*Inverter*
Library	17	3	14	7	1	0	0	0	3	0
Principal's office	2	2	2	2	0	1	0	0	0	1
Administrative office	15	0	9	10	9	0	0	0	0	1
Computer	8	0	4	23	3	2	0	0	0	1
Information Technology	5	0	3	18	2	0	1	0	0	0
Multipurpose Hall	14	0	20	0	0	0	0	0	0	0
Play Ground	0	0	0	0	0	0	0	0	0	0
YCMU	4	0	2	4	2	0	0	0	2	0
Sport Room	4	0	2	1	1	0	0	0	0	0
Jim	12	0	9	0	0	0	0	0	0	0
Botany	18	8	1	1	1	1	0	0	0	0
Zoology	15	2	0	1	1	0	0	1	0	0
Zoology Research Lab	1	2	2	1	1	0	0	1	0	0
Microbiology	4	2	5	1	0	1	0	0	0	1
Electronics	10	5	6	12	0	0	1	0	0	0
Physics	16	6	0	10	3	0	0	0	0	1
Psychology	3	2	2	1	1	0	2	0	0	1
IQAC office	7	0	4	4	2	2	1	0	0	0
Conference Hall	6	0	2	0	0	1	1	0	0	0
BCA Lab	6	0	6	20	1	0	0	0	0	0
Staff Room	9	0	12	0	0	0	0	0	0	0
Ladies Room	5	0	6	0	0	0	0	0	0	0
English	4	0	3	2	1	0	1	0	0	0
Chemistry	20		4	2	1	0	0	0	0	0
Geography	10	4	6	12	2	0	1	0	0	0
Statistic	2	0	2	18	1	0	0	1	0	0
Mathematics	1	1	0	1	1	0	1	0	0	0
Total	218	37	126	151	34	8	9	3	5	6

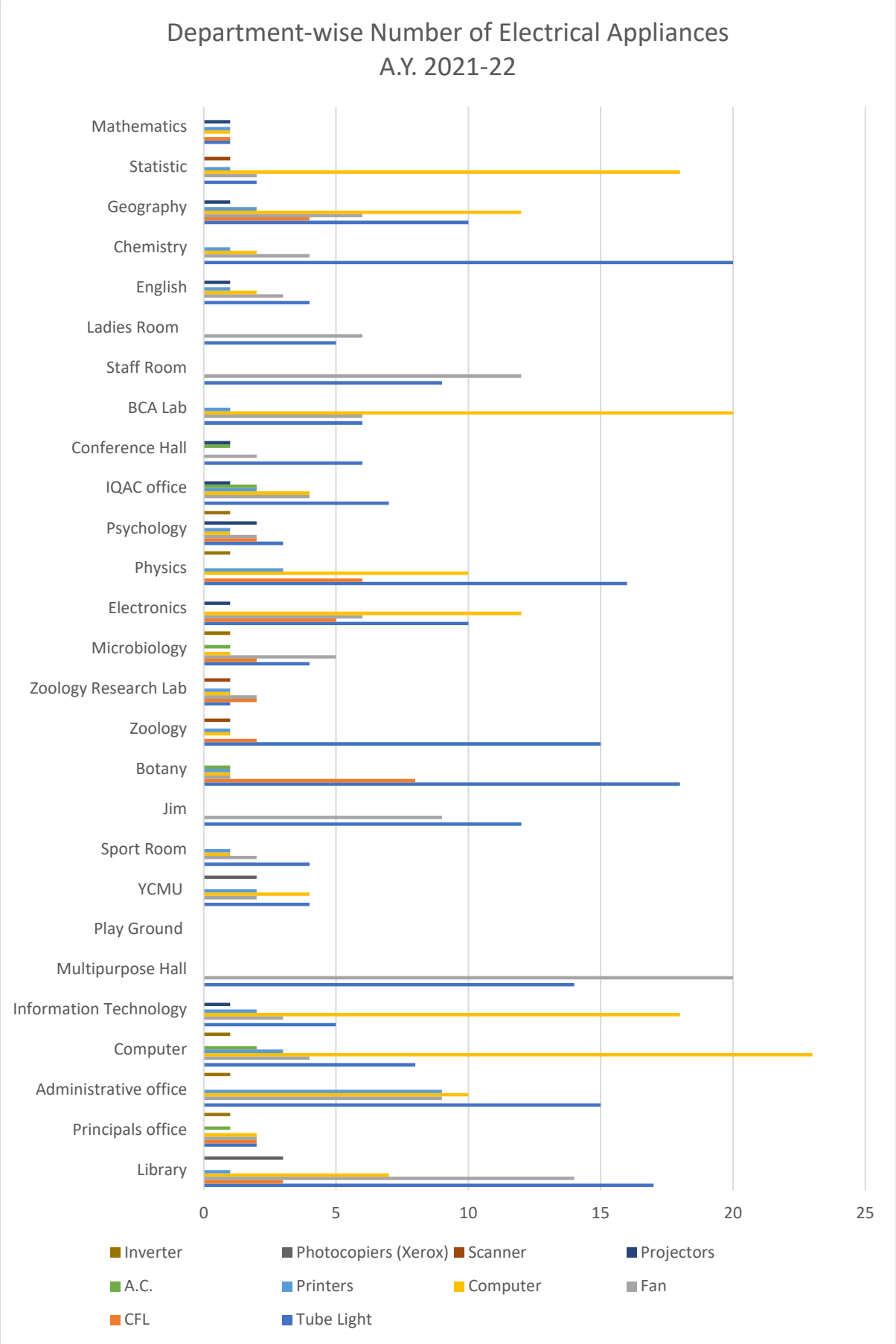


Figure 1 Department-wise Number of Electrical Appliances A.Y. 2021-22

Table 2 Department-wise Energy Consumption per day (kwh) A.Y. 2021-22

Department/Section	Tube Light	CFL	Fan	Computer	Printers	A.C.	Projectors	Scanner	Photocopiers (Xerox)	Inverter
Library	1.36	0.12	2.1	2.8	0.03	0	0	0	3.3	0
Principal's office	0.16	0.08	0.3	0.8	0	1.5	0	0	0	3.48
Administrative office	1.2	0	1.35	6	0.27	0	0	0	0	3.48
Computer	0.48	0	0.6	18.4	0.09	6	0	0	0	3.48
Information Technology	0.3	0	0.45	14.4	0.06	0	0.8	0	0	0
Multipurpose Hall	0.056	0	0.3	0	0	0	0	0	0	0
Play Ground	0	0	0	0	0	0	0	0	0	0
YCMU	0.016	0	0.15	0.8	0.06	0	0	0	2.2	0
Sport Room	0.016	0	0.03	0.1	0	0	0	0	0	0
Jim	0.24	0	0.675	0	0	0	0	0	0	0
Botany	0.72	0.16	0.075	0.2	0.03	0.75	0	0	0	0
Zoology	0.6	0.04	0	0.2	0.03	0	0	0.0006	0	0
Zoology Research Lab	0.04	0.04	0.15	0.2	0.03	0	0	0.0006	0	0
Microbiology	0.16	0.04	0.375	0.2	0	0.75	0	0	0	3.48
Electronics	0.4	0.1	0.45	2.4	0	0	0.16	0	0	0
Physics	0.64	0.12	0	2	0.09	0	0	0	0	3.48
Psychology	0.12	0.04	0.15	0.2	0.03	0	0.16	0	0	3.48
NAAC office	0.028	0	0.06	0.8	0.6	1.5	0.08	0	0	0
Conference Hall	0.024	0	0.03	0	0	0	0.08	0	0	0
BCA Lab	0.36	0	0.45	12	0	0	0	0	0	0
Staff Room	0.54	0	0.9	0	0	0	0	0	0	0
Ladies Room	0.3	0	0.45	0	0	0	0	0	0	0
English	0.16	0	0.225	0.4	0.03	0	0.08	0	0	0
Chemistry	0.8	0	0.3	0.4	0.03	0	0	0	0	0
Geography	0.4	0.08	0.45	2.4	0.06	0	0.04	0	0	0
Statistic	0.08	0	0.15	3.6	0.03	0	0	0.0006	0	0
Mathematics	0.04	0.02	0	0.2	0.03	0	0.08	0	0	0
Total	9.24	0.84	10.17	68.5	1.5	10.5	1.48	0.0018	5.5	20.88

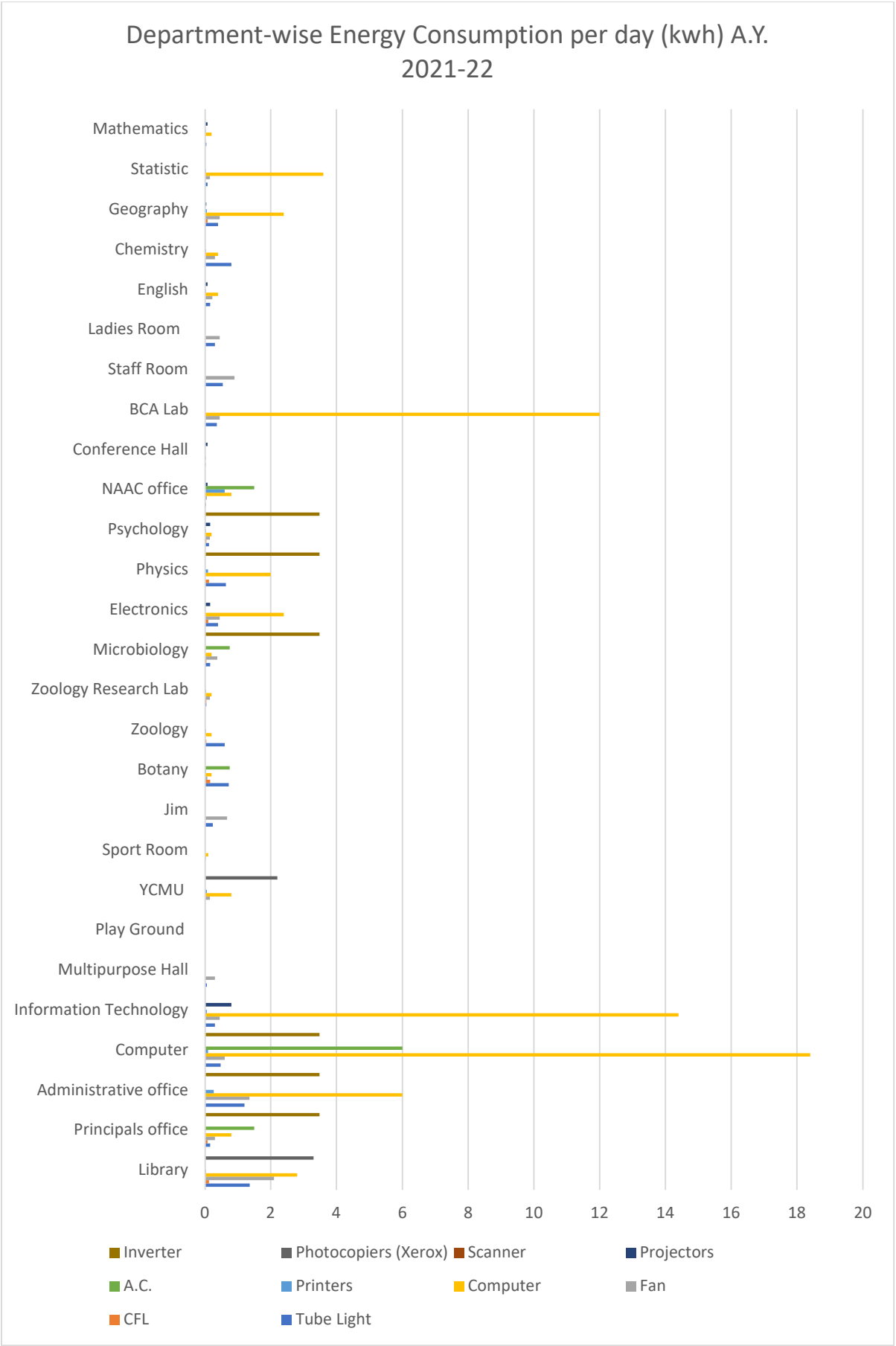


Figure 2 Department-wise Energy Consumption per day (kwh) A.Y. 2021-22

Table 3 List of instruments and its energy consumption

Laboratory equipment's	*Number of equipment's*	*Energy consumption (kWh)*
Water Filter	1	0.0125
Flood lamp	6	3
TV	2	0.5
Mixture	1	0.1
Hot Plates	4	2.4
Water bath	6	3
Incubator	5	0.25
Autoclave	4	18
Centrifugal pump	2	0.14
Spectrometer	3	0.375
Bio-spectrometer	1	0.125
Calorimeter	1	0.5
Fame photometer	1	0.5
Hot Plates	2	2
Oven	4	4
Stirrer with hot Plate	8	8
Tissue embedding centre	1	0.3
Slide staining Machine	1	8.5
Distillation Plant	1	0.05
BOD incubator	1	0.675
Cooling plants	1	0.4
Light Microscope	1	0.05
Laminator air flow	2	0.3
CRO	10	5
Function generator	10	0.0002
Power Supply	25	1.5
pH meter	5	0.005
Slide Projector	1	0.0115
Earth Globe	2	0.001
CCTV	10	3.6

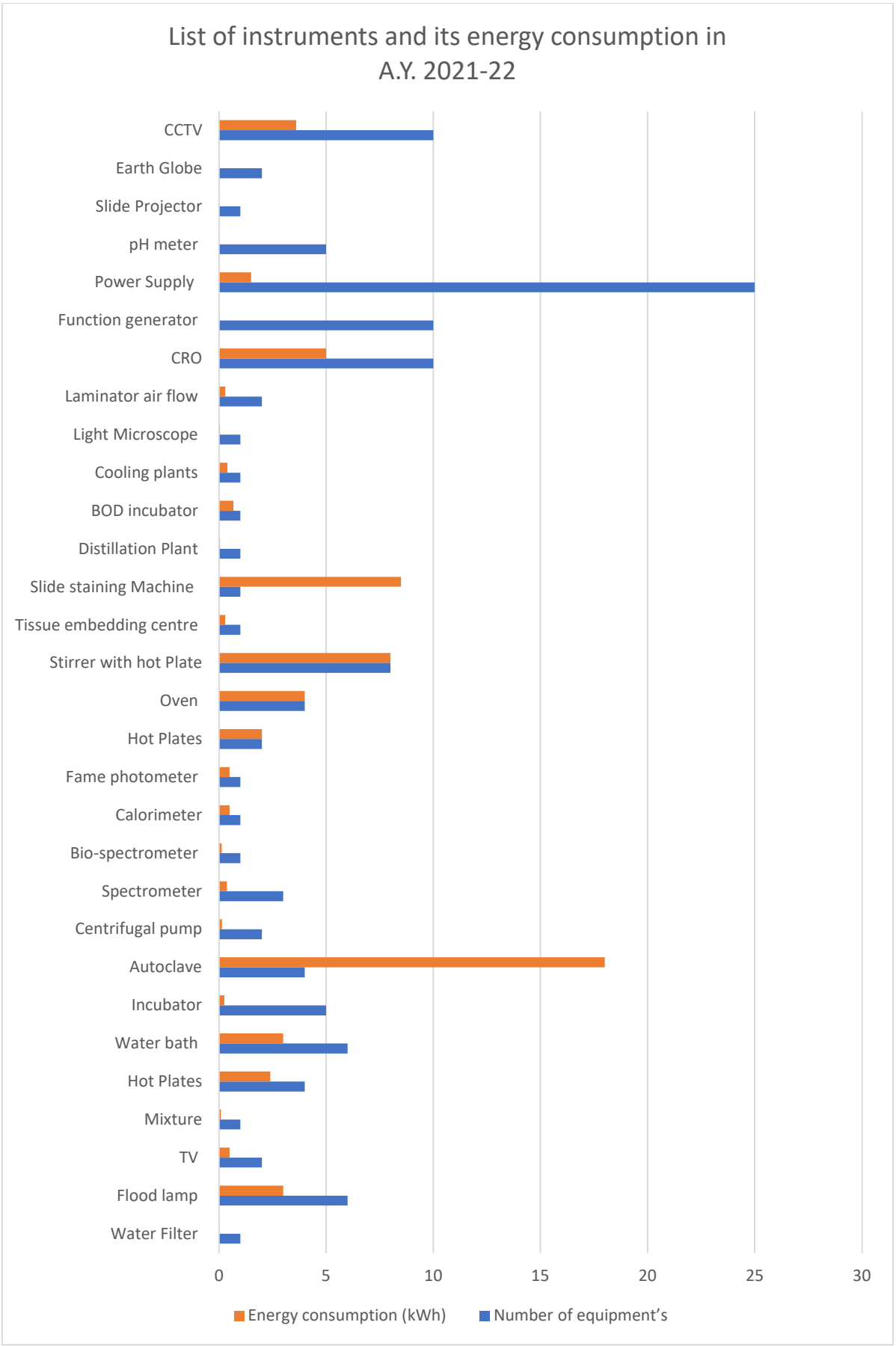


Figure 3 List of instruments and its energy consumption

Finally, by highlighting areas of high energy consumption and opportunities for efficiency improvements, the energy audit report based on the supplied table provides insightful information about the institution's energy usage patterns. The institution can work toward reaching its energy conservation goals while lowering operational costs and environmental impact by putting targeted strategies like equipment upgrades, behavioral changes, and renewable energy integration into practice. The energy consumption in kWh of various laboratory equipment is displayed in table (3). It sorts the equipment according to its kind and the quantity of each kind that is in the laboratory. With 90 kWh of energy usage, the autoclave is the energy consumer with the highest consumption. Autoclaves are sterilizing devices that require a lot of energy to heat up and keep their high pressure. Because they are used to heat and stir solutions for extended periods of time, stirrers with hot plates use the second most energy (8 kWh). With 4 kWh of energy usage each, ovens and incubators are also quite energy-hungry devices. This is because they have to keep a steady temperature for long stretches of time.

Table 4 Details of Energy import and export from MSEDCL

Month	*Energy Consumption*	*Unit Produced by Renewable Source*	*Unit Balance*	*Unit Required From MSEB*	*Total Unit Save*
August 2021	977	477	0	500	-500
September 2021	842	778	0	64	-64
October 2021	951	840	0	111	-111
November 2021	1013	1112	99	0	99
December 2021	1236	1321	85	0	85
January 2022	1190	1214	24	0	24
February 2022	1045	1134	89	0	89
March 2022	1300	1323	23	0	23
April 2022	1400	1450	50	0	50
May 2022	776	847	71	0	71
June 2022	1513	1365	0	148	-148
July 2022	448	539	0	91	-91

Total energy consumption from 1 August 2021 to 31 July 2022 = 12691 W

Total Unit Produced by Solar Panel from 1 August 2021 to 31 July 2022 = 12400 W

Energy Import from the MSEB = 914 W

Energy Export to the MSEB = 441 W

The college's total energy consumption for the period of August 1, 2021 to July 31, 2022 was 12691 W. The solar panels generated 12400 W during the same period. The college imported 914 W from MSEB and exported 441 W.

CONCLUSION

The key findings of the energy audit conducted at Rashtriya Sahakari Shikshan Prasarak Mandal Ltd., Chalisgaon Sanstha's Nanasaheb Yashvantrao Narayanrao Chavan Arts, Science & Commerce College are as follows:

1. Variation in Energy Consumption: Significant differences in energy consumption between the college's various departments and sections were found during the audit. The "Computer," "Administrative Office," and "Library" departments were identified as high energy users because of the abundance of electrical devices they had, including photocopiers, air conditioners, and computers. Conversely, spaces such as the "Sport Room," "Play Ground," and "Multipurpose Hall" showed very little energy use.

2. Impact of Specific Appliances: The audit made clear how much of an impact some appliances have on total energy use. Several departments found that the main sources of energy consumption were air conditioners and computers. This finding highlighted the significance of taking usage patterns and appliance efficiency into account when evaluating energy consumption.

3. Laboratory Equipment Energy Consumption: The audit also looked at how much energy different lab equipment used. The highest energy consumption was discovered in autoclaves, which used 90 kWh, and stirrers with hot plates, which used 8 kWh. The requirement to maintain consistent temperatures for prolonged periods of time led to a relatively high energy consumption in ovens and incubators.

4. Importance of Behavioral Changes: The audit stressed the significance of encouraging faculty, staff, and students to behave in an energy-conscious manner in addition to making infrastructure and equipment upgrades. Easy things like shutting off lights and appliances when not in use have been found to make a big difference in the overall energy conservation efforts.

These findings provide valuable insights into the college's energy usage patterns, highlighting areas of high energy consumption and opportunities for efficiency improvements. By implementing targeted strategies such as equipment upgrades, behavioral changes, and renewable energy integration, the college can work towards achieving its energy conservation goals while reducing operational costs and environmental impact. The college was able to

generate a significant portion (12400 W out of 12691 W) of its energy consumption through solar panels. There was a net export of energy (441 W) to MSEB, indicating that the college produced more energy than it consumed.

In conclusion, the energy audit conducted at Rashtriya Sahakari Shikshan Prasarak Mandal Ltd., Chalisgaon Sanstha's Nanasaheb Yashvantrao Narayanrao Chavan Arts, Science & Commerce College has provided valuable insights into the college's energy consumption patterns and environmental impact. Significant differences in energy consumption between departments were found during the audit, with certain appliances—such as air conditioners and computers—emerging as the main energy consumers. The audit also found opportunities for energy conservation through equipment upgrades and behavioral modifications, and it emphasized the significance of encouraging stakeholders to adopt energy-conscious behavior. Through the implementation of the audit report's recommendations, which include maximizing appliance efficiency, encouraging energy-saving behaviors, and taking into account renewable energy options, the college can improve its energy efficiency, minimize operating expenses, and lessen its environmental impact. All things considered, the college uses the energy audit as an essential instrument to advance sustainable practices, coordinate with environmental stewardship objectives, and encourage ethical energy management. The college can move toward a more environmentally conscious and energy-efficient campus, helping to create a more sustainable and greener future, by utilizing the audit's findings and recommendations.

RECOMMENDATIONS

- Air conditioners: Air conditioners are major energy consumers. Setting thermostats to a higher temperature in the summer and a lower temperature in the winter can help to reduce energy consumption.
- Tubes lights and bulbs: The majority of departments are still using tubes lights and bulbs, which are less energy-efficient than CFLs or LEDs. Replacing tubes lights and bulbs with CFLs or LEDs can significantly reduce energy consumption.
- Computers and monitors: Computers and monitors are also major energy consumers. Encouraging users to turn off their computers and monitors when they are not in use can help to reduce energy consumption.
- Printers and copiers: Printers and copiers can also consume a significant amount of energy. Using duplex printing and copying can help to reduce paper consumption and energy use.
- Projectors: Projectors can be energy-intensive. Using projectors in eco-mode can help to reduce energy consumption.
- Power management software: Installing power management software on computers can help to reduce energy consumption by putting computers into sleep mode when they are not in use.
- Ceiling fans: Ceiling fans are the largest energy consumer in most departments. Installing energy-efficient ceiling fans can reduce energy consumption by up to 50%.
- The college should continue to invest in and maintain its solar panel system. Exploring additional energy-saving measures could further reduce reliance on imported energy and increase exported energy.
- Lighting controls: Installing lighting controls, such as occupancy sensors and timers, can help to ensure that lights are only turned on when they are needed.

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