

Report of Green, Environment and Energy Audits



Submitted to

**CHRISTIAN COLLEGE OF ENGINEERING AND
TECHNOLOGY, ODDANCHATRAM,
DINDIGUL – 624 619, TAMIL NADU**

Date of Audit: 05.12.2022

Valid Till: 04.12.2024



Submitted by

NATURE SCIENCE FOUNDATION

(A Unique Research and Development Centre for Society Improvement)

[ISO Certified and Ministry of MSME Registered Organization]

No. 2669, LIG-II, Gandhi Managar, Peelamedu

Coimbatore 641 004, Tamil Nadu, India

Phone: 0422 4917999, Mobile: 9566777255, 9566777258

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Dr. S. RAJALAKSHMI, M.B.A., Ph.D., FNSF.,
 Chairman

Mr. P. KANAGARAJ, FNSF.,
 Secretary


Certificate of Declaration

The **Office of Nature Science Foundation**, Coimbatore, Tamil Nadu declare that

1. Nature Science Foundation has conducted onsite green audit at **Christian College of Engineering and Technology, Oddanchatram, Dindigul – 624 619, Tamil Nadu** by deputing certified Lead Auditors and Technical Experts.
2. On the basis of audit observations by the auditors and pertinent data collected from the Auditee, the Technical Report has been prepared and being submitted.
3. Data presented in the Technical Report are verified and to best of our knowledge, the data are authentic and reliable.
4. Nature Science Foundation declares that data generated were not shared with any third parties and the soft copy of the report is available with Nature Science Foundation's Office.
5. Provided the Auditee desired to publish or share the data with other agencies, Nature Science Foundation has no conflict of interest.

Date: 05.12.2022
 Place: Coimbatore




 Authorized Signatory
 Nature Science Foundation

Dr. D. Vinoth Kumar, M.Sc., M.Phil., Ph.D., FNSF.,
 Director
 NATURE SCIENCE FOUNDATION
 No. 2669, LIG - II, Gandhi Managar
 Coimbatore - 641 004, Tamil Nadu, India.

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1. GENERAL INTRODUCTION

1.1. Introduction

Green campus is an area of the Organization or the Organization as a whole itself contributing to have an infrastructure or development that is structured/planned to incur less energy, less water, less or no CO₂ emission and less or pollution free environment. Green Audit is a tool to evaluate environment management system which is systematically executed to protect and preserve the environment. Green audit constitutes the environmental friendly practices and education combined to promote sustenance of green environment by adopting user-friendly technology within the campus. It creates awareness on environmental ethics, resolves environmental issues and offers solutions to various social and economic needs. It strengthens the concept of ‘Green Building’ and ‘Oxygenated Building’ which in turn provides a healthy atmosphere to the stakeholders.

1.2. Environment Friendly Campus

As stated earlier, Organization is liable to provide an eco-friendly atmosphere along with good quality of drinking water facility to all the stakeholders. Manuring the cultivated plants/grown within the campus may applied with organic manure, cow dung, farmyard manure and vermicompost instead of using chemical fertilizers. All non-compostable and single-use disposable plastic items, plastic utensils, plastic straws and stirrers should be avoided. Demonstration / awareness programme on establishing plastic-free environment and utility of organic alternatives for all incoming and current students, staff and faculty should be organized. Reduction of use of papers alternated with e-services, e-circulars, etc., and proper disposal of wastes, recycling and suitable waste management system should be considered to establish environment friendly campus.

The term ‘auditing’ is to examine the management practices and to evaluate performance of an organization in relation to environmental issues. World along with Associated Chambers of Commerce and Industry of India (ASSOCHAM), Green Building Council (IGBC) and Green Ratings Systems (GBCRS), Green Rating for Integrated Habitat Assessment (GRIHA), Bureau of Energy Efficiency (BEE), Leadership in Energy and Environmental Design (LEED), CII-GreenCo –GreenCo Rating System (CII-GRS), Food Safety Management System & Occupational Safety & Health (FSMS), Swach Bharath under India Clean Mission (SBICM) and International Standard Organization (ISO 2021) have formulated a series of standards in the field of environmental auditing. These standards are basically intended to guide organizations and auditors on the general principles common to the execution of environmental audits.

1.3. About Nature Science Foundation (NSF)

NSF is the ISO QMS (9001:2015), EMS (14001:2015), OHSMS (45001:2018) and EnMS (5001:2018) Certified and registered with Ministry of Micro, Small and Medium Enterprise (MSME), Government of India Organization functioning energetically towards the noble cause of nature conservation and environmental protection. NSF is managed by a Board of Trustees which is a Public Charitable Trust registered under the TN Societies registration Act 1975 (TN Act 27 of 1975) on 29th November, 2017 at Peelamedu, Coimbatore 641 004, Tamil Nadu, India with Certificate of Registration No. 114 / 2017. In addition, NSF has 12AA, 80G and Form 10AC certificates for income tax

exemption and implanting various Government schemes. The main motto of the NSF is 'Save the Nature to Save the Future' and 'Go Green to Save the Planet'.

1.4. About the Organization

Christian College of Engineering and Technology

Christian College of Engineering and Technology, Oddanchatram was first founded by the Dr. Jacob Cherian M.B.B.S., FRCS., who is also a member of The Christian Fellowship Hospital (CFH).

The first batch was Started on 2001-2005. The Christian Fellowship Community started as a medical mission serving the poor and rural people in the backward Oddanchatram Taluk in Dindigul District.

By the grace of God and by the generous donations of our well-wishers, we were able to establish a string of educational Institutions and latest of which is the Christian College of Engineering & Technology.

The Christian Education Health and Development Society believes in imparting a socially relevant and value based education which will enable students to cope with the increasing demand for the fast changing globalize economy. The Society also believes that each student of our college will emerge as a well-balanced, emotionally mature and dynamic individual equipped with a set of professional life in the near future.

To still more actualize their dream of providing wholesome and professional education to people, founder thought of starting an engineering college to provide quality and technical education So, the Christian College of Engineering & Technology was found in 2001 by Padmabhushan Dr. Jacob Cherian and Dr. Mrs. Mary Cherian through the registered charitable society (CEH & D society).

As the chairman of this society, his primary concern is to bring professional & technical education from primary to college and professional levels to the people irrespective of caste, creed and socio-economical status.

Vision

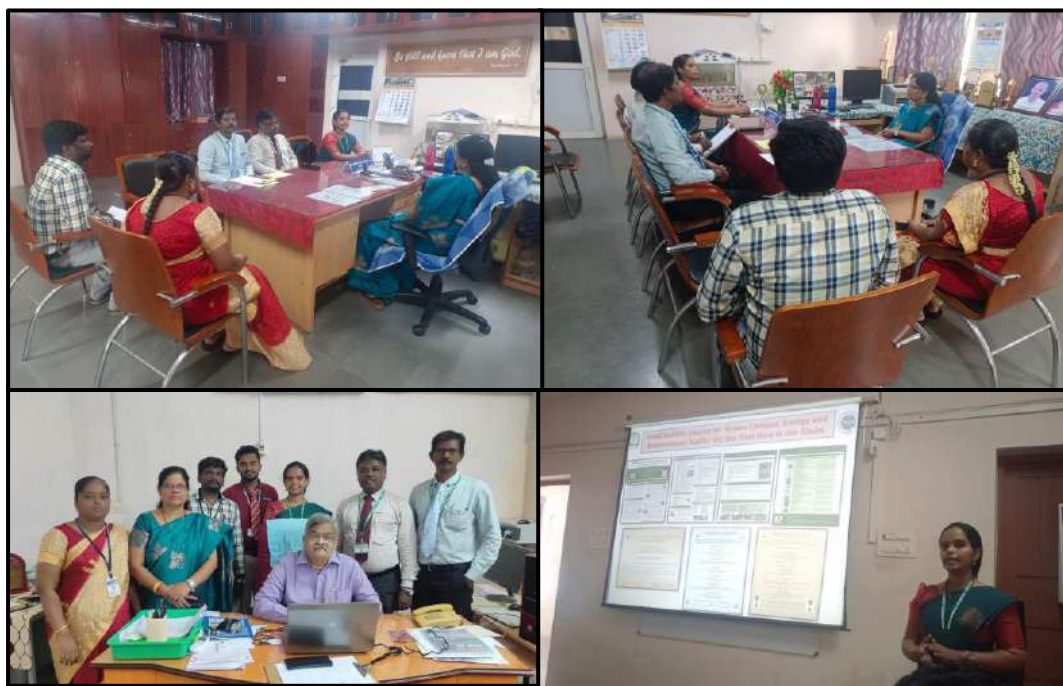
We seek to bring out the fullest ability in every student, irrespective of one's cultural, economical, social, religious or ethnic background in the Spirit of Christ, for the Greater Glory of God for the service of man.

Mission

The college aims at imparting Christian spiritual values of hard work, honesty, charity, service to the needy and nationalism. Accordingly, the students are moulded to abide by the Christian and Gandhian teachings of truth, integrity, ethical behavior, equity, fairness and love

1.5. Audit Details

1. **Date of Audit** : **05.12.2022**
2. **Audit Site** : **Christian College of Engineering and Technology ,**
Palani- Dindigul Main Road, Oddanchatram,
Dindigul District-624619.
3. **Inspection Body** : **Nature Science Foundation**
Coimbatore, Tamil Nadu, India.
4. **Audit Scope** : **Green, Environment and Energy Audits**
5. **Name of the Auditing Chairman** : **Dr. S. Rajalakshmi**
ISO QMS, EMS and EnMS Certified Lead Auditor, Founder & Chairman of NSF.
6. **Name of the Auditing Team Leader** : **Ms. V. Sri Santhya**
ISO QMS, EMS and EnMS Certified Lead Auditor, Assistant Director & Programme Manager, NSF.
7. **Name of the Lead Auditor for Green Audit** : **Dr. R. Mary Josephine**
ISO EMS and EnMS Certified Lead Auditor.
8. **Name of the Lead Auditor for Environment Audit** : **Ar. N. M. Pradeep Kumar**
ISO EMS and IGBC Certified Lead Auditor.
9. **Name of the Lead Auditor for Energy Audit** : **Er. A. Karthik**
Bureau of Energy Efficiency Certified Auditor.



**Opening & Closing meetings with the Head of the Organization,
NAAC / IQAC Coordinators and NSF Inspection Team**

2. GREEN AUDIT

2.1. Introduction

Green audit ensures the Organization's campus should have greenish with large diversity of trees, herbs, shrubs, climbers and lawns to reduce the environmental pollution and soil erosion; it is also useful in relation to biodiversity conservation, landscape management, irrigation/economic water utilization and maintenance of natural topography besides vegetation. For the benefit of stakeholders, solid waste management, recycling of water, disposal of sewage and waste materials (electronic and biomedical wastes), 'zero' use of plastics, single use plastic items, etc. should be followed consistently in the organization campus. Green Audit procedures includes the definition of green audit, methodology on how to conduct green audit at Educational Institutions and Industrial sectors.

2.2. Importance of green audit

The Management of the Organization (Auditee) should be exposed their inherent commitment towards making ecofriendly atmosphere through the green auditing and ready to encourage/follow all types of green activities. A clean and healthy environment will enhance an effective teaching/learning process. They should create the awareness on the importance of greenish initiatives through environmental education among the student members and research scholars. Green audit is the most effective, ecological approach to manage environmental complications (Rajalakshmi *et al.*, 2023). Green audit is a kind of professional care and a simple indigenized system about the environment monitoring in terms of planting more number of trees which is a duty of each and every individual who are the part of economical, financial, social and environmental factors. Green audit is a professional and useful measure for an Organization to determine how and where they are retaining the campus eco-friendly manner. It can also be used to implement the alleviation measures at win-win situation for the stakeholders and the planet. It provides an opportunity to the stakeholders for the development of ownership, personal and social responsibility.

2.3. Green audit observations

- It is observed that the Organization has facilities (ramp walk , Wheel chair etc.,) for disabled and different age group people.
- Adequate training and awareness programmes are conducted to the Stakeholders for sustainable development at all stages of building life cycle.
- More than 30% of open space is maintained as soft scapes (vegetation) to lower the energy conservation in the campus.
- Land scape design are planned to maintain the natural capacity of the site.
- Land scape irrigation are performed as per the microclimatic condition like during humid / winter season less watering through irrigation is observed.
- Vegetation / vegetative structures are available around the building to reduce energy consumption and maintain indoor climates.
- Ornamental garden and green roof system are available to maintain sustainability.

2.3.1. Facilities for Human Comforts

As per the ISO Standards under elements of sustainability quality of plumbing services and buildings are maintained in line with the standard. Ramp walk and Wheel chair facilities are implemented for the benefit of disabled and different age group people.



Ramp walk & Wheel chair facilities available for the comfort of person with disability.

2.3.2. Natural topography, vegetation and monitoring

Natural topography means the original geographical features and natural resources of the Site. It is observed that the organization has the natural features like rocks, water resources, slopes, landscape, pathways, etc. Vegetation is the cultivation of a bunch of plants irrespective of the plant *taxa* for the covering of the area or ground topography. The observation at the campus indicated that there are more than 40% natural topography and vegetation. Monitoring plan for maintaining the vegetation and sustainability are evident through separate operation and maintenance team & their records for regular watering as per the micro climatic condition through irrigation.



Natural Topography and Vegetation at the Campus

2.3.3. Landscape design and soil erosion control

Landscape design is an important feature for any disasters to control especially with respect to the soil erosion. In general, soil erosion occurs if the design of the land is not altered so as to prevent the slope features by strong vegetation and use of a plant buffer zone as safe for escape of nutrients or fertilizers entering the streams. Observation revealed that the audited site has very good landscape design without disturbing the natural vegetation. Contour ploughing is being done at right angles to the slope wherever possible and ridges and furrows are properly maintained to break the flow of water down to the empty land. These activities are widely adopted to control soil erosion in the campus. Microclimatic conditions are considered, during winter season irrigation and watering to plants are controlled as per the water management plan. External landscapes are designed based on the shading pattern of the building. Green vegetation are available around the building to reduce the energy consumption.

2.3.4. Establishment of different gardens, vertical landscaping and roof gardens

It is observed that Organization has implemented and maintaining gardens to lower the energy consumption. To maintain certain biomass critical for human health and also to reduce the bio-retention through water flow rates different types of gardens like ornamental garden is implemented in the campus.



Ornamental garden observed in the Campus

2.3.5. Survey of Flora and Fauna

Ensuring the rich biodiversity in the green campus is an important parameter which reflects the real-time ecosystem. In general, plants improve the outdoor air quality with increased oxygen levels and reduced temperature and carbon dioxide. The record on maintenance of the plant biomass and its management are important with respect to green campus initiatives. The existence of such plants and birds in the green campus are recorded for the rich flora and fauna which are being considered as a value addition to the campus.



Dieffenbachia seguine
(Jacq.) Schott



Ficus benghalensis L



Araucaria heterophylla
(Salisb.) Franco

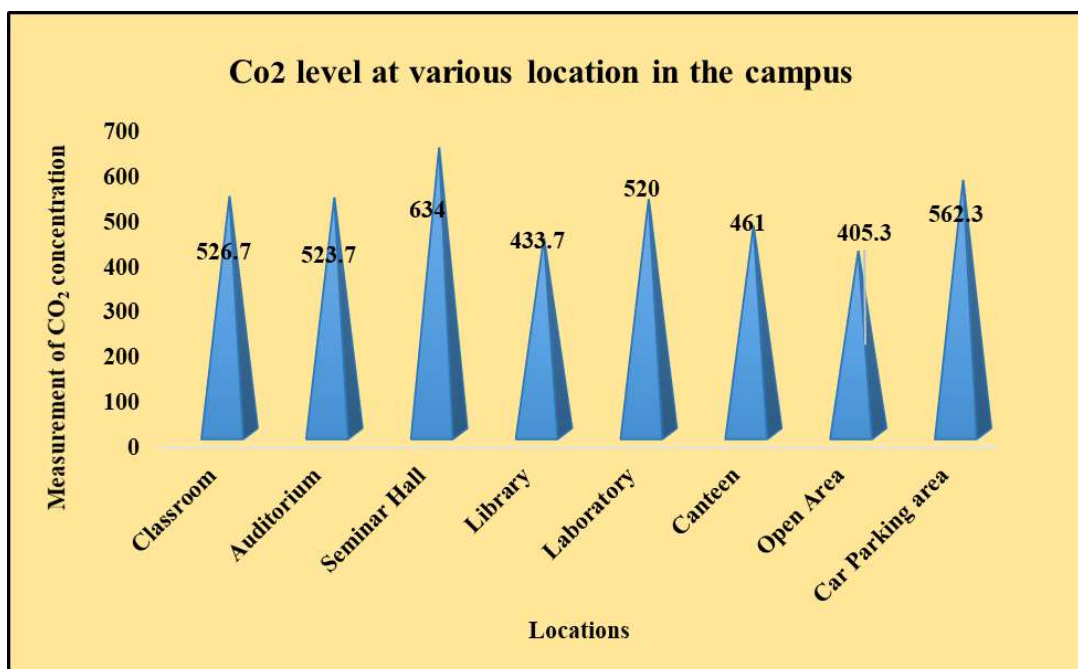
2.4. Air quality audit observations

It is observed that carbon dioxide and oxygen values are acceptable range. The air circulation is very good in all the places which in turn useful to give pure air to the stakeholders. The observation showed that the concentration of CO₂ in the atmosphere is found to be optimal which did not exceed the critical limit of CO₂. It is further revealed that all the selected locations are having pure air without any air contaminants with good air exchange/circulation in the campus. Some of the places like Canteen and Class Rooms are recorded with high level of carbon dioxide level due to student mobilization and the maximum number of electrical items fixed from which the carbon dioxide emission was observed followed by all laboratories and seminar and auditorium halls (Table 1).

Table 1. Measurement of CO₂ concentration in the Organization

S. No.	Different locations of the Organization's Campus	Carbon dioxide level (ppm)*	Remarks
1.	Classroom	526.7	Within permissible limits
2.	Auditorium	523.7	Within permissible limits
3.	Seminar Hall	634	Within permissible limits
4.	Library	433.7	Within permissible limits
5.	Laboratory	520.0	Within permissible limits
6.	Canteen	461.0	Within permissible limits
7.	Open Area	405.3	Within permissible limits
8.	Car Parking area	562.3	Within permissible limits

Figure 1. Measurement of CO₂ concentration in the Organization



2.5. Atmospheric oxygen level measurements analysis and interpretation

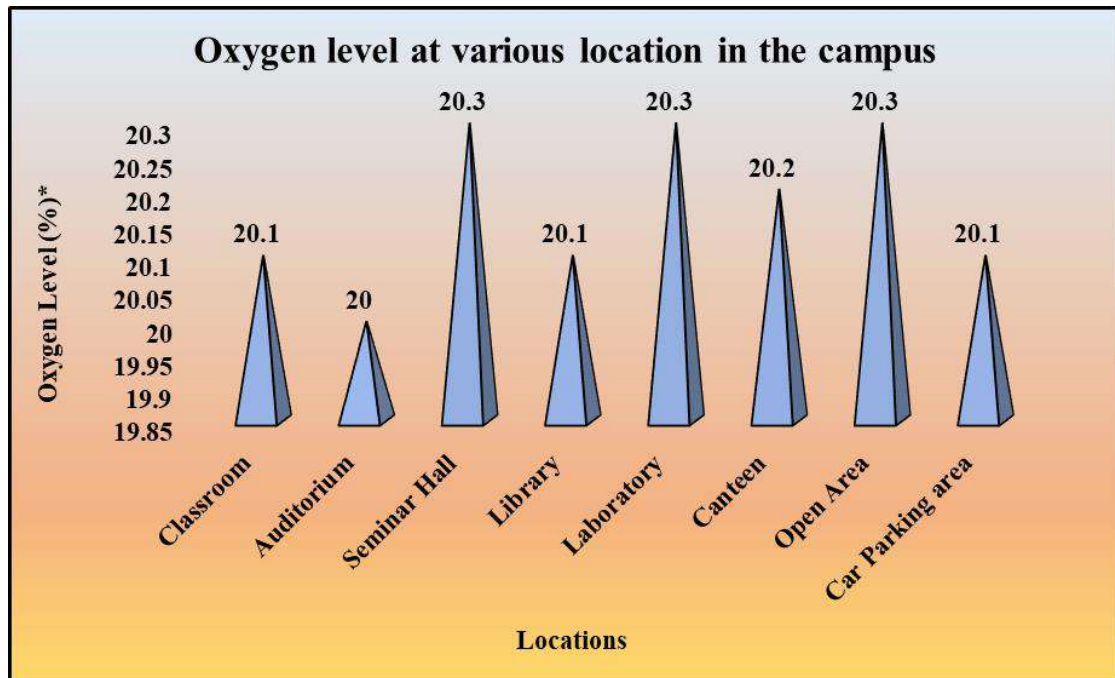
Oxygen level refers to the amount of oxygen available within the atmosphere or water bodies. Oxygen is produced/released as a by-product of photosynthesis, the metabolic activity of all green plants besides certain microbes. Oxygen plays a paramount role in metabolic activities like respiration and the energy-producing chemistry of all living organisms. In order to quantify the oxygen level, Oxygen Meter is used.

The atmosphere contains 18-21% oxygen concentration, 75-78.5% nitrogen and 2- 3% other gases like carbon dioxide, neon and hydrogen. The amount of oxygen level in the atmosphere is determined by abiotic factors like altitude, latitude and longitude and biotic factors like plantations in the surroundings. If it excess, it causes oxygen toxicity and oxygen poisoning by creating coughing, breathing trouble and damage the lungs to human beings. The oxygen level of different places at the campus are monitored and presented (Table 2).

Table 2. The oxygen concentration at different places of audited organization

S. No	Location	Oxygen Level (%)*	Remarks
1.	Classroom	20.1	O ₂ level is good
2.	Auditorium	20.0	O ₂ level is good
3.	Seminar Hall	20.3	O ₂ level is good
4.	Library	20.1	O ₂ level is good
5.	Laboratory	20.3	O ₂ level is good
6.	Canteen	20.2	O ₂ level is good
7.	Open Area	20.3	O ₂ level is good
8.	Car Parking area	20.1	O ₂ level is good

Figure 2. The oxygen concentration in the Organization



CO₂ and O₂ analysis are observed in the campus

3. ENVIRONMENT AUDIT

3.1. Introduction

Environmental (Eco) audit is quantitative and qualitative data to track air, soil and water and to gain actionable insights to improve the operational performance in the atmosphere. It provides a 360° view of a surrounding campus and makes it easy for Owners / Managers / Environmentalists to collaborate, measure, control and reduce environmental negative impacts. Finally, it leads to enhance the quality of life of all living organisms. Eco audit initiatives are the need of the hour across the world due to changing environmental conditions and global warming besides ever-increasing human population and anthropogenic activities (NCP, 2016). Eco audit aims to make a sustainable and friendly environment for the stakeholders. In this context, to conserve eco-friendly atmosphere of an organization, well-developed environmental objectives and targets should be undertaken to reduce the harmful effects to a greater extent (Gnanamangai *et al.*, 2021).

The audit process can remarkably minimize the environmental pollution in the campus which in turn reduces the impact of global warming scenario. As per the Rules and Regulations laid by Government, the environmental legislations should be followed by all the Institutions and Organizations and make sure that their activities should not degrade the environment. The environmental audit involves systematic documentation of periodic objective review by a regulated entity on available facilities, their operations and practices related to resolve the environmental requirements. In general, environmental audit is planned to achieve an optimum resource utilization and improved process performance in the audit sites. Venkataraman (2009) stated that it is a 'Common Sense Approach' to identify the problems and solve those problems pertaining to curb eco-friendly atmosphere. Environmental audit enables an overall and complete overview at the audit sites to facilitate our understanding of flow of materials and to focus the priority areas where waste reduction is achieved thereby cost saving is made possible.

Purpose of the audit is to determine performance of the environmental management systems and equipment related to environmental safety. Audit reports can provide key information to the management in relation to risk areas, progress towards strategic objectives and targets. Audit work can be undertaken voluntary for the benefit/advantage of the company and it can be executed with the help of environmental auditing authorities. As mentioned earlier, it helps in the proper natural resource utilization and on the whole, it improves the quality of environment.

An environmental auditor will study an organization's performance towards the environmental sustainability in a systematic manner where environmental management systems and equipment are performing with the aims of a) facilitating management control of environmental practices, b) assessing compliance with company policies, c) facilitating professional competence, d) sustenance activities without harming the environment and e) practicing the environmental conservation.

3.2. Organization Details

Table 3. Campus details

S.No.	Details / Descriptions	Quantity
1.	Total strength of Students	879
2.	Total strength of Employees	133
3.	Total number of Buses in the campus	13
4.	Number of Cars entering in the campus	4
5.	Number of Motorcycles entering in the campus	20
6.	Number of other vehicles (Lorry, Ambulance, Jeep, Trucks, Cranes, Poclair, and etc. entering in the campus)	1
7.	Number of E-Vehicles	1
8.	Number of RO Water Plants	6
9.	Number of Borewells	3
10.	Number of Open wells	2
11.	Number of Water Reservoirs	Nil
12.	Number of Wastewater treatment facility	1
13.	Number of Rain harvesting system	6
14.	Number of Composting pits and Vermicompost units	Nil

3.3. Environment audit observations.

- Human comforts are implemented and observed like ramp walk, fire safety, etc.,
- To reduce the demand of water, rain water harvesting system is implemented.
- Fire extinguishers are available in the building to consider the safety of all the Stakeholders and maintained properly.
- Parking is provided under the tree shade to reduce the Heat Island effect (Temperature).
- Rain water harvesting unit is maintained well without using any chemical, the water is used for irrigation purpose.
- Use of potable and non-potable waters are identified and differentiated to conserve water.
- Public transport facilities are available in the campus to control air pollution.
- The pedestrian pathways are maintained with adequate shading facilities by planting more number of trees.
- No offsite and subsidized parking are encouraged in the campus.
- Waste are segregated before the disposal.
- Biodegradable waste are used in the vermicomposting as a recycling practice.
- STP Unit is observed in the campus

3.3.1. Integrated Water Management System

Water is one of the major source of living. Per capita water consumption in the building is calculated as per the water management plan (litres / person/ day). To reduce the demand of water consumption rain water harvesting unit is implemented and practiced. Proper monitoring plan is made evident to reduce the water consumption in the leakage areas.



Rainwater Harvesting units observed in the organization

3.3.2. Corporate Governance

Training and awareness programmes are conducted to the stake holders to maintain sustainability. National And International events are conducted by the Organization are documented and those documents are verified.

3.3.3. Safety measures and green building conservation code

Environmental safety measures are very important in the buildings as far as students, staff members and other stakeholders are concerned and it requires vigilance and awareness. Management should extend by issuing guidance and the best safety tools. The organization has have a police force, escort services, call boxes, first aid box, fire extinguishers, fire alarms, security systems and staffs towards the safety measures. Organization has very good safety measures as per the green building conservation code such as fire extinguisher and fire bell and alarms in all the place.



Fire Extinguishers designed at the campus to ensure the safety of the Stakeholders

3.3.4. Applicability and Implementation

Guidelines of Architect, Designer and Civil contractor for the existing building addresses the choice of material, design methodology, operation and maintenance related options, etc., and also addresses the applicability.

3.3.5. Parking facilities to reduce Heat Island Effect

Heat island effect denotes the temperature level. It is observed that the vehicles are parked under the Tree shade to reduce the heat island effect for the benefit of stakeholders and to maintain sustainability. To reduce the heat island effect parking areas are made up of high albedo materials with light colored paints observed in the organization.

3.3.6. Public transport, low emitting vehicles and control of car smokes

Utility of public transportation (buses) reduces carbon emissions greatly and decreases the development of smog within the towns. This means that human beings have healthy air to respire. Comparing a bus travelling with a car transport for a person, it has been observed that buses are the most effective system by producing lower quantum of emission of carbon when compared to that of car transport. This will be a huge decrease in utility of natural resources per person. Other than this, it also gives more benefits like less noise and traffic congestion. Whenever possible, try to take public transport in place of one's own vehicle. The audited Organization is provided two E- Vehicles to maintain eco-friendly environment in the campus and to reduce carbon dioxide emissions. Apart from the e-vehicles, students are encouraged to use bicycles. The tree species are planted abundantly to provide shade to the pedestrian.



Two wheelers parked under the shades to reduce the Heat Island Effect



College Buses are parked under the shades to reduce the Heat Island Effect

3.3.7. Pedestrian path facility at the campus

The concept of pedestrian path is to give safe space to walk freely by the pedestrian. It is very important in the green campus in terms of freely walk pedestrians or people going on foot without any obstacles. The pedestrian path is otherwise called as zebra crossing by the combination of black and white stripes remained to characterize the zebra. In addition, pedestrian path is created in the green campus along with road side which meant for walking only using special cement bricks and stones. The pedestrian path aims to end circulation not only cars, buses, vans, trucks and other vehicles but also giving safe space to the pedestrians, where cross and pass through blocks and also forcing vehicles to comply with it. The audited organization is having very good facility in creating pedestrian path for stakeholders with all the facilities such as accessible public toilets, barrier free environment, dustbins, stone benches, etc. Use of bicycles are encouraged in the Campus to control carbon emission and air pollution.

3.3.8. Carbon footprint

Carbon footprint means measuring/recording the greenhouse gases (GHG) emissions of an organization within its defined boundary. Observations on carbon dioxide and oxygen levels monitored in different parts of the campus are presented under Air Quality Audit section while observation on carbon footprint due to electricity usage per year at the Organization along with other fossil fuel utility are presented under Energy Audit portion of this Technical Report.



3.3.9. Selection of Building Material

Building materials are selected as per the Guidelines to Architect, Designer and Civil contractors. Low carbon emitting cements, bricks, etc., are used for the construction and recycled glass materials are used for windows. Construction material are not stored in the campus.

3.3.10. Waste and Water management activities

Management of water and waste are the two important parameters which plays a vital role to maintain sustainability. Rainwater harvesting is implemented and maintained properly for water conservation, this water is used for irrigation and domestic purpose. It is observed that different colored dustbins are used in the Organization to segregate the waste at the source of generation.



Waste Management Measures – Dustbins & STP units facilities observed at the Campus

3.3.11. Post Occupancy maintenance

Post occupancy maintenance is the activities performed after the completion of construction work and handed over to the owner for further maintenance. The following activities are observed during the onsite visit as post occupancy maintenance

- Vegetation and plants are maintained properly with regular watering through irrigation facilities.
- Soil is maintained well without adding any chemical fertilizers and pesticides.
- To reduce the energy consumption HVAC system are maintained properly.

4. ENERGY AUDIT

4.1. Introduction

An energy audit is a survey in which the study of energy flows for the purpose of conservation is examined at an organization. It refers to a technique or system that seeks to reduce the amount of energy used in the Organization without impacting the output. The audit includes suggestions of alternative means and methods for achieving energy savings to a greater extent. Conventionally, electrical energy is generated by means of fossil fuels, hydraulic and wind energy. The availability of fossil fuels and their depletion rate, insist the need for alternate energy systems and conservation of conventional electric energy. In general, the primary objective of an energy auditing and management of energy consumption is to offer goods or services at the lowest possible cost and with the least amount of environmental impact.

Energy Conservation Building Code (ECBC) is established in the year 2017, which provides minimum requirements for the energy-efficient design and construction of buildings across India. It also provides two additional sets of incremental requirements for buildings to achieve enhanced levels of energy efficiency that go beyond the minimum requirements. Bureau of Energy Efficiency (BEE) came into force in 2002 towards implementation of energy saving practices in an organization. Energy-efficiency labels are information affixed to manufactured products and usually communicate the product energy performance.

BEE Star Rating Scheme is based on actual performance of the building as well as equipment in terms of specific energy usage termed as 'Energy Performance Indicator' by means of star ratings labelled items used which will be useful for energy savings in a sustainable manner (Mishra and Patel, 2016). Energy audit programme provide aid in maintaining a focus on energy price variations, energy supply availability and efficiency, determining an appropriate energy mix, identifying energy-saving technology, retrofitting for energy-saving equipment and so on (Gnanamangai *et al.*, 2021). In general, an energy audit process dealt with the driving energy conservation concepts into reality by giving technically possible solutions within a specified time limit while considering the economic and other organizational issues. It also dealt with the uncover ways to cut operating expenses or reduce energy use per unit of production interms of savings. It serves as a "benchmark" for managing energy in the organization for planning more energy-efficient use across the board.

4.2. Energy audit observations

During onsite audit following departments were verified for physical facility availability.

- Adequate awareness programmes are organized and conducted to the stakeholders for the proper handling and maintenance of the appliances.
- Adequate external and vertical shading are provided to conserve energy.
- Natural ventilation through windows and shading is available adequately to reduce the energy consumption.
- It is observed that large foliage trees are planted inside the campus to reduce noise pollution.

- External and internal signage lits are differentiated to conserve energy.
- ‘Danger’ and ‘warning boards’ are available near transformer, generator and UPS.
- Outside air is introduced through windows for ventilation in the conditioned spaces.
- Five star rated appliances AC, Air cooler, Refrigerator, etc.,) are procured to conserve energy.
- All the fluorescent (tube) lights are replaced with LED lights to conserve energy.
- Awareness posters like ‘Turn off when not in use’, ‘Save Energy’, etc., are displayed for conserving energy.
- Noise level observed in the different location resulted in normal range.
- Adequate training and awareness programmes are conducted to the stakeholders for energy conservation.
- To optimize the energy campus has implemented solar panel, water heater, sensor lights, operation and maintenance, etc.,

4.2.1. Energy Efficient Design and Process

In the campus, it is observed that for lighting, cooling and ventilation renewable sources of energy like solar panel, water heater, etc., are used. Local resources are made available in post occupant stage as per the operation and maintenance plan. Standard Operating Procedures for lifts, UPS, AC are available to conserve energy and to avoid damage.

4.2.2. Lighting facilities

External shading facilities are made based on the sun path to reduce the energy consumption. Day light integration is implemented in the building by placing adequate number of windows. Electrical lighting facilities during day time increases the energy consumption, it is observed that sufficient day lighting facilities are available through windows which in turn reduce the energy consumption bill of the Organization. Artificial lighting facilities are regularly monitored and maintained. In some areas sensor lights are implemented to save energy. External and internal signage lits are made up of recycled material with maximum light intensity. In the buildings windows head are higher to penetrate day light.



Natural Lighting facilities observed during day time

4.2.3. Building Service Optimization

To save energy in the buildings there should be a proper plan for HVAC system. In the organization it is observed that adequate natural ventilation is implemented and practices. In some places exhaust fans are used for ventilation especially in the canteen and laboratories. To reduce the heat inside the building shading patterns are maintained by planting trees in and around the campus. Solar panels are implemented at the roof top to reduce the heat and to save energy. Air conditioning are provided at specific areas. Energy conservation plays an vital role in maintaining the sustainability. It is observed that the Organization has replaced all the tube light with CFL / LED lamps, has proper metering and submetering facilities, availability of BEE star rated appliances in Air cooler, lift, AC, generator, etc., Solar water heater and panels are implemented to conserve energy. Instruments and meters are properly maintained and calibrated at regular intervals or annual maintenance plan is observed as one of the energy saving opportunity. Adequate energy saving awareness programmes are conducted to the stakeholders. Emissions and leaks are monitored through operation and maintenance manual.



Energy conservation facilities observed in the Campus

4.2.4. Energy consumption and cost profile

The following chart shows the profile of energy consumed and the cost for one year by the auditee (Figures 3 & 4; Table 4).

Figure 3. Electrical energy consumption profile

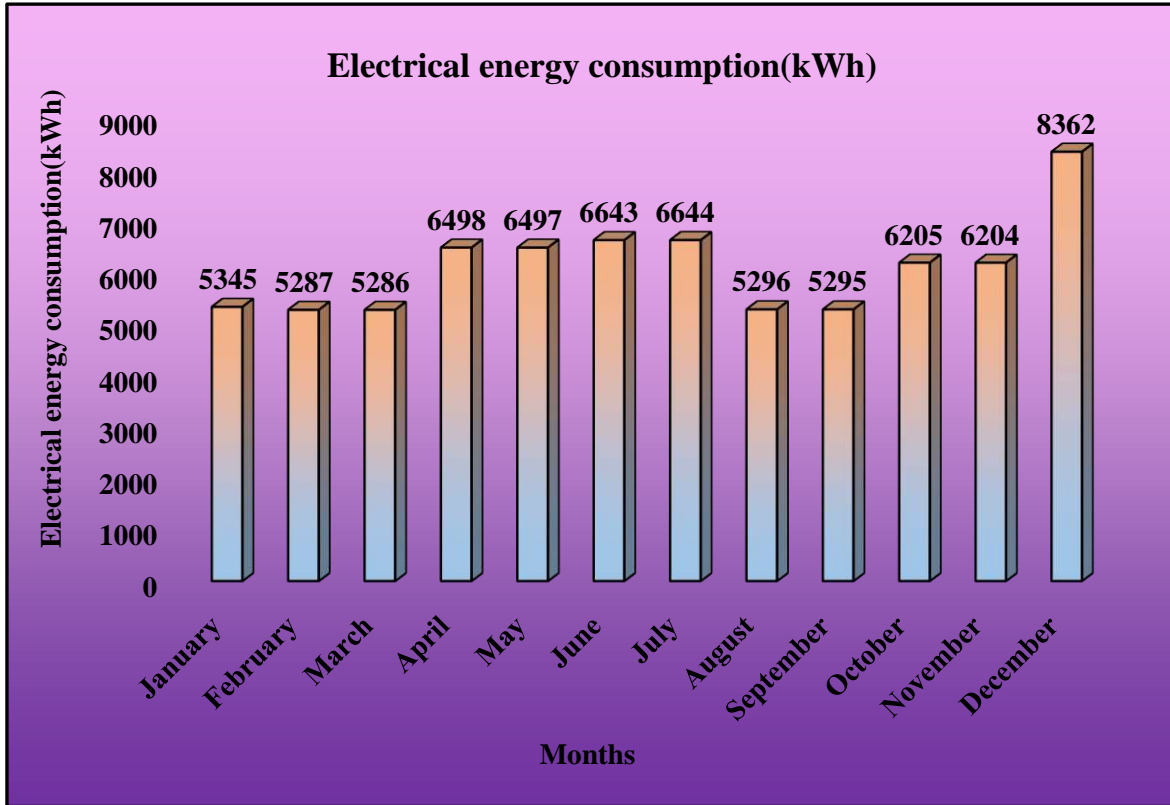


Figure 4. Overall electrical energy consumption and cost profile

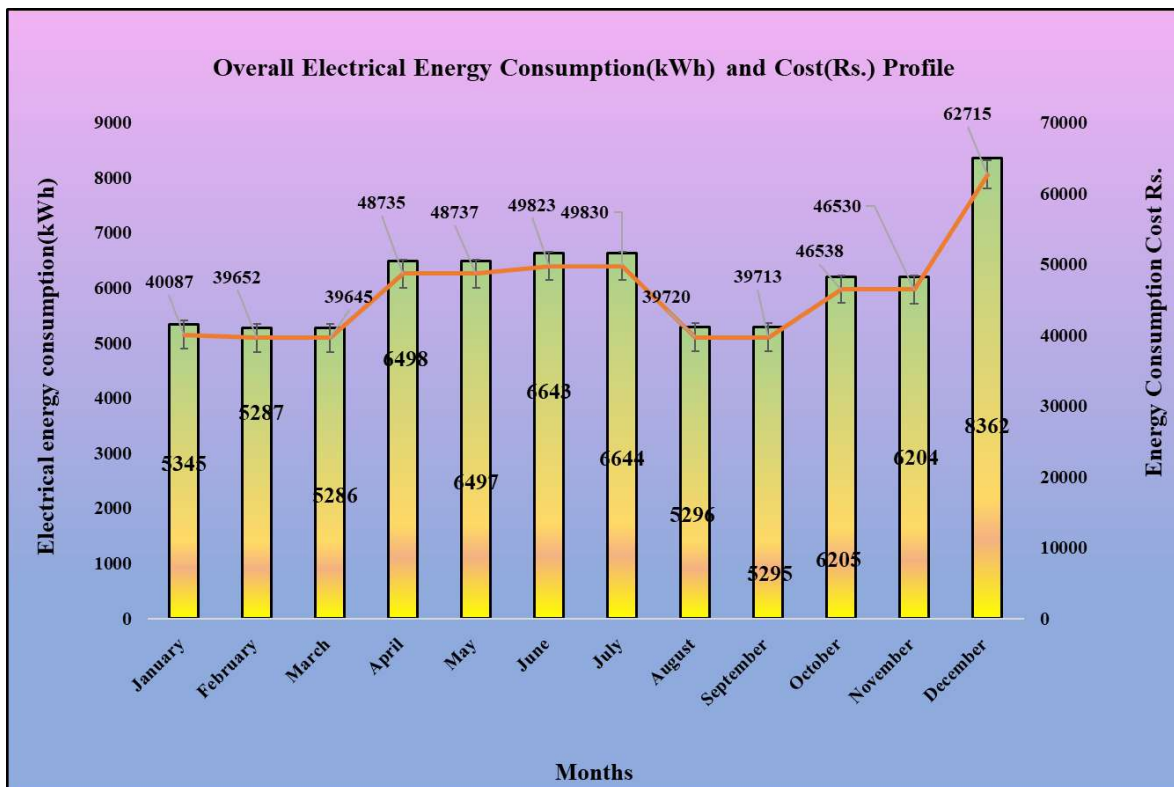


Table 4. Electrical energy consumption and cost profile in the College

S. No	Months	Rating / Capacity units in kWh	Cost in Rs.
1.	January	5345	40087
2.	February	5287	39652
3.	March	5286	39645
4.	April	6498	48735
5.	May	6497	48737
6.	June	6643	49823
7.	July	6644	49830
8.	August	5296	39720
9.	September	5295	39713
10.	October	6205	46538
11.	November	6204	46530
12.	December	8362	62715

4.2.5. Power consuming equipment and electrical appliances

Other than electrical energy from grid, energy generated using fossil fuels for the year are presented in the Table 5.

Table 5. Annual Energy Consumption of Fuels in the College

S.No	Month	Diesel consumption (Liters)	Petrol consumption (Liters)	LPG consumption (kg)
1	January	4000	Nil	15
2	February	4010	Nil	16
3	March	3900	Nil	18
4	April	3800	Nil	14
5	May	3000	Nil	13
6	June	3110	Nil	17
7	July	3255	Nil	16
8	August	4050	Nil	19
9	September	4100	Nil	15
10	October	3950	Nil	18
11	November	3800	Nil	15
12	December	3050	Nil	16

4.2.6. Carbon footprint

The carbon footprint per year is calculated (www.carbonfootprint.com) based on electricity usage per year in which CO₂ emission from electricity and the sum of transportation per year in terms of number of the shuttle buses service operated by the Organization and number of cars, motorcycles and trucks entering in the Organization campus. These factors are multiplied with total number of trips in each day and approximate travel distance of vehicles covered in each day with a coefficient (0.01) to calculate the emission of CO₂ in metric tons per year. Humans contribute to a massive increase of carbon dioxide emissions by burning fossil fuels, deforestation, and other industrial activities.

4.2.7. Calculation of carbon footprint

The carbon footprint analysis can be calculated based on the earlier reports as stated in www.carbonfootprint.com which is the sum of electricity usage per year. According to the data provided by the Management, carbon emission due to electricity consumption and fossil fuels are presented hereunder.

The CO₂ emission from electricity

$$\begin{aligned} &= (\text{electricity usage per year in kWh}/1000) \times 0.84, \text{ where } 0.84 \text{ is the coefficient} \\ &\text{to convert kWh to metric tons} \\ &= (73562 \text{ kWh}/1000) \times 0.84 \\ &= 61.79 \text{ metric tons} \end{aligned}$$

According to the above calculations, carbon emission due to electricity usage per year accounts for 97.9 metric tons.

Transportation per year (Shuttle)

$$\begin{aligned} &= (\text{Number of the shuttle vehicle in the campus } (2) \times \text{total trips for shuttle bus} \\ &\text{service each day} \times \text{approximate travel distance of a vehicle each day inside} \\ &\text{campus only } (20 \text{ km}) \times 365/100) \times 0.01 \\ &= (13 \times 2 \times 20 \times 365/100) \times 0.01 \\ &= 18.98 \text{ metric tons} \end{aligned}$$

365 is the number of days per year

0.01 is the coefficient to calculate the emission in metric tons per 100 km for bus

a. Transportation per year (Car)

$$\begin{aligned} &= (\text{Number of cars entering the campus } \times 2 \times \text{approximate travel distance of a} \\ &\text{vehicle each day inside campus only (in kilometers)} \times 365/100) \times 0.02 \\ &= ((4 \times 2 \times 20 \times 365)/100) \times 0.02 \\ &= 11.68 \text{ metric tons} \end{aligned}$$

365 is the number of days per year

0.02 is the coefficient to calculate the emission in metric tons per 100 km car

b. Transportation per year (Motorcycles)

$$\begin{aligned} &= (\text{Number of motorcycles entering the campus } \times 2 \times \text{approximate travel} \\ &\text{distance of a vehicle each day inside campus only (in kilometers)} \times 365/100) \times \\ &0.01 \\ &= ((20 \times 2 \times 20 \times 365)/100) \times 0.01 \\ &= 29.2 \text{ metric tons} \end{aligned}$$

365 is the number of days per year

0.01 is the coefficient to calculate the emission in metric tons per 100 km for motorcycles.

c. Total Carbon emission per year

$$\begin{aligned} &= \text{total emission from electricity usage} + \text{transportation (bus, car, motorcycle)} \\ &= (61.79 + 18.98 + 11.68 + 29.2) \\ &= 121.65 \end{aligned}$$

4.2.8. Noise level measurements

Noise is all unwanted sound or set of sounds that causes annoyance or can have a health impact and noise level is measured in decibels (dB). The body can also respond to lower noise levels. Level of noise are expected to be within 55 dB in residential areas, including institutions. Class room noise levels are supposed to be around 50 db. Sound Level Meter / Noise Thermometer are used to measure the noise level in the surroundings which converts the sound signal to an equivalent electrical signal and the resulting sound pressure level in decibels (dB) referenced to 20 μ Pa. Noise level prescribed by Central Pollution Control Board was presented in the Table 6.

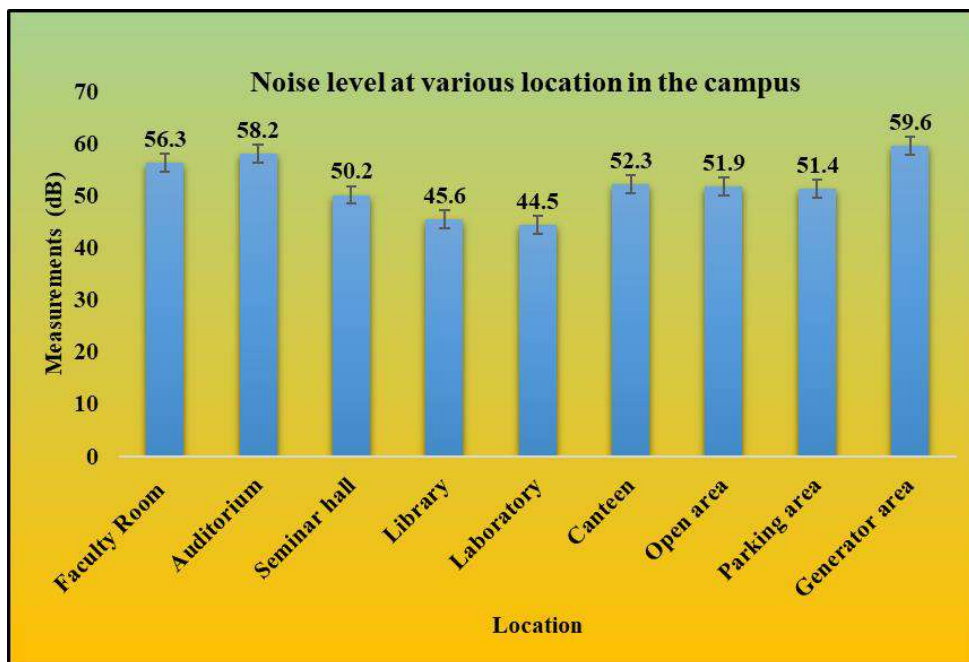
Table 6. Noise level standard prescribed by Central Pollution Control Board, Government of India

Area Code	Zone	Limits in dB (A) Leq	
		Day Time	Night Time
A	Industrial	75	70
B	Commercial	65	55
C	Residential	55	45
D	Silence	50	40

Source: IS : 12065 - 1987

Table 7. Noise level at various location in the campus

S.No	Locations	Measurements (dB)	Major noise sources	Remarks
1.	Faculty Room	56.3	Students and Staff	No Noise Pollution
2.	Auditorium	58.2	Students	No Noise Pollution
3.	Seminar hall	50.2	Students	No Noise Pollution
4.	Library	45.6	Staff members	No Noise Pollution
5.	Laboratory	44.5	Students	No Noise Pollution
6.	Canteen	52.3	Students and Staff	No Noise Pollution
7.	Open area	51.9	Students and staff	No Noise Pollution
8.	Parking area	51.4	Vehicles	No Noise Pollution
9.	Generator area	59.6	Generator Sound	No Noise Pollution

Figure 5. Noise level at various location in the campus

4.2.8.1. Light intensity measurement at the campus

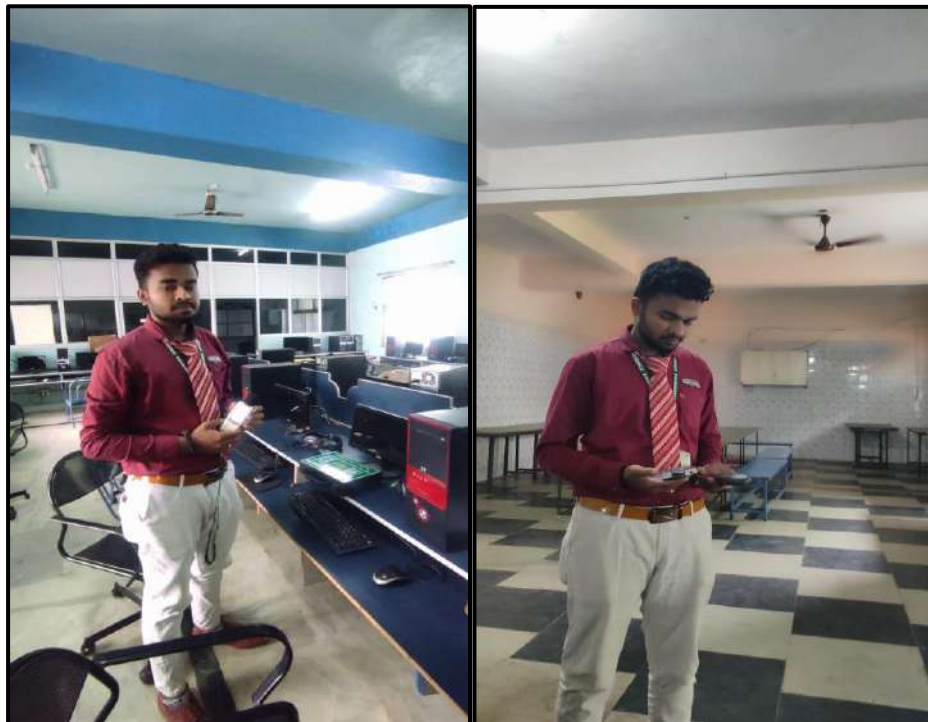
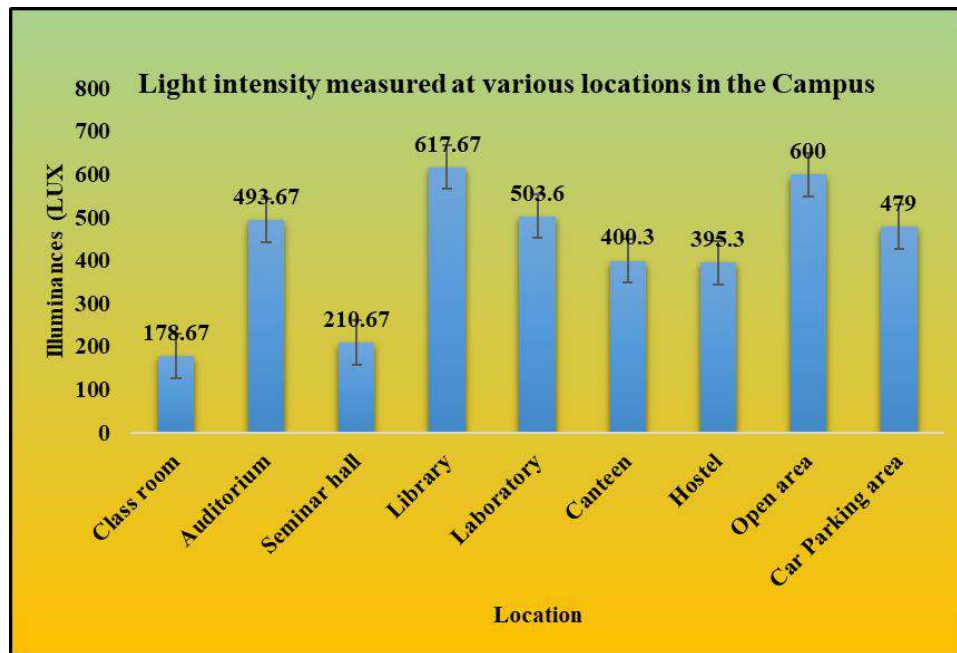
Light intensity or light output is used to measure whether a particular light source provides enough light for an application needed. There is a well-established light level recommendation for a wide range of applications in lighting industry and also for the type of space. Light intensity is measured in terms of lumens per square foot (foot-candles) or lumens per square meter (lux). A light meter (lux meter) is used to measure the amount of light in a space/on a particular work surface. The light meter consists of a sensor that measures the light falling on it and provides the user with a measurable illuminance reading. Light meters are an especially useful tool for measuring light for safety or over-illumination.

Table 8. Light intensity measured at various locations in the College

S. No	Type of Spaces	Illuminances (LUX)
1.	Class room	178.67
2.	Auditorium	493.67
3.	Seminar hall	210.67
4.	Library	617.67
5.	Laboratory	503.6
6.	Canteen	400.3
7.	Hostel	395.3
8.	Open area	600
9.	Car Parking area	479

Source: IS: 6665-1972

Figure 6. Light intensity Measured at the campus



Analysis of Light Intensity and Noise level analysis in the Campus

5. Conclusion

Considering the fact that the organization is a well-established academic institution and there is significant scope for conserving green, environment and energy, which in turn make the campus as self-sustained. The organization has taken enormous efforts to maintain green campus in a sustainable manner. It has conducting a large number of activities for the benefit of rural and tribal community people without disturbing the natural environment. The installation of a rainwater harvesting system and irrigation system to conserve rainwater and improve the ground water levels are noteworthy. The Organization has created medicinal, herbal and ornamental gardens at small scale level for establishing a massive reforestation / afforestation programme in which a large number of trees and shrubs species were planted together for providing an eco-friendly atmosphere to the stakeholders in a sustainable manner.

The energy conservation initiatives taken by the organization are substantial. Water and Soil conservation activities are also implemented and practiced. Proper facilities and procedures are followed for waste collection, segregation, disposal, recycle and reuse. Quality of soil and water observed to be good. Hygienic practices are monitored and maintained considering the health and sustainability of the stakeholders at canteen and hostel premises. Tree plantation at appropriate locations are maintained to resist the indoor climate and conserve energy. The organization has made significant progressive contributions with respect to teaching learning, research and consultancy, innovation and transfer of technology, community service and value education, in toto. It imparts quality education to rural, tribal and urban people across the nation which is excellent in terms of academic activities and providing an eco-friendly atmosphere to the stakeholders

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