CRITERION – VII	
KEY INDICATOR	**7.1.3 Quality audits on environment and energy regularly undertaken by the Institution. The institutional environment and energy initiatives are confirmed through the following** **1. Green audit / Environment audit** **2. Energy audit** **3. Clean and green campus initiatives** **4. Beyond the campus environmental promotion activities**
METRIC NO.	**7.1.3**

REPORTS OF THE BOTH [GREEN AUDIT / ENVIRONMENT AUDIT AND ENERGY AUDIT] AUDITS

CARMEL VIDYA BHAVAN TRUST'S

CHRIST COLLEGE PUNE

(Affiliated to Savitribai Phule Pune University)

Criterion VII

INSTITUTIONAL ENVIRONMENT AND ENERGY INITIATIVES

7.1.3 Green Audit / Environmental & Energy Audit Reports

Environmental & Green Audit Report 2021-2022

CARMEL VIDYA BHAVAN TRUST'S

CHRIST COLLEGE-PUNE

26/4 A, Vadgaon Sheri, Off Pune Nagar Road Pune Maharashtra 411014

By
GREENEX ENVIRONMENTAL
T-71,- 1A/2, Telco Road, General Block, Near Indrayani Corner, above Kotak Mahindra bank, MIDC, Bhosari, Pune – 411026

Acknowledgement

We would like to express our sincere gratitude towards all who made it possible for us to complete the Green Audit of Carmel Vidya Bhavan Trust's Christ College, Pune smoothly. We would like to extend our gratitude to Dr (Fr) Sony J. Chundattu CMI, Director/Principal from Christ College, Pune, for offering us the opportunity to perform Green Audit of Christ College, Pune. We would also like to thank Mrs. Deepa Sujith, Dr. Priya Wahab, Mr. Francis Jose and Mr. Deepak Bhosale for making time and assisting us throughout the audit.

We would like to thank each and every staff member at the college who helped us collect the resourceful data. Last but not the least; we thank our team for their unwavering support.

- Greenex Environmental

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1.0 Introduction

1.1 Christ College, Pune

Christ College, Pune is a noble venture by Carmel Vidya Bhavan Trust formed by the members of the congregation of the Carmelites of Mary Immaculate (CMI), the first indigenous religious congregation in India. Christ College, Pune is a Christian minority institution affiliated to the Savitribai Phule Pune College since its inception. The College is recognized by Government of Maharashtra and managed by Carmel Vidya Bhavan Trust of the CMI (Carmelites of Mary Immaculate) congregation.

Christ College, Pune offered 10 graduate courses like B.A. (eco), BSc, BSc(comp. science), B.Com, Professional Courses like B.B.A, B.B.A (Computer Application), B.B.A (International Business), ACCA, Fashion Design, Interior Design, Event Management and 2Post Graduate Courses like M.Com, M.Sc. (Comp. Sc).These courses were housed in 3 buildings and spread over a total area 20234.3SQ.M with built up area of 13575.08 SQM.

Christ College, Pune is located at Vadgaon Sheri in North-East Pune, opposite Weikfield IT Park, with the fast-developing suburbs of Kalyani Nagar, Viman Nagar and Kharadi as surrounding areas with large IT Parks and residential areas. The proximity with the national highway provides good connectivity. It is a matter of great pride that the college has made big strides within a short span.

The College is relentlessly putting its endeavors in enhancing the standards in teaching, research, skill-based programs, extra-curricular and sports activities to impart sound learning to students under circumstances congenial to their all-round development. There is a strong research pursuance and publications carried out by each school. The College is committed to the all-round developments of students to encourage the students to aim at excellence not only in academic pursuits, but also in every aspect of human endeavor to achieve perfection. As a result, a number of students have been bringing laurels at the state and national youth festivals, sports and research events.

Education in a favorable learning environment in the serene campus of Christ College Pune has an extensive and distinctive significance which strengthen every individual to lead a unique life. A highly systematic and disciplined atmosphere with state-of-the-art technology and facilities, transform education as a holistic understanding of the mysteries and miracles of life. A campus provides a different learning experience, create avenues and provide opportunities for the students to explore themselves. The College aims to guide, mould and encourage students to develop a passion in them to be successful in the ever-changing competitive world. The College has been regularly organizing State level, inter College level and international seminars, conferences, sports and research events.

Figure 1: Christ College

Figure 2: Satellite image of Christ College, Pune

1.2 Infrastructure

All the 3 buildings in the College are well-spaced and well-constructed to provide proper illumination and ventilation. Around 50% of the campus area is covered with vegetation, giving it an aesthetic view and providing a healthy environment. All the buildings in the campus have open courtyards which consist of various plants. Three buildings within the campus consist of 70 rooms for around 1600 students and 54 staff members. The Christ College, Pune campus is based in scenic environs and has well-maintained gardens with buildings sheltered under a canopy of trees, fully equipped classrooms, well developed laboratories and an exhaustive library that has all the requirements of an institute of higher learning.

There are 2 Computer labs with the capacity of around 90 computers, 2 seminar halls with the capacity of 90people each, library, electronic lab, yoga room, medical room, gym, basketball court, canteen and smart room.

Area	Sq.m
Plot Area	20234.3
Built up Area	13575.08

Figure 4: Smart room

Figure 5: Class room

Figure 6: Library

Figure 7: Computer Lab

Figure 8: Central Courtyard

Figure 9: Yoga Room

1.3 Vision and Mission of the College

Vision

Inspired by the perennial response to the age old aspirations of the Rishis of our Arsha Bharatha expressed in the Upanishadic prayer; "Thamasoma Jyothirgamaya", Christ College, Pune has taken "Enlighten to Excel" as its Motto. The attainment of true knowledge makes one enlightened so that one can lead oneself and others on the path of truth and achieve intellectual and ethical excellence.

Mission

As a C.M.I. Educational Institution, the college regards education as integral to the formation of the human person for the fulfillment of his/her individual and social responsibilities. The college aims at forming leaders who are intellectually competent, spiritually mature, morally upright, psychologically integrated, physically healthy and socially responsible, individuals who are open to grow and champion the cause of justice, love, truth and peace.

Values

The values that students imbibe are an integral part of their personal growth. As part of value-clarification, core values are prioritized as follows and they help all in conflict resolution.

- Faith in God
- Moral Uprightness
- Social Responsibility
- Pursuit of Excellence

Goals of the institution

- To continue to improve the quality of the undergraduate and postgraduate courses that prepares the students for professional life, leadership and citizenship in a changing world.
- To make special efforts to provide access to higher education to economically challenged and underprivileged sections of the society.
- To optimize the usage of resources and infrastructure in an integrated fashion to improve, enhance and strengthen the students' faculties.
- To produce global students with Indian ethos.
- To inculcate self-discipline and high ethical standards, among students, staff, faculty and societal individuals.
- To create a pool of self-motivated and dedicated researchers.
- To provide facilities and support to the staff to take up innovative methods of teaching in accordance with the developments in the academic world and also take care of the development in industry and commerce.
- To transform the 'Student' into "Knowledge Professional" empowered with scientific intellect, entrepreneurial skills, and innovation, who have learnt their skills in a highly competent environment under the guidance of research oriented and skilled Professors.
- To create an ambience for learning and scholarship.
- To become a nationally renowned Centre of Excellence in teaching - learning, research and extension activities, beneficial to the current and forth coming generations.

2.0 Environmental and Green Audit – A Preview

2.1 Environmental Audit

An environmental audit is a type of evaluation intended to identify environmental compliance and management system implementation gaps, along with related corrective actions. In this way, environmental audit performs an analogous (similar) function to financial audit. There are generally two different types of environmental audits: compliance audits and management systems audits. ISO 14001 is a voluntary international standard for environmental management systems ("EMS"). ISO 14001:2004 provides the requirements for an EMS and ISO 14004gives general EMS guidelines.

The Supreme Audit Institution (SAI) in India is headed by the Comptroller and Auditor General (CAG) of India which is a constitutional authority. The audit conducted by CAG is broadly classified into Financial, Compliance and Performance Audit. Environmental audit by SAI India is conducted within the broad framework of compliance and performance audit.

Environmental auditing is a systematic, documented, periodic and objective process in assessing an organization's activities and services in relation to:

- Assessing compliance with relevant statutory and internal requirements
- Facilitating management control of environmental practices
- Promoting good environmental management
- Maintaining credibility with the public
- Raising staff awareness and enforcing commitment to departmental environmental policy
- Exploring improvement opportunities
- Establishing the performance baseline for developing an Environmental Management System (EMS)

Figure 10: Aspects of Environmental Audit

Figure 11: Green Campus Illustration

2.2 Green Audit

Green Audit is a part of Environmental Audit. Green Audit is a process of systematic identification, quantification, recording, reporting and analysis of components of environmental diversity of various establishments. It aims at analyzing environmental practices within and outside of the concerned sites, which will have an impact on the eco-friendly ambience.

Green audit can be a useful tool for an academic institution to determine how and where the institution is using the energy or water or resources more than requirements. It can also be used to determine the type and volume of waste, which can be used for a recycling project or to improve waste minimization plan. It can create health consciousness and promote environmental awareness, values and ethics. It provides staff and students a better understanding of green impact on campus. Thus, it is imperative that the institute evaluates its own contributions towards a sustainable future. As environmental sustainability is becoming an increasingly important issue for the nation and for the world, the role of higher educational institutions in relation to environmental sustainability is more significant.

The rapid urbanization and economic development at local, regional and global level has led to several environmental and ecological crises. On this background, it becomes essential to adopt the system of the Green Campus for the institutes which will lead towards sustainable development and at the same time reduce a sizable amount of atmospheric carbon-di-oxide from the environment. **Green Audit is assigned to the Criteria 7 of NAAC (National Assessment and Accreditation Council) evaluation** that declares the institutions as Grade A, Grade B or Grade C according to the scores gained at the time of accreditation. Moreover, it is a part of the responsibility of the Higher Educational Institutions to ensure that there is reduction of global warming through Carbon Footprint reduction measures.

Therefore, the need or purpose of the green audit is to identify, quantify, describe and prioritize framework of Environment Sustainability in compliance with the applicable regulations, policies and standards.

3.0 Objectives of Green audit

The overall objectives of green auditing are to help safeguard the environment and minimize risks to human health. The key objectives of an environmental audit therefore are:

- To determine how well the environmental management systems and equipment are performing
- To verify compliance with the relevant national, local or other laws and regulations
- To minimize human exposure to risks from environmental, health and safety problems.
- More efficient resource management
- To provide basis for improved sustainability
- To enable waste management through reduction of waste generation, solid- waste and water recycling
- To create plastic free campus and evolve health consciousness among the stakeholders
- To recognize the cost saving methods through waste minimizing processes
- To point out the prevailing and forthcoming complications
- Impart environmental education through systematic environmental management approach and improving environmental standards
- Financial savings through a reduction in resource use
- Enhancement of College profile
- To develop an environmental ethics and value system amongst students

4.0 Goals of Green Audit

- To achieve compliance standards and establish a report with regulatory bodies
- To identify needs, strengths, and weaknesses of the educational institute
- To review management systems and identify liabilities
- To assess environmental performance of the educational institute with the help of direct assessment.
- To promote environmental awareness among the staff and students
- To conserve non-renewable resources for betterment of future
- The long-term goal is to collect the baseline data in terms of environmental parameters, calculate its impact on the environment and recommend measures to reduce them

5.0 Target Areas of Green Auditing

- **Energy Conservation and Management:** This indicator addresses energy consumption, energy sources, energy monitoring, lighting, appliances, and vehicles.
- **Water Quality and Conservation**: This indicator addresses water consumption, water sources, irrigation, storm water, appliances and fixtures.
- **Biodiversity Conservation**: All plant and animal species - including microorganisms - are a part of biodiversity. All types of gardens, lawns and trees are considered in this aspect.
- **Waste Management**: This indicator addresses all types of waste from the College and associated amenities. The minimization, safe handling, and ultimate elimination of these materials are essential to the long-term health of the planet.
- **Carbon Footprint:** This aspect is for quantifying the carbon emissions from all the parts of the institution and quantifying how much of it is sequestrated with the help of landscape.

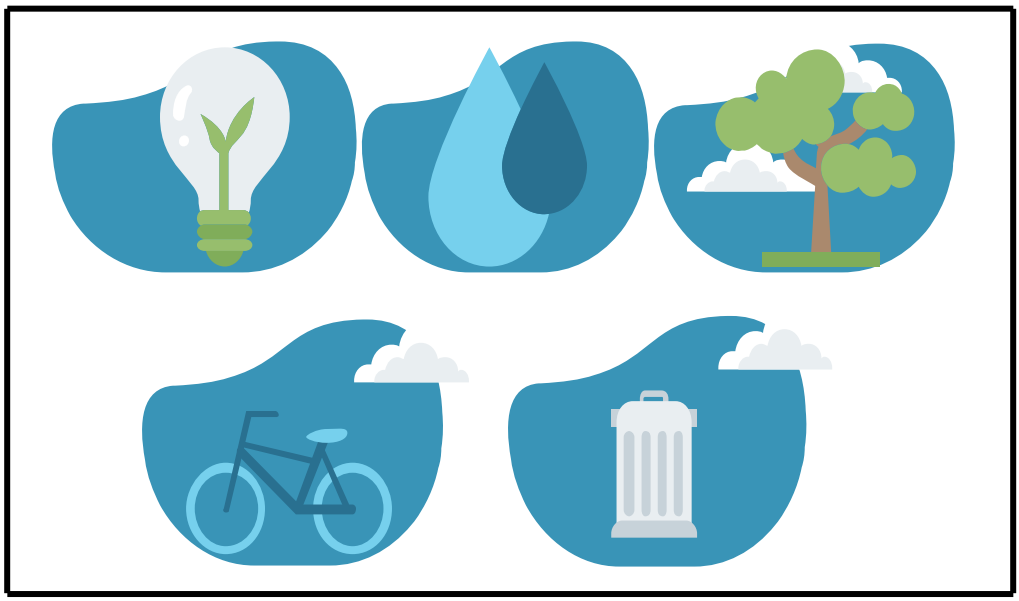


Figure 12: Target Areas of Green Audit

6.0 Methodology

6.1 Data Collection

In preliminary data collection phase, exhaustive data collection is performed using different tools such as preparation of questionnaire, physical inspection of the campus, observation and review of the documentation, interviewing key persons, etc. Focus groups, if practiced, can also be a vital part of data collection stage to acquire qualitative information.

6.2 Survey by Questionnaire

Baseline data for green audit report preparation was collected by questionnaire survey method. Most of the guidelines and formats are based on broad aspects. Therefore, using these guidelines and formats, combinations, modifications and restructuring was done and sets of questionnaires were prepared as solid waste, energy, water, biodiversity, carbon footprint. Questionnaires are attached as Annexure I.

6.3 Data Analysis

The data required for the analysis is taken from the data collection, it includes: calculation of energy consumption, analysis of latest electricity bill of the campus, measuring water consumption, carbon foot printing, etc. The data from questionnaire and survey forms is tabulated for the convenience of data availability; Recommendations and Environmental Management Plan is built according to the analysis done in this step.

6.4 Recommendations and Reporting

Based on the data analysis step, some recommendations in the target areas are made. Specific measures are suggested to reduce water and energy consumption. Proper treatments of waste are suggested with respect to waste collection, waste disposal and recycling. Recommendations to reduce the use of fossil fuels are made for the betterment of community health. Proper disposal of hazardous waste is suggested to prevent mishaps. Management also takes into account the suggestions related to reducing their carbon footprint.

7.0 Detailed Analysis

7.1 Water quality and conservation

The overall objective of conducting a water audit is to identify opportunities to make system or building water use more efficient to balance the demand and supply of water.

Water consumption of Christ College, Pune is **53.47** average kiloliter usage per month for residential building and **103.50** average kiloliter usage per month for college.

The College has 3 water tanks for domestic use each with the capacity of 5000 liters. Hence total capacity of 15 kiloliters is provided. Out of 15 Kiloliters, 10 kiloliters is being used for residential purpose and remaining 5 kiloliters for college building. Rainwater from College building roof is also collected and used further. Tank capacity of rainwater storage is 502830 liters which is used for the purpose of gardening and washing.

Table No.3: No. of tanks and its capacity

Water tank (nos)	Capacity (liters)
Water tank 1	5000
Water tank 2	5000
Water tank 3	5000
TOTAL	15000

Table No. 4: Water usage for College Building

Total capacity (liters)	15000
Number of persons	1654
Total water usage per day (liters)	5000
Total water usage per month (liters)	150000

For Residential quarters water requirement – 10000 liter/ day

a) Current practices of water management:

- Rain Water Harvesting is practiced by the College to save around 6, 00,000 liters for gardening and washing.

Figure 13. Municipal Underground water tank

Figure 14. Municipal Underground water tank

Figure15. Water tank System

7.2 Energy Conservation and Management

This indicator addresses energy consumption, energy sources, energy monitoring, lighting, appliances, and vehicles. Data for electricity consumption of the College was collected and is listed below.

a) Electricity consumption:

Total Energy Consumption of the College is 2027 KWH per month.

Solar Power Generation by the College is 20.16kVA

Table No. 5: Energy Consumption by College

Sr. No.	Electricity Consumption	Source
1.	2027(KWH per month)	MSEDCL
2.	750 kVA per month	Solar Panels

b) Current practices for energy management

Conserving energy produces a higher quality of life. In addition, it helps to create a healthier planet, or at least helps to sustain the resources already have.

The institution has installed **solar panels** on the roof of the college building that produces renewable energy to try to meet the increased electricity demand. Currently, the institute has solar panels that contribute to **37**% of the overall monthly electricity consumption.

- **Solar Panels** of **20.16kVA** are installed on the college building
- **Generator** of 45Kva is present to provide electricity at all times with high energy efficiency.

Figure 16: Solar panels

Figure 17: Signage to save electricity

7.3 Waste Management

Solid waste can be divided into three categories: bio-degradable, non-biodegradable and hazardous waste. Bio-degradable wastes include food wastes, canteen waste, wastes from toilets etc. Non-biodegradable wastes include what is usually thrown away in homes and schools such as plastics, tins and glass bottles, etc. E-waste is among the fastest growing solid waste classes and represents a serious hazard to the environment too.

The details of solid waste generation using questionnaires and observations are tabulated below.

a) Generation of waste:

Total Waste Generation of the College is 2481 kg/month

Table No. 6: Category Wise Waste Generation

Dry waste	Wet waste
49.62 (kg/day)	33.08(kg/day)
1488.60(kg/month)	992.40(kg/month)

Table No. 7: E-Waste Generation

Type of Waste	Generation Quantity
E-waste	6 (kg/year)

b) Current practices of solid waste management

- The garden waste is diverted to the **vermicomposting pit,** which then produces organic manure. This organic manure is used for trees in the campus.
- **Sanitary incineration system** is installed to reduce sanitary waste and convert the waste to energy.
- **Dry waste, wet waste and E waste** is collected and segregated within the campus.

Figure 18: Waste Collection and signage

7.4 Biodiversity Conservation

This aspect addresses all the flora and fauna of the campus. The list below has the name and quantity of trees as well as bird species. Around 6000 shrubs are planted within the college campus.

Table No. 8: Plant Species in the College

Sr. no	Common name of plant	Botanical name	Quantity
1.	Palm	*Roystonea regia*	74
2.	Foxtail Palm	*Wodyetia bifurcata*	37
3.	Bamboo palm	*Rhapis excelsa*	6
4.	Japanese cedar	*Cryptomeria japonica*	2
5.	Ashok	*Saruca asoca*	18
6.	Manila tamarind	*Pithecellobium dulce*	3
7.	Sagwan	*Tectona grandis*	3
8.	Gulmohar	*Delonix regia*	2
9.	Badam	*Terminalia katappa*	8
10.	Limbu	*Citrus aurantifolia*	3
11.	Tamarind	*Tamarindus indica*	5
12.	Mango	*Mangifera indica*	17
13.	Bamboo	*Bambusoideae*	1
14.	Chafa	*Plumeria rubra*	19
15.	Crabapples	*Malus*	1
16.	Neem	*Azadirachta indica*	4
17.	Coconut	*Cocos nucifera*	28
18.	Banana	*Musa acuminata*	200
19.	Wandering jew	*Tradescantia zebrina*	50
20.	Awala	*Phyllanthus emblica*	4
21.	Chikoo	*Manilkara zapota*	11
22.	Nilgiri	*Eucalyptus globulus*	2

23.	Guava	*Psidium guajava*	20
24.	Christmas Tree	*Araucaria columnaris*	7
25.	Sitafal	*Annona reticulate*	2
26.	Ficus	*Ficus benjamina*	1
27.	Thuja	*Thuja occidentalis*	3
28.	Papaya	*Carica papaya*	53
29.	Red flag bush	*Mussaenda erythrophylla*	14
30.	Powder Puff	*Calliandra inaequilatera*	2
31.	Betel	*Piper betle*	1
32.	Golden cypress	*Cupressus macrocarpa*	26
		Total	627

Some of the onsite pictures of the plants:





Fauna in the College campus

Table No. 9: Fauna observed in the College

Sr. No.	Specie Name	Scientific Name
Birds		
1	White Pekin	*Anas platyrhynchos domesticus*
2	Black Kite	*Milvus migrans*
3	Hen	*Gallus gallus domesticus*
4	Black Hen	*Gallus gallus domesticus*
5	Rock Pigeon	*Columba livia*
6	Green bee Eater	*Merops orientalis*
7	Asian Koel	*Eudynamys scolopaceus*
8	House Crow	*Corvus splendens*
9	Black Drongo	*Dicrurus macrocercus*
10	House Sparrow	*Passer domesticus*
11	Red-vented Bulbul	*Pycnonotus cafer*
12	Indian Robin	*Saxicoloides fulicatus*
13	Purple-rumped Sunbird	*Leptocoma zeylonica*
14	Common Myna	*Acridotheres tristis*
15	Parrot	*Psittaciformes*
Mammals		
1	Indian gray mongoose	*Herpestes edwardsii*
2	Stripped Squirrel	*Funambulus palmarum*
3	Rabbit	*Lepus refieeandatus*
4	House Mouse	*Mus musculus*
5	Cat	*Felis silvestriscatus*
6	Dog	*Canis lupus familiaries*
Reptiles		
1	Skink	*Eutropis macularia*
2	Common Bark Gecko	*Hemidactylus leschenaultia*
3	Common Indian monitor lizard	*Varanus benghalensis*
Butterflies		
1	Common grass yellow	*Eurema hecabe*
2	Common Indian crow	*Euploea core*
3	Psyche	*Leptosia nina*
4	Common Emigrant	*Catopsilia pyranthe*
5	Common Rose	*Pachliopta aristolochae*
6	Denaid Eggfly	*Hypolimnus misippus*
7	Plain Cupid	*Chilades pandava*
8	Stripped Tiger	*Danaus genutia*

9	Plain Tiger	*Danaus chrysippus*
10	Tiny grass blue	*Zizula hylax*

- **Birds**


Indian Robin


White pekin


Hen


Green bee eater


Rock Pigeon


Black Hen


Black Kite


Asian koel


Black Drongo


House Sparrow


Red - vented bulbul


Parrot


House Crow


Common myna


Purple-rumped Sunbird

- **Mammals**


Indian gray mongoose


Stripped Squirrel


Cat


Dog

- **Butterflies**

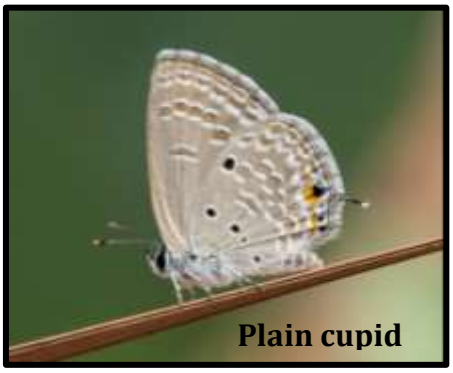

Common grass yellow


Common Indian crow


Common Rose


Plain Tiger


Tiny grass blue


Plain cupid

- **Reptiles**

Common Indian monitor lizard

Common Bark Gecko

Ambience of the campus: The ambience of the College is calm, spacious with good amenities and utilities in a visually appealing landscape. The building footprint of the College is 30% whereas green area is about 60% i.e. around 12140.40SQ.M. of the total plot area i.e. 20234.3SQ.M.

Various trees are planted at the periphery of roads which in turn reduces the College's Heat Island Effect and due to reduction of concrete pathways; rain water harvesting has been managed efficiently. The College has retained a huge amount of natural topography which aids in plenty of water percolation and ground water recharging. The campus knotted up divine atmosphere with academic ambience as green environment with trees and lawns, open corridors and large playgrounds enthusing students and staff to learn, develop skills and nurture teaching learning process.

7.5Carbon Footprint

Carbon footprint (CF) is the total amount of **greenhouse gases** (including carbon dioxide and methane) that are generated by human actions.

A) Carbon Emissions:

Table No. 10: Scopes of carbon emissions

Scopes	Sources	Description
Scope 1 (Direct)	Resource usage	Emissions from LPG Cylinder, D.G. Set, College owned vehicles, Air Conditioners
Scope 2 (Indirect)	Electricity Use	Emissions from Purchased Electricity and Renewable Energy
Scope 3 (Indirect)	Personnel commuting and materials transportation	Emissions from Personnel commutation and raw materials transportation
	Wastewater treatment	Emissions from waste water treatment
	Solid Waste treatment	Emissions from solid waste management

Emission Data and Calculations:

- **Scope 1 –** All Direct Emissions from the activities of an institution or under its control. Including fuel combustion on site such as gas, etc.

Table No. 11: Scope 1 Emissions

Type of Fuel	Quantity per month	Emission Factor	$KgCO_2$/month
Fuel used for DG set	35 liters	2.653	92.85
LPG	42.6 Kg	2.983	127.07
College owned vehicles - Petrol	1125 km	0.18	219
TOTAL SCOPE 1 EMISSIONS $KgCO_2$ / month			**438**

- **Scope 2 –** Indirect Emissions from electricity purchased and used by the institution. Emissions are created during the production of the energy and eventually used by the organization.

Emissions from Purchased electricity:

Table No. 12: Scope 2 emissions

Type of Emission	Quantity (KWH per month)	Emission Factor	$KgCO_2$ / month
Emissions from Purchased electricity	2027	0.97	1966.19
Renewable Energy	600	0.97	582
TOTAL SCOPE 2 EMISSIONS- $KgCO_2$ / month			**1966.19**

- **Scope 3 – All Other Indirect Emissions** from activities of the institution, occurring from sources that they do not own or control

1. **Employee Transportation:** Increase in student intake can lead to increased greenhouse gas (GHG) pollution caused by the resulting growth in vehicular traffic, energy use, and other activities. This unit seeks to identify the impact on global climate change through its emissions of greenhouse gases (GHGs), notably carbon dioxide (CO_2).

Table No. 13: Fuel Consumption through staff Transportation

Mode of transportation	Daily Count (staff)	Travelling distance (Km/Vehicle) (to and fro)	Total Km	Emission Factor	$KgCO_2$/day
2 wheeler	39	15	585	0.0319	18.66
4 Wheeler (Cars)	11	15	165	0.18	29.7
Bus	1	15	15	0.5289	7.93
TOTAL $KgCO_2$/day					**56.29**
TOTAL $KgCO_2$/month					**1407.33**

Table No. 14: Fuel Consumption through students Transportation

Mode of transportation	Daily Count (students)	Travelling distance (Km/Vehicle) (to and fro)	Total Km	Emission Factor	$KgCO_2$/day
2-wheeler	150	15	2250	0.0319	71.775
4-Wheeler (Cars)	3	15	45	0.18	8.1
Bus	40	15	600	0.5289	317.34
Cycle/walk	160	15		-	
TOTAL $KgCO_2$/day					**397.215**
TOTAL $KgCO_2$/month					**11916.45**

2. Solid Waste Generation:

Table No. 15: Waste Generation

Solid waste generated (Kg)	Solid waste generated (MT)	Emission factor	Total	Total
82.9Kg per day	0.0829 MT/day	0.05	0.004135 TCO_2 /day	**4.145 $KgCO_2$ /day**
2487Kg per month	2.487 MT/ month	0.05	0.12435 TCO_2 /month	**124.35 $KgCO_2$ /month**

3. Waste Water Generation:

Table No. 16: Waste Water Generation

Wastewater generated (liters)	Wastewater generated (cu.m)	Emission Factor	Total	Total
4185.86 liters per day	4.185	9.6643	40.445 Kg Co2	**40.445 Kg Co2**
122576 liters per month	122.576	9.6643	1184.611 Kg Co2/month	**1184.611Kg CO_2/month**

- **Total emissions throughout the year**

Table No. 17: Total emissions throughout the year

Scope	Total Emissions per month (Kg CO_2 per month)	Total Emissions per year(Kg CO_2 per year)
Scope 1	219	2628
Scope 2	1966.19	23594.28
Scope 3	14632.741	175592.892
Total Emissions	16817.931	201815.172

Reporting Year	Total Emissions (Kg CO_2 per month)	Total Emissions (Kg CO_2 per year)
2021-2022	16817.931	201815.172

Carbon Sequestration

Table 18: Carbon Sequestration of Trees

Sr. no	Category of Trees	Quantity	Kg CO_2 sequestration/year	Total Kg CO_2 sequestration
1.	Trees	627	250	156750

Total carbon Emissions: 201815 KgCO_2 per year

Avoided Emissions by Renewable Energy: 6984 Kg CO_2 per year

Carbon Sequestration: 156750 Kg CO_2 per year

Net emissions: 38081 Kg Co2 per year.

Percentage of carbon reduced: 82 % by using renewable energy & tree plantation

b)Carbon Emissions Management:

The College has planted 627 trees in the campus to sequestrate carbon emissions.

8.0 Highlights of the College

- The Christ College, Pune is accredited by NAAC with grade 'B+'.
- The institution has a provision of solar panels on the roof of the college building in order to generate renewable energy to meet the electricity demand. Currently, this contributes to 37% of the overall monthly electricity consumption.
- Around 627 trees are planted within the campus to sequestrate carbon emissions of about 78%.
- The garden waste is diverted to the vermicomposting pit to produce organic manure. This organic manure is then used for trees in the campus.
- Sanitary incineration system is installed to reduce sanitary waste and convert the waste to energy.
- Dry waste, wet waste and E waste generated is collected and segregated within the campus.

9.0 Recommendations from the audit

1. **Water Quality and Conservation**

- Installation of **Sewage Treatment Plant** for waste water management of whole campus is recommended.
- Installation of **low flow plumbing fixtures like aerators and water regulators** for water conservation
- Install **water aerators and automatic shut-off** devices on faucets.
- 

Figure 20: Difference between normal and low flow plumbing fixtures

- Installation of water **meters** is suggested to track water consumption of various entities
- Performing internal **water audits** every six months
- Checking **potability of water** on quarterly basis is recommended
- Installation of **motion sensed sprinklers** is advised for gardening purposes

2. **Energy Conservation and Mangaement**

- Installation of **energy meters** for every department to track electricity consumption is suggested
- Installing **5-star energy efficient appliances** wherever possible is encouraged

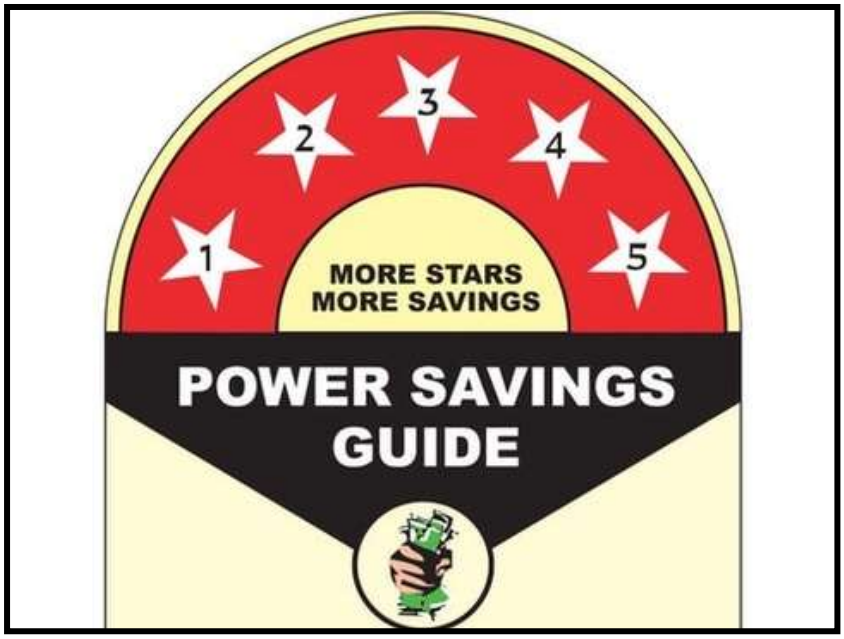


Figure 21: 5-star rating label

- Installation of **LED lamps** instead of TL and CFLs is a smart way of energy saving
- Installation of **energy efficient fans** in the new as well as old buildings
- Setting **Yearly Performance targets**
- Putting up **sign boards** to spread awareness for electricity consumption
- College has many areas where lighting is not required at all times. Installing **sensor based lighting** in such areas can generate massive rewards
- Planning **workshops** on energy conservation to educate students, faculty and staff can generate huge results of awareness
- Establishing a **purchase policy** that is energy saving and eco-friendly is needed
- Performing **internal energy audits** every year is advised

3. Waste Management

- **Vermicomposting pit** is recommended to maintain in good condition.
- **Separate waste transportation** is recommended for different types of waste
- One of the suggested methods for garden waste disposal is **Mulching**
- Plastic and paper waste should be sold to **authorized vendors for recycling**
- One of the preferred methods to treat paper waste is **shredding and composting**

Figure 22: Paper shredding machine

- Maintain **waste collection record** on daily basis for future convenience
- Try to inculcate the concept of **'Plastic free Campus'**
- To cut down the waste and carbon footprint, the College should follow **paperless methods of communication** and use emails, that too as minimum as possible
- Installation of **biogas plant** can convert wet waste into energy

[Biogas typically refers to a gas produced by the anaerobic digestion of organic matter including manure, sewage sludge, municipal solid waste, biodegradable waste or any other biodegradable feedstock, under anaerobic conditions. Biogas is comprised primarily of methane and carbon dioxide. It also contains smaller amounts of hydrogen sulphide, nitrogen, hydrogen, methyl mercaptans and oxygen.]

Below is the biogas equivalent to different fuels:

- 1 Kg firewood = 0.2 m^3 biogas
- 1 Kg dried cow dung = 0.1 m^3 biogas
- 1 Kg Charcoal = 0.5 m^3 biogas
- 1 Liter Kerosene = 2.0 m^3 biogas

Well-functioning biogas systems can yield a whole range of benefits for its users, the society and the environment in general.

4. **Biodiversity Conservation**
    - Maintain **natural topography** wherever possible
    - Planting more **fruit-bearing** trees can attract birds
    - Displaying **boards of Flora & fauna diversity** in the campus can generate enthusiasm for learners
    - Develop a **butterfly garden** that arouses appreciation towards flora and fauna diversity in the College
    - Plant more **native trees**
5. **Carbon Footprint**
    - Maintain **'No Vehicle Day'** at least once a month
    - Use **CFC free** equipments
    - Encourage **carpooling or ride share** program
6. **General Recommendations**
    - Maintain **EMP plan** to ensure positive benefits
    - Activate **Environmental management committee** to look after the compliance of EMP plan
    - Conducting **internal environmental audits** can help understand grey points
    - Celebrating **World Environment Day, World Water Day and Ozone Day** in the campus to provide awareness to the students about the importance of the environment, its conservation and sustainable use of environmental resources.
    - Putting up **posters related to Environment, Health and Safety** (Saving Electricity, Water Conservation, etc.) is an easiest way to spread awareness
    - Adopting **IGBC Green campus** rating system will help boost the College Profile

10.0 Conclusions

Green Audit is the most efficient way to identify the strength and weakness of environmental sustainable practices and to find a way to solve problems. Green Audit is one kind of a professional approach towards a responsible way in utilizing economic, financial, social and environmental resources. Green audit can "add value" to the management approaches being taken by the College and is a way of identifying, evaluating and managing environmental risks (known and unknown). The institution has incorporated most of the recommendation from Green Audit 2021-2022. There is scope for further improvement, particularly in relation to waste, energy, and carbon footprint and water management. The College considers the environmental impacts from most of its actions and makes a concerted effort to act in an environmentally responsible manner. Even though the College does perform fairly well, the recommendations in this report highlight many ways in which the College can work to improve its actions and become a more sustainable institution.

11.0 Environmental Management Plan

By keeping in mind, the current scenario of consumption of various entities and the current practices of the management, Greenex Environmental has prepared an 'Environmental Management Plan' for the College. This plan will reveal strengths and weaknesses of the College as well as suggestions on how to tackle the issues and develop green and clean campus. It also gives suggestion for the priority of work to carry out.

Water					
Details	**Daily**	**Monthly**	**Quarterly**	**Yearly**	**Remarks**
Analysis of STP inlet and outlet water		√			
Perform in-house water analysis of drinking water			√		
Installing water meter and keeping its record	√				
Maintenance of Rain water Harvesting System			√		
Perform water audits				√	
Cleaning of water tanks		√			
Quarterly drip irrigation maintenance			√		
Energy					
Performing energy audits				√	
Installing energy meters for various entities and maintaining its record		√			
Waste					
Disposal of E-waste to authorized vendors				√	
Maintaining waste quantity record	√				
Biodiversity					

Monthly checking of labels on trees		√			
Maintain quarterly tree count			√		
Carbon footprint					
Recording usage of College owned vehicles	√				
Recording of diesel usage in D.G. sets	√				
Recording LPG gas refilling frequency		√			
Recording of number of visitors	√				

12.0 References

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- https://www.epa.gov/sites/production/files/2016-03/documents/warm_v14_containers_packaging_non-durable_goods_materials.pdf
- http://wgbis.ces.iisc.ernet.in/energy/paper/IISc_Emissions_from_Indias_Transport_sector/index.htm
- https://dsclatur.org/mission-goals/
- http://www.neptjournal.com/upload-images/NL-46-33-(31)B-2040.pdf
- https://www.ijsr.net/archive/v5i4/NOV163155.pdf
- https://www.unm.edu/~jbrink/365/Documents/Calculating_tree_carbon.pdf

Annexure I

Energy Conservation and Management

Prerequisites	Affirmation	Response	Capacity	Documentary Evidence
Total Energy Consumption	Yes/No			Light Bills
Renewable Energy	Yes/No			Technical Specifications
Energy Audit Report	Yes/No			Report
Energy use breakup	Yes/No			Report/Documents
Energy Meter	Yes/No			Photos
Outdoor Bulb Directions	--			Photos

Water Quality and Conservation

Total number of water users	
Number of Employee	
Number of visitors (daily)	
Number of Students	
Rain water harvesting system availability	
Is rain water harvesting system working?	
Daily water supply (liters)	
Source of water	
Water Meter	

Water Storage:

Details of the storage structures -

Storage tanks	Capacity (Liters)	Number	Number of times it is topped (or filled) daily
Overhead			
Underground			
Total			

Waste Management

Type of Waste	Quantity	Method of Disposal
Paper		
Plastic		
Garden Waste		
Glass		
Wood		
Biodegradable		
Cloth		
Hazardous		
Clinical		
E-Waste		
Metal		

Carbon Footprint

Prerequisites

Scope I	College Owned Vehicles	Transportation per month:	No. -
	D.G. Set	Diesel consumed per month:	No. -
	LPG	Consumption per month:	No. -
	CO_2 Extinguishers		No. -
	AC	Capacity: Make up :	No. –

Scope III	Staff Commuting	Distance:	Type of Vehicle:	No. -
	Students	Distance:	Type of Vehicle:	No. -
	Business Travel	Distance:	Type of Vehicle:	No. -
	Other Material Deliveries	Distance:	Type of Vehicle:	No. of trips-

Biodiversity

Sr. no	Name	Quantity
Flora		
1.		
2.		
3.		
Fauna		
4.		
5.		
6.		

Our Team

1. Arati Bhosale

M. Sc. Environment, PGDISHE
Director, Greenex Environmental
IGBC AP, GRIHA CP, LEED GA, EMS lead Auditor, CII certified Carbon Footprint Professional

Work Experience:

Rich experience of 10 + years in Environment field. Expertise in Life cycle assessment study, carbon footprint, water footprint & IGBC, GRIHA, LEED Certifications. She has successfully accomplished 150 + Products LCA study and 50 + Green building projects.

2. Dr. Ganesh Kadam

PhD (Environmental Science & Technology), M.Sc. (Env. Sci.), RIO +20 India (2013), PGDISHE (Post Graduate Diploma in Industrial Safety Health & Environment), PGDGIS (Post Graduate Diploma in Geoinformatics)

Work Experience:

More than 12 yrs of experience in the Environmental research field with 6 years' experience of Institutional Green Auditing. Conducted more than 10 audits for various Colleges and College. Total 6 National and International Publications published in reputed journals.

3. Anjella Patel

M.Sc. (Environment Science), B.Sc. (Environment Science), Diploma (Remote Sensing and Geographic Information System)

Work Experience:

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Environmental Architect, Greenex Environmental

Work Experience:

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ENERGY AUDIT REPORT-2023

CHRIST COLLEGE, PUNE

Prepared by,

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Acknowledgement

Team Enertek wishes to thank trust members and staff members of Christ College, Pune and the ever-helping team members of administrative team. Team Enertek wishes to express their gratitude for all the help extended to our team members.

Team Enertek

Anand Dande – CEA 29754

BEE Certified Energy Auditor

Preamble:

Christ College in Pune is a remarkable initiative, driven by the Carmel Vidya Bhavan Trust, which was founded by members of the congregation of the Carmelites of Mary Immaculate (CMI), the first indigenous religious congregation in India. The inspiration for this noble venture stems from Saint Chavara, a visionary and pioneer who made significant contributions to education, social reform, communication, culture, and religious formation.

Christ College boasts a rich educational heritage and a clear mission: to provide quality education without discrimination based on religion, caste, or creed. The institution aspires to inspire its students to become individuals of integrity, and the dedicated faculty ensures that students stay abreast of the latest developments in their respective fields.

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Executive Summary:

I. Electricity Bill:

1. Tariff Structure:

Sanctioned load for energy meters is 25 kW and connected load is around 25 kW. Current tariff structures, **LTVII-B I** According to #322 of 2019 MERC amendment (Maharashtra Electricity Regulatory Commission); the recommended category for public services (such as schools, hospitals) is **LTVII–B tariff**. In this category there will be fixed demand charges per month.

II. Power Quality:

1. **Voltage:** The voltage fluctuations are observed between 360V to 425V. But there already voltage stabilizer is installed in the circuit.
2. **Harmonics:** -

Individual voltage harmonics are in limits but for neutral voltage, harmonics exceed due to the faulty Earthings and load balancing. Due to the load improper load balancing Current harmonics in R phase and neutral current are higher.

III. Lighting and Illumination System:

The average illumination level inside the classrooms was observed as 222 Lux. As per NBC college illumination recommended should be 300 Lux inside each classroom.

In order to provide appropriate illumination to levels with high Uniformity and Diversity, we have proposed to replace these existing T5 and T8 lighting system with LED tube light for improving illumination levels up-to 300 Lux improve efficacy of lighting to 100 Lumen/Watt.

- Currently, 108 lighting fixtures are needed to replace with LED Lights which reduces the facility load from 8.5 kW to 6.6kW
- But Additional Lighting fixtures are needed to be installed to mitigate the standard lux levels in the specified area.

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Chapter 1- Audit Methodology

ESIPL team carried out the entire energy and MEP audit study with a well-defined methodology and all the energy consuming areas were covered including billing analysis. The detailed methodology followed was as under:

1.1 Electrical Distribution System:

Scope of Work:

- Study the Load distribution pattern of major energy meters
- To suggest various energy efficient measures with first order cost benefit analysis

Methodology:

Census:

- Find out the electrical normal & emergency loading.
- Type of tariff
- General hygiene as per standard maintenance practices
- Data on operating hours data was collected from the operating staff

Performance audit:

Electric load recording with:

- Voltage, current, kVA, kW, kWh, P.F. and Hz
- Harmonic analysis for V_{THD} and I_{THD} levels
- Thermography of electrical panels for identifying 'hot-spots', if any

1.2. Indoor Lighting:

Scope of Work:

- To study existing lighting scenario of facility and verify the building data
- To find out the performance of lighting fixtures
- To calculate (Watt/m^2) and compare lux with the bench mark/prevailing standard in the facility
- To suggest various energy efficient measures with first order cost benefit analysis

Methodology:

Census:

All the lighting fixtures were inspected for following:

- No. of lights installed and no. of lights working
- Type of lights
- General hygiene as per standard maintenance practices

- Data on operating hours data was collected from the operating staff

Performance audit:

Total connected lighting load from the Census was studied in detail as per following:

- Measurement of Lux level
- Measurement of room dimensions
- Power drawn by the lighting system

1.3. Pumps:

Scope of Work:

- To study existing pumping system of facility and verify the building data
- To carry out analysis
- To find out the performance of pumping system
- To compare the operating efficiency with the bench mark/prevailing standard in the facility
- To identify the causes of deviation in the performance and suggest recommendations for corrective actions
- To suggest various energy efficient measures with first order cost benefit analysis

Methodology:

Census:

All pumps (Chilled water, Cooling water and domestic water) were audited for following:

- Total no. of pumps installed
- Total no. of pumps working
- Pressure gauge working
- Ammeter working
- General hygiene conditions
- Data on operating hours data was collected from the operating staff

Performance audit:

All working pumps from the Census were studied in detail as per following:

- Water flowrate, m^3/hr
- Head generated, mWC
- Power drawn by pump, kW

1.4. Power Quality Analysis:

Scope of Work:

- Check of incoming power quality using power analyser device (Data collected will indicate the status of deviations in power, harmonics, voltage sags, frequency
- Specific corrective actions will lead to decrease in losses and increased life of equipment)

Methodology:

- Inspection of power quality with Three phase power quality analyser at main incomer for understanding of various parameters.

1.5. HVAC System:

Scope of Work:

- To study existing split air conditioners of facility and verify the building data
- To find out the performance of air conditioners
- To compare the specific energy consumption with the bench mark/prevailing standard in the facility
- To identify the causes of deviation in the performance and suggest recommendations for corrective actions
- To suggest various energy efficient measures with first order cost benefit analysis

Methodology:

- No. of ODUs and IDUs installed and no. of regularly operated machines
- General hygiene as per standard maintenance practices
- Data on operating hours data was collected from the operating staff

1.6. Green Audit:

Scope of Work:

- To evaluate water layout and water consumption pattern in college premises
- To evaluate carbon footprints for energy consumption at college

- To identify opportunities for sewage treatment plant and waste management at college premises.

Methodology:

- To identify water usage consumption pattern in campus
- Identification of water sources and distribution analysis across points.
- Usage of renewable energy and consumption pattern for energy perspective
- Review of existing facilities available for waste disposal methodologies in campus.

Chapter 2- Bill Analysis:

Christ College, Pune receives electricity supply from MSEDCL. One LT energy meters were installed for the college premises at electrical room.

The electrical load mainly comprises of the classroom lighting, office lighting, fans, Split AC units, domestic water pumping on an average, the building functions for about 10-11 hours a day for five and half day on weekend. Christ college has the following contract with the MSEDCL.

2.1. Consumer Details:

- Consumer No: **160235379152**
- Tariff Category: **88 LT-VII B I**
- Phase: **3**
- Contract Demand: **31kVA**
- Connected Load: **25kW**

2.2. Detailed Bill Analysis:

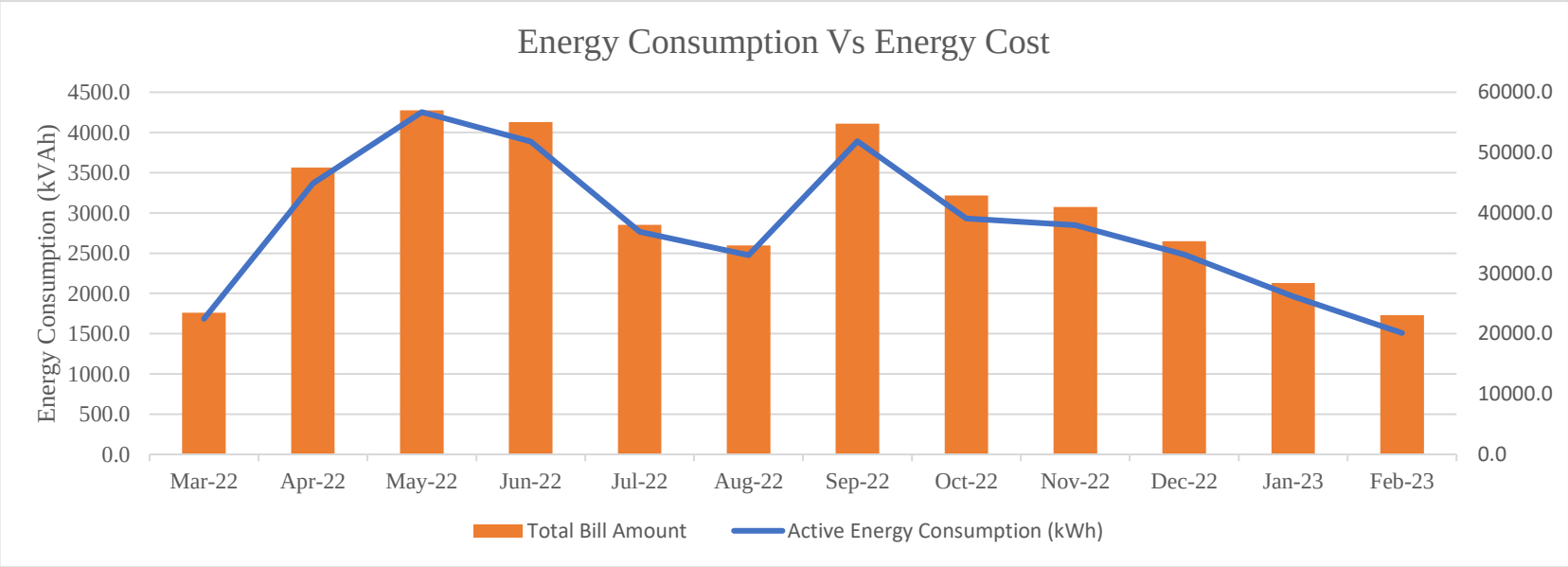
The following table shows the detailed bill analysis from the month of Mar-22 to Aug-23.

Parameter	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22	Jan-23	Feb-23
Contract Demand	28	28	28	31	31	31	31	31	31	31	31	31
Billed Demand (kVA)	14	21	21	19	12	12	18	18	15	13	12	12
Maximum Demand (kVA)	21	32	32	29	19	19	28	27	23	20	12	18
Maximum Demand (kW)	21	32	32	29	19	19	28	27	23	20	12	18
Billed PF	0.99	1	1	0.998	1	0.994	1	0.996	0.99	0.99	0.994	0.99
kWh	1,685	3,366	4,253	3,886	2,767	2,476	3,890	2,932	2,848	2484	1965	1,509
KVAH	2,281	3,797	4,562	4,108	2,918	2,703	3,990	3,417	3,052	2900	2343	1,951
kVARH lag	219	283	287	154	114	152	99	80	174	75	170	127
kVARH lead	29	14	19	118	167	152	269	219	315	304	91	156
a zone	-1182	-1308	-1451	-1340	-1362	-1304	-1170	-1181	-1088	-1344	-1142	-1025
b zone	-	-	-	-	-	-	-	-	-	-	-	-
c zone	127	695	884	786	411	174	758	436	430	178	35	130
d zone	441	519	600	515	525	514	472	472	465	642	452	398
Demand Rate (Rs. kVA)	373	384	384	384	384	384	384	384	384	384	384	384
Demand Charges	5,222	8,064	8,064	7,296	4,608	4,608	6,912	6,912	5,760	4,992	4,608	4,608
Wheeling Charges	2,325	4,544	5,742	28,096	3,735	3,343	5,252	3,958	3,845	3,353	2,653	2,037
Energy charges	12,266.80	24,336.18	30,749.19	5,246.10	20,005.41	17,901.48	28,124.70	21,198.36	20,591.04	17,959.32	14,206.95	10,910.07
TOD Tariff EC	-614	-94	33	-38	-426	-615	60	-273	-192	-523	-654	-496
FAC	337	673	851	5,635	4,012	3,590	5,641	4,251	4,130	3,602	2,849	2,188
Electricity Duty	4,103	8,364	10,026	9,709	6,706	6,054	9,658	7,570	7,168	6,171	4,969	4,042
Tax on sale	321	641	810	740	527	471	741	558	542	473	374	287

Parameter	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22	Jan-23	Feb-23
P.F Penal Charges	-488.44	-1313.34	-1590.34	-1618.2	-1117.72	-720.67	-1609.59	-1261.66	-853.34	-734.58	-591.57	-481.18
Charges for Excess demand	-	2,304	2,304	-	-	-	-	-	-	-	-	-
Total Amount	23,472.63	47,519.28	56,987.66	55,065.17	38,050.36	34,631.28	54,776.79	42,913.90	40,990.62	35,292.19	28,414.50	23,095.45

2.3. Energy consumption Vs Energy Cost Trend:

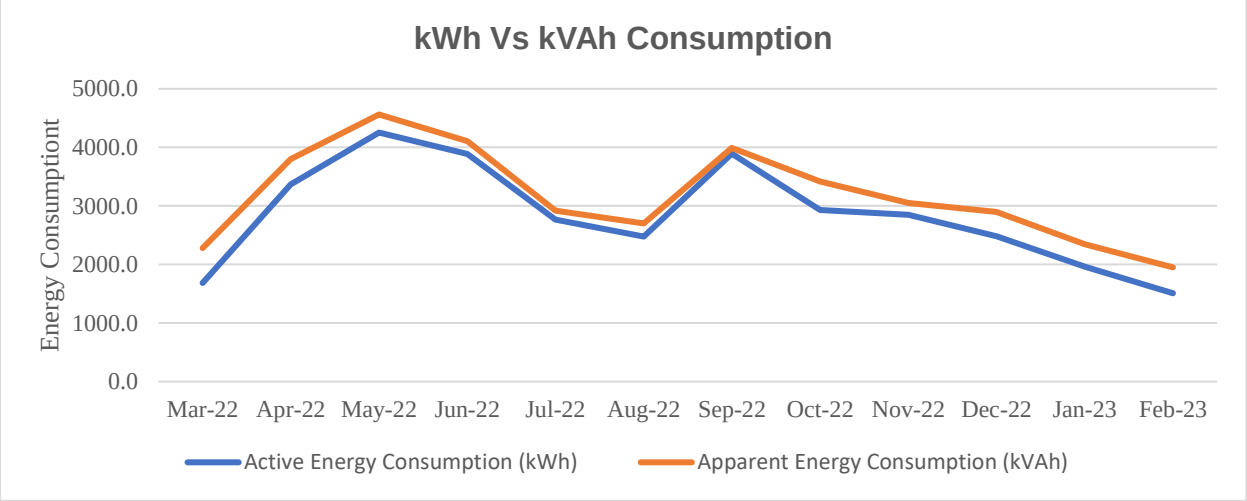
The following graph Shows the trend for the energy consumption and energy cost trend.



Graph 1: Energy Consumption Vs Energy Cost

2.4. Active energy (kWh) Vs Apparent Energy (kVAh)

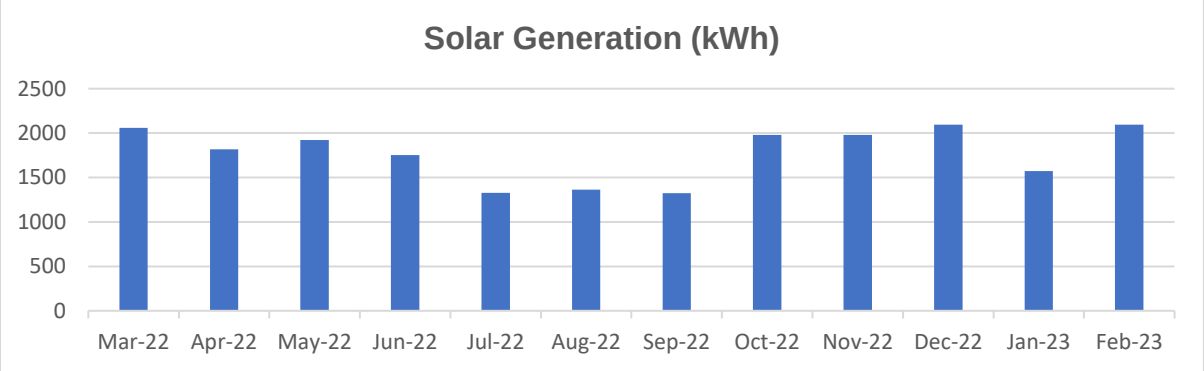
The following table shows the trend for the active and apparent energy. The graph indicates that gap between the active and apparent energy is minimum due to good power factor maintained over the period of time.



Graph 2: Active Vs Apparent Energy Trend

2.5. Solar Power Plant

The facility has solar roof top power plant of 20 kW capacity and has following generation data.



Graph 3: Solar Generation

2.6. Other Cost Saving measures:

As per MERC guidelines, a prompt payment discount of one percent of the monthly bill (excluding Taxes and Duties) shall be provided to consumers for payment of electricity bills within 7 days from the date of their issue.

In case the electricity bill is not paid within the due date mentioned on the bill, delayed payment charges on the billed amount, including the taxes, cess, duties, etc..., shall be levied on simple interest basis at the rate of 1.25% on the billed amount for the first month of delay.

A discount of 0.25% of the monthly bill (excluding taxes and duties), subject

to a cap of Rs. 500/-, shall be provided to LT category consumers for payment of electricity bills through various modes of digital payment such as credit cards, debit cards, UPI, BHIM, internet banking, mobile banking, mobile wallets, etc.

College management can avail this benefit and make necessary provisions for making digital payments to MSEDCL.

Chapter 3-Power Quality Analysis

3.1. Understanding Power Quality:

Power quality refers to the consistency and reliability of the electrical power supply. It encompasses factors such as voltage stability, harmonics, frequency variation, and transient disturbances.

3.2. Importance in College Buildings:

Equipment Protection:

Ensuring optimal power quality safeguards sensitive equipment like computers, laboratory instruments, and AV systems from damage due to voltage irregularities.

Academic Continuity: High-quality power minimizes downtime, ensuring uninterrupted classes and research activities.

3.3. Common Power Quality Issues:

Voltage Fluctuations:

Identifying and rectifying voltage sags, swells, and interruptions that can harm equipment or disrupt academic activities.

Harmonics Mitigation:

Managing harmonics generated by modern electronic equipment to prevent overheating and equipment failure.

Transient Protection:

Safeguarding against voltage spikes and surges caused by external events or internal factors.

3.4. Benefits of Power Quality Improvement:

Enhanced Equipment Lifespan: -

Protecting sensitive equipment from damage extends its lifespan, reducing replacement costs.

Academic Efficiency:

Reduced downtime and uninterrupted operations contribute to smoother academic schedules.

3.5. Conclusion:

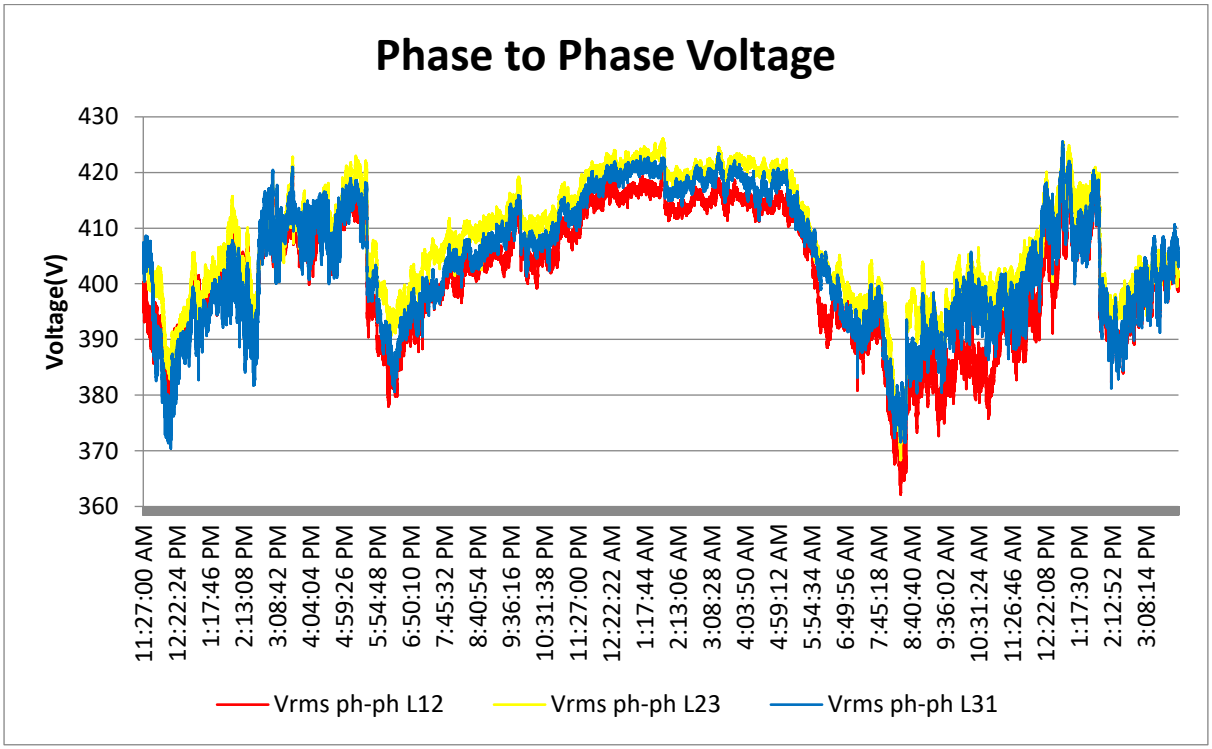
Power quality analysis is integral to ensuring the smooth functioning of college buildings. By addressing power quality concerns, colleges can protect their equipment investments, minimize disruptions to academic activities, and enhance the overall efficiency and reliability of their electrical systems. This chapter sets the stage for deeper exploration into power quality improvement strategies and their real-world applications in educational institutions

3.6. Existing Scenario:

During the audit we have connected the three-power quality analyzer to the main incomer of the facility for more 24 hrs. The following are the results of the power quality analysis.

3.6.1. Voltage:

During the audit it was observed that there is a voltage stabilizer connected after the meter to control the voltage fluctuations in the system. To observe the voltage fluctuations, we have connected the analyser before the stabilizer in the main circuit. Following graph show the voltage variation for the 24 hrs.

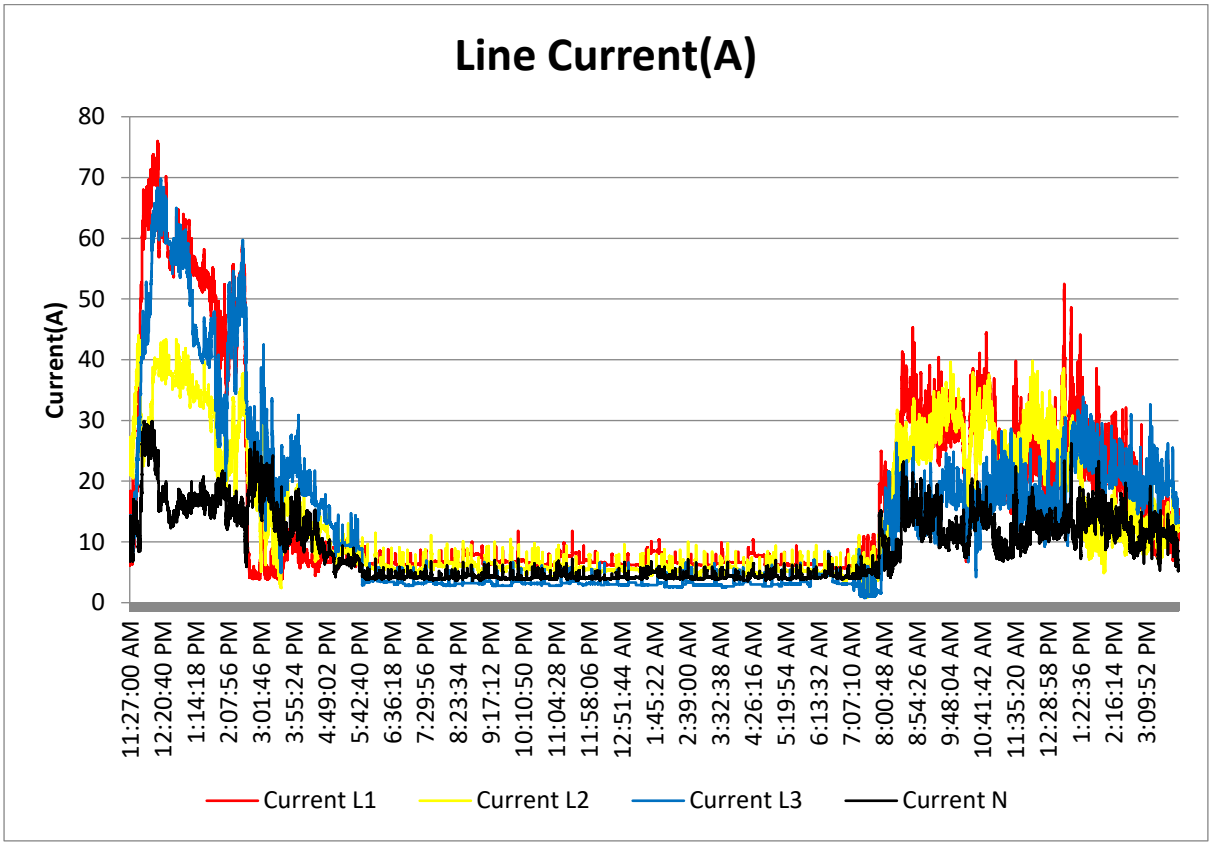


Graph 4: Voltage trend

- Voltage fluctuations are observed between the range of 360Vto 425V

3.6.2. Current

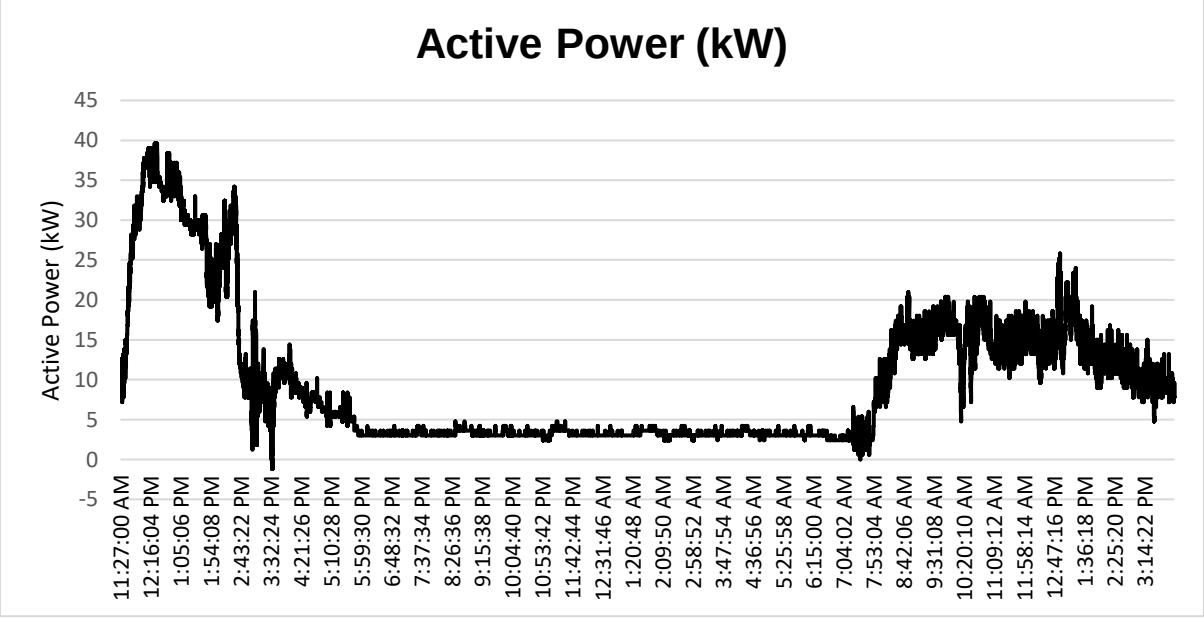
The following graph shows the current variation for the 24 hrs.



Graph 5: Current Trend

3.6.3. Active Power: -

The following graph show the power consumption or load variation during the 24 hrs

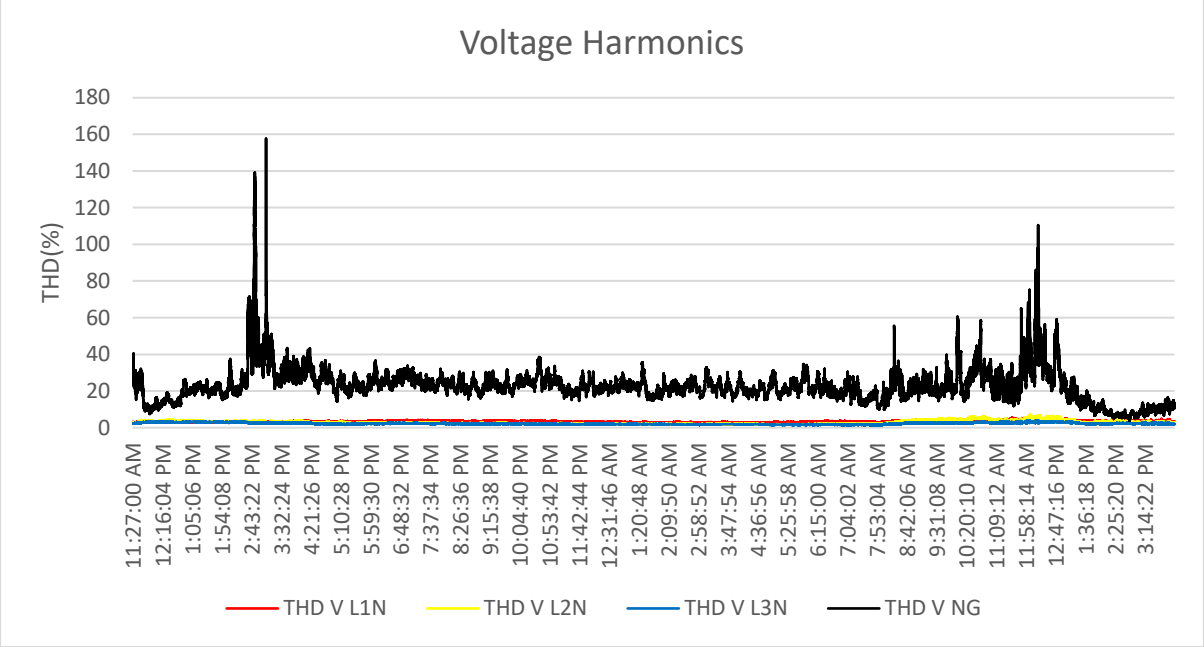


Graph 6: Active Power trend (kW)

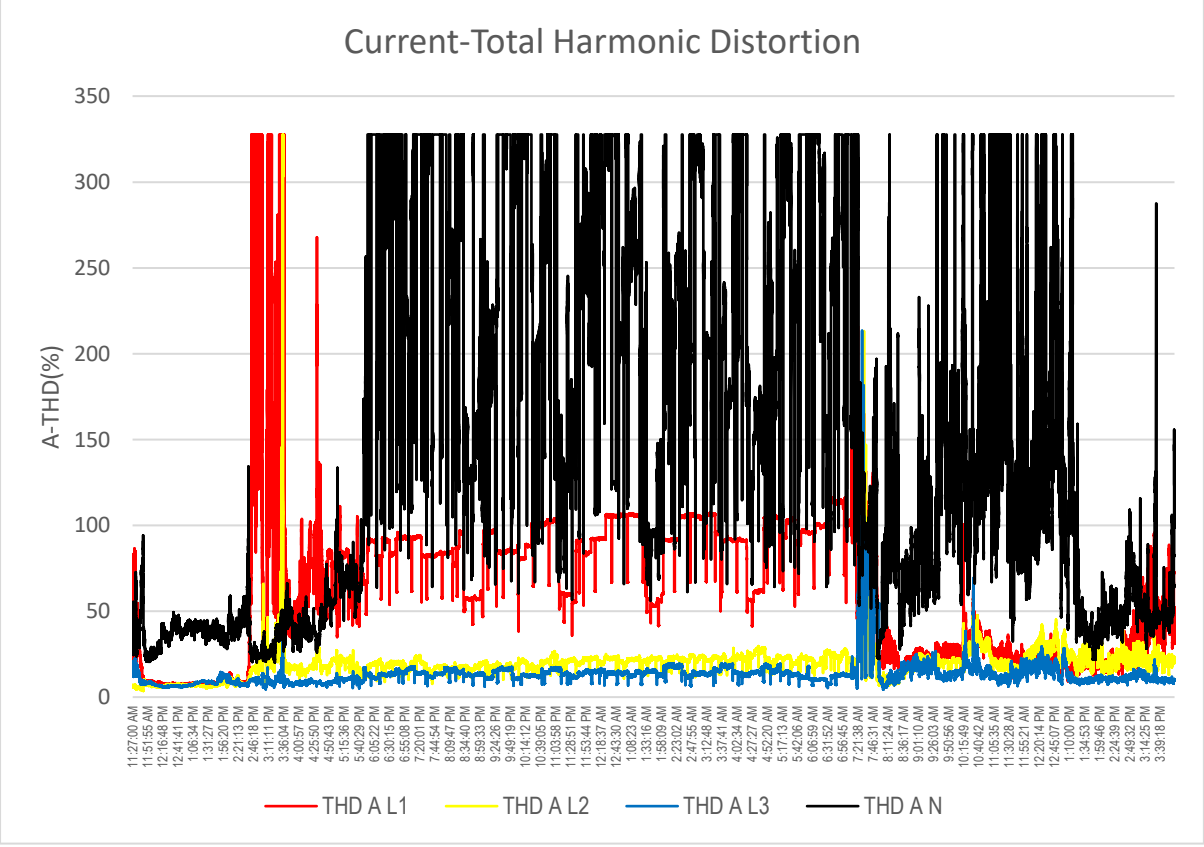
- The maximum load is 39.6kW and average load is about 9.45kW.

3.6.4. Voltage and Current Harmonics:

The following graph shows the current and voltage harmonics in the system.



Graph 7: Voltage Current Total Harmonic Distortion:



Graph 8: Current Total Harmonic Distortion

- The individual voltage harmonics are within standard limit but neutral voltage harmonics are exceeding the limit due to the phase faulty balancing
- The earthing system of the facility is need to be checked to mitigate the voltage and current harmonics.
- In current harmonics for Y and B phase harmonics are in the limit but for R phase harmonics are beyond the standard limit. This is due the higher load on the R phase than other two Phases.
- Again, in current neutral phase has more harmonics due to phase balancing.

Chapter 4-Lighting and Illumination Study

4.1. Existing Scenario:

Christ College, Pune has single building, which includes 409 number of lighting fixtures and out of that 27% of lighting fixtures are T5 and T8 Type. This lighting is inefficient in terms of lumens/watt and that can be better replaced with LED lighting fixtures.

The total lighting load for all building is 8.523 kW and with overall BUA of 31,375.24 ft^2 the actual LPD is 0.272 W/ft^2.Avergae diversity for illumination is 0.24 and uniformity is 0.40. Both Diversity and Uniformity need to be improved by fixing additional lighting fixtures

4.2. Existing Lighting scheme:

Sr No	Location	Area (m2)	Lighting Load (W)				
			8	9	12	18	36
1	Support Staff Dining Room	72.10				6	
2	Parking Area Near Canteen	559.66				6	
3	Canteen-1	182.55		16			
4	Canteen-2	182.61		9			
5	4-Wheeler Parking	0.00				19	
6	Ground Floor Assembly Hall	3672.00				26	
7	Lecture Hall-10	88.33			1	5	
8	Lecture Hall-11	92.48				1	5
9	Lecture Hall -12	90.56					
10	Lecture Hall-13	90.56				1	5
11	Faculty room	56.71					
12	Passage near Girls Rest Room	32.97			1	1	
13	Lecture Hall -14	118.72				1	5
14	Lecture Hall-15	122.91				1	5
15	Lecture Hall-16	120.23				1	5
16	Lecture Hall-17	118.09				1	4
17	Passage front to the H-15,16,17	125.53			8		
18	Passage near Faculty room	10.05			4		
19	Conference room	115.53			32		
20	2nd floor Lecture Hall-26	121.66					
21	2nd floor Lecture Hall-25	121.66					
22	2nd floor Lecture Hall-24	121.02					6
23	2nd floor Lecture Hall-23	121.55				1	5
24	2nd floor Lecture Hall-22	93.80				2	4
25	Director Phy. Education	20.38	4				
26	2nd Floor Lecture Hall-21	93.02				2	4
27	2nd Floor Lecture Hall-20	93.46				3	3
28	2nd Floor Lecture Hall-19	93.46				6	
29	2nd Floor Lecture Hall-18	93.46			1	6	
30	2nd Floor Seminar Hall-1	117.96				9	
31	2nd Floor Smart Room	98.54	8				12
32	2nd Floor Dining Room	0.00				8	

Sr No	Location	Area (m2)	Lighting Load (W)				
			8	9	12	18	36
33	2nd Floor Lecture Hall -27	93.46				1	2
34	2nd Floor Lecture Hall -28	93.46				1	3
35	2nd Floor Lecture Hall -30	93.46				1	3
36	2nd Floor Library	180.87					
37	2nd Floor Lecture Hall -31	82.03					4
38	Ground Floor Activity Room-1	37.13				4	
39	Ground Floor Activity Room-2	18.90					
40	Ground Floor Sport Room	15.67				2	
41	1st floor Manage Room + 2 Small Room	83.39			13		
42	1st Floor NAAC Room	22.61			5	1	
43	1st Floor Office	64.91			4	5	
44	1st Admin Office	31.00			4	1	
45	Office Staff Dining Room	12.21				1	
46	1st Floor Teacher Dining Hall	113.95				8	
47	1st Floor Teacher Management Dept.	117.96				9	
48	Exam Storage Room	37.48				1	1
49	2nd Floor Exam Control Office	41.48				1	1
50	2nd Floor Dept. of Computer Science	73.57				2	1
51	2nd Floor Library	180.87				8	6
52	3rd Floor Electronic Room	123.32				8	3
53	3rd Floor Chemistry Room	126.71				2	3
54	3rd Floor Computer Lab-1	124.77				3	3
55	3rd Floor Computer Lab-2	124.77				3	3
56	3rd Floor IT Department	50.98				2	1
57	3rd Floor Dark Room	40.01					2
58	3rd Floor Physics Lab	93.20				1	2
59	3rd Floor Lecture Hall-33	94.48				1	2
60	3rd Floor Lecture Hall-3	82.06				3	
61	Floor Staff Room (4th and 3rd)	31.92				4	1
62	Floor Staff Room (3rd and 2nd)	45.24				1	2
63	Floor Staff Room (1st and 2nd)	45.24				3	1
64	Floor Staff Room	45.24				3	
65	1st Floor Facility Room	56.71				2	1
66	1st Floor Girls rest Room	42.51				3	

4.3. Energy Saving Calculations:

1. Energy Saving by replacing 36W lights with 18W LED

Currently, there are 27% of old lighting fixtures of 36W are installed in the building. These lighting fixtures are needed to be replaced with 18W LED lighting fixtures The following table shows the saving calculations for the same.

Particular	value
Existing Light Wattage	36
Existing Lighting Fixtures	108
Excising Lighting Energy Consumption (kW)	3.8
Proposed Lighting Wattage	18
Proposed Lighting Energy Consumption (kW)	1.94
Annual Energy Saving (kWh)	3888
Cost Saving (lakh Rs)	0.55

Initial Investment (Lakh Rs)	0.20
Payback Period (Months)	4.46

Recommendation:

Majority of fluorescent lighting fixtures are of T5 and T8 type, their lumen output values are lower, when compared with energy efficient LED tubes. An exercise was carried of calculating existing lumen levels in the classroom and how many fixtures would be needed to get required illumination levels, when 18W LED tube-lights would be used.

Total, 409 (considering existing LED fixtures) nos. of LED tube-lights would be needed to meet desired illumination levels as NBC-2016. Quantity of fixtures would increase and hence the lighting load will also be increase.

2. Energy saving with lighting based on the Motion Sensor: -

Currently, there is no sensor-based lighting system in common areas, these lights are continuously ON and are consuming energy. So, if these lights are equipped with motion sensors, then part of energy can be saved. The following table shows the saving calculations for the same.

Parameters	UOM	Value
Common Area Lighting Total Load	kW	3.4
Annual Energy Consumption	kWh	7480
Energy Saving with Sensor based lighting	kWh	2244
Cost Saving	Lakh Rs	0.32
Initial Investment	Lakh Rs	0.50
Payback Period	Years	1.57

- The facility is already started to implement this kind of lighting system and will be adopted at all common areas in upcoming time.

4.4. Illumination Study:

The illumination includes the area wise lux levels measurements to verify the adequacy of the lighting levels. The standards referred for the illumination study is national building code 2016 Volume-2. The following table shows the area wise lux levels.

Sr No	Location	Average	Maximum	Minimum	Diversity	Uniformity	Comment
1	Support Staff Dining Room	121.7	227	58	0.48	0.26	Adequate
2	Parking Area Near Canteen	290.8	587	58	0.10	0.20	Adequate
3	Canteen-1	193	411	77	0.19	0.40	Adequate
4	Canteen-2	311	548	199	0.36	0.64	Adequate
5	4-Wheeler Parking	319.7	533	159	0.30	0.50	Adequate
6	Ground Floor Assembly Hall	399.1	508	199	0.39	0.50	Adequate
7	Lecture Hall-10	240.2	412	91	0.22	0.38	Inadequate
8	Lecture Hall-11	189.8	483	64	0.13	0.34	Inadequate
9	Lecture Hall -12	211.2	483	93	0.19	0.44	Inadequate
10	Lecture Hall-13	136.1	286	83	0.29	0.61	Inadequate

Sr No	Location	Average	Maximum	Minimum	Diversity	Uniformity	Comment
11	Faculty room	166.1	286	94	0.33	0.57	Adequate
12	Passage near Girls Rest Room	120	141	91	0.65	0.76	Adequate
13	Lecture Hall -14	129.4	239	16	0.07	0.12	Inadequate
14	Lecture Hall-15	111.4	214	12	0.06	0.11	Inadequate
15	Lecture Hall-16	195.4	501	44	0.09	0.23	Inadequate
16	Lecture Hall-17	83.7	191	27	0.14	0.32	Inadequate
17	Passage front to the H-15,16,17	1035	2200	378	0.17	0.37	Adequate
18	Passage near Faculty room	1058.2	2200	378	0.17	0.36	Adequate
19	Conference room	235.2	290	176	0.61	0.75	Inadequate
20	2nd floor Lecture Hall-26	154.1	225	59	0.26	0.38	Inadequate
21	2nd floor Lecture Hall-25	143	225	90	0.40	0.63	Inadequate
22	2nd floor Lecture Hall-24	222.2	392	142	0.36	0.64	Inadequate
23	2nd floor Lecture Hall-23	278.5	455	172	0.38	0.62	Inadequate
24	2nd floor Lecture Hall-22	324.7	771	172	0.22	0.53	Inadequate
25	Director Phy. Education	299.9	771	123	0.16	0.41	Adequate
26	2nd Floor Lecture Hall-21	205.6	756	19	0.03	0.09	Inadequate
27	2nd Floor Lecture Hall-20	219.7	322	111	0.34	0.51	Inadequate
28	2nd Floor Lecture Hall-19	228.8	322	151	0.47	0.66	Inadequate
29	2nd Floor Lecture Hall-18	215.3	322	151	0.47	0.70	Inadequate
30	2nd Floor Seminar Hall-1	271.5	421	91	0.22	0.34	Inadequate
31	2nd Floor Smart Room	633.1	819	220	0.27	0.35	Adequate
32	2nd Floor Dining Room	221.6	322	144	0.45	0.65	Adequate
33	2nd Floor Lecture Hall -27	131	287	46	0.16	0.35	Inadequate
34	2nd Floor Lecture Hall -28	285.8	971	87	0.09	0.30	Inadequate
35	2nd Floor Lecture Hall -30	365.6	1221	56	0.05	0.15	Adequate
36	2nd Floor Library	308.6	971	56	0.06	0.18	Adequate
37	2nd Floor Lecture Hall -31	181.3	601	44	0.07	0.24	Inadequate
38	Ground Floor Activity Room-1	226.2	305	123	0.40	0.54	Inadequate
39	Ground Floor Activity Room-2	160	319	48	0.15	0.30	Inadequate
40	Ground Floor Sport Room	141.2	194	40	0.21	0.28	Inadequate
41	1st floor Manage Room + 2 Small Room	98.3	192	30	0.16	0.31	Inadequate
42	1st Floor NAAC Room	96.6	199	26	0.13	0.27	Inadequate
43	1st Floor Office	118.8	199	59	0.30	0.50	Inadequate
44	1st Admin Office	120.3	254	28	0.11	0.23	Inadequate
45	Office Staff Dining Room	113.9	191	11	0.06	0.10	Inadequate
46	1st Floor Teacher Dining Hall	157.3	299	11	0.04	0.07	Inadequate
47	1st Floor Teacher Management Dept.	113.9	191	11	0.06	0.10	Inadequate
48	Exam Storage Room	90.8	192	27	0.14	0.30	Inadequate
49	2nd Floor Exam Control Office	100.1	172	31	0.18	0.31	Inadequate
50	2nd Floor Dept. of Computer Science	146.4	258	59	0.23	0.40	Inadequate
51	2nd Floor Library	210.8	311	111	0.36	0.53	Inadequate
52	3rd Floor Electronic Room	159.9	529	41	0.08	0.26	Inadequate
53	3rd Floor Chemistry Room	208.4	529	92	0.17	0.44	Inadequate

Sr No	Location	Average	Maximum	Minimum	Diversity	Uniformity	Comment
54	3rd Floor Computer Lab-1	223.3	612	29	0.05	0.13	Inadequate
55	3rd Floor Computer Lab-2	118.5	149	54	0.36	0.46	Inadequate
56	3rd Floor IT Department	171.9	263	124	0.47	0.72	Inadequate
57	3rd Floor Dark Room	57	95	26	0.27	0.46	Inadequate
58	3rd Floor Physics Lab	252.1	450	105	0.23	0.42	Inadequate
59	3rd Floor Lecture Hall-33	205.1	551	21	0.04	0.10	Inadequate
60	3rd Floor Lecture Hall-3	106.5	169	51	0.30	0.48	Inadequate
61	Floor Staff Room (4th and 3rd)	200.5	411	111	0.27	0.55	Inadequate
62	Floor Staff Room (3rd and 2nd)	203.7	411	121	0.29	0.59	Inadequate
63	Floor Staff Room (1st and 2nd)	180.1	581	111	0.19	0.62	Inadequate
64	Floor Staff Room	219	581	114	0.20	0.52	Inadequate
65	1st Floor Facility Room	112.6	140	69	0.49	0.61	Inadequate
66	1st Floor Girls rest Room	151.3	221	85	0.38	0.56	Inadequate

- The table shows that 51 areas have inadequate lighting levels and 15 Areas has adequate lighting levels.
- To mitigate the standard lighting levels facility needs to install additional lighting levels.

Chapter 5- Carbon Foot printing:

3.1. Introduction

A Carbon Foot print is defined as the total greenhouse gas emissions, emitted due to various activities. In this we compute the emissions of Carbon-Di-Oxide, by usage of the various forms of Energy used by the College for performing its day-to-day activities. The college uses electrical energy for operating various electrical gadgets.

3.2. Basis for computation of CO2 Emissions:

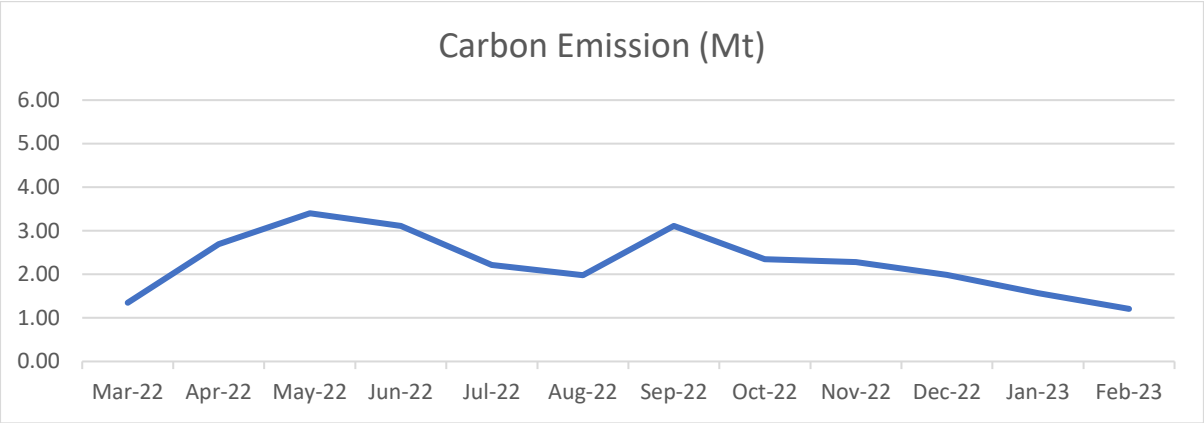
The basis of Calculation for CO2 emissions due to Electrical Energy are as under 1 Unit (kWh) of Electrical Energy releases 0.8 Kg of CO2 into atmosphere Based on the above Data we compute the CO2 emissions which are being released in to the atmosphere by the College due to its Day-to-Day operations.

3.3. Month wise Consumption of Electrical Energy:

We herewith furnish the details of electrical Energy consumption consumer number wise as under –

Month wise CO2 Emissions:

Month	Active Energy Consumption (kWh)	Carbon Emitted (MT)
Mar-22	1685.0	1.348
Apr-22	3366.0	2.6928
May-22	4253.0	3.4024
Jun-22	3886.0	3.1088
Jul-22	2767.0	2.2136
Aug-22	2476.0	1.9808
Sep-22	3890.0	3.112
Oct-22	2932.0	2.3456
Nov-22	2848.0	2.2784
Dec-22	2484.0	1.9872
Jan-23	1965.0	1.572
Feb-23	1509.0	1.2072



Graph 9: Carbon Emissions

3.4. . Benchmarking:

Now we compute the CO2 emissions per Sq. ft basis as under:

Sr. No	Parameter	Value	Unit
1	CO_2 emissions	30.27	MT/annum
2	Total Built up area	31,375.24	Sq. ft
3	**CO_2 Emission Benchmark**	**0.96**	**Kg of CO2/Sq. ft**

Chapter 6-Rain Water Harvesting:

6.1. Introduction:

The system of rain water harvesting is an integral part of any educational institution. This system helps to conserve the rain water and also to use during the time of its desirable. This system helps the students to understand the basic concepts of rainwater harvesting system and their effective use in the real life.

It is seen that there is a natural slope at the Institute campus, such natural slope can be used to take the water through some specific path and absorb under the ground. There is one empty bore well in the Institute campus, such empty bore well can be charged with the use of rainwater harvesting system. In addition to this some ring wells can be prepared and rainwater, gray waste water from all the building can be taken through some specific path in these ring wells and used to charge under the ground to maintain the ground level water.

6.2. Advantages of rain water harvesting –

(a) Promotes adequacy of underground water
(b) Mitigates the effect of drought
(c) Reduces soil erosion as surface run-off is reduced
(d) Decreases load on storm water disposal system
(e) Reduces flood hazards
(f) Improves ground water quality / decreases salinity (by dilution)
(g) Prevents ingress of sea water in subsurface aquifers in coastal areas
(h) Improves ground water table, thus saving energy (to lift water)
(i) The cost of recharging subsurface aquifer is lower than surface reservoirs
(j) The subsurface aquifer also serves as storage and distribution system
(k) No land is wasted for storage purpose and no population displacement is involved
(l) Storing water underground is environment friendly

6.3. Rain water harvesting potential –

The total amount of water that is received in the form of rainfall over an area is called the rain water endowment of that area. Out of this, the amount that can be effectively harvested is called rain water harvesting potential.

All the water which is falling over an area cannot be effectively harvested, due to various losses on account of evaporation, spillage etc. Because of these factors the quantity of rain water which can effectively be harvested is always less than the rain water endowment. The collection efficiency is mainly dependent on factors like runoff coefficient and first flush wastage etc. Runoff is the term applied to the water that flows away from catchments after falling on its surface in the form of rain.

Runoff depends upon the area and type of catchment over which it falls as well as surface features. Runoff can be generated from both paved and unpaved catchment areas. Paved surfaces have a greater capacity of retaining water on the surface and runoff from unpaved surface is less in comparison to paved surface. In all calculations for runoff estimation, runoff coefficient is used to account for losses due to spillage, leakage, infiltrations catchment surface wetting and evaporation, which will ultimately result into reduced runoff. Runoff coefficient for any catchment is the ratio of the volume of water that run off a surface to the total volume of rainfall on the surface.

The runoff coefficient for various surfaces is given in following table –

Sr. No.	Type of catchment	Coefficient
1.	Roof Catchment	
	Tiles	0.8 – 0.9
	Corrugated metal sheets	0.7 – 0.
2.	Ground Surface Coverings	
	Concrete	0.6 – 0.8
	Brick Surface	0.5 – 0.6
3.	Untreated ground catchments	
	Soil on slope less than10 %	– 0.3
	Rocky natural catchments	0.2 – 0.5

Based on the above factors, the water harvesting potential of site could be estimated using the following equation:

Rain Water harvesting potential = Amount of Rainfall x area of catchment x Runoff coefficient

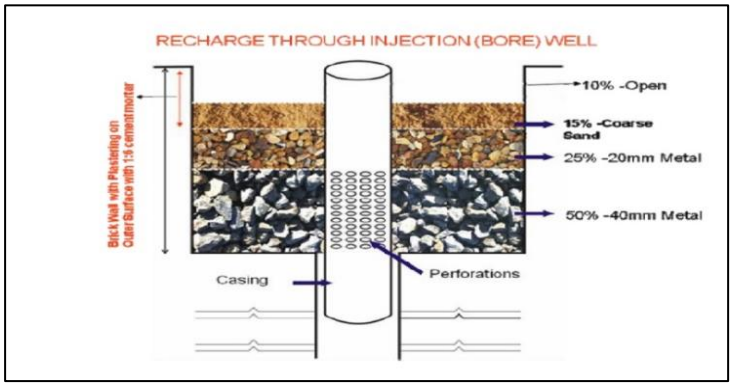
6.4. Rain water harvesting methods –

(a) Storing rain water for direct use

(b) Recharging ground water aquifers, from roof top run off

(c) Recharging ground water aquifers with runoff from ground area

According to the site of Institute the method of recharging ground water aquifers from roof top run off may be suitable. Recharging ground water aquifers from roof top run off. Rain water that is collected on the roof top of the building may be diverted by drain pipes to a filtration tank (for bore well, through settlement tank) from which it flows into the recharge well, as shown in following Figure. The recharge well should preferably be shallower than the water table. This method of rain water harvesting is preferable in the areas where the rainfall occurs only for a short period in a year and water table is at a shallow depth.



The schematic diagram of recharging water aquifers from solar roof top run off is as follows -

6.5. Existing Situation –

The college has 4 Floor C shaped building. Small rain water harvesting system is installed.

6.6. Recommendations:

- Vermicomposting Pit is recommended to maintain in good conditions
- Separate Waste Transportation is recommended for different type of waste.