Preliminary Energy Data Analysis Report

November 2022

VISAT Engineering College

Mutholapuram Post, Elanji, Ernakulam,
Kerala 686665

PRINCIPAL
VISAT ENGINEERING COLLEGE
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Acknowledgement

Bigeta Energy Solutions is thankful to VISAT Engineering College, Ernakulam for providing us an opportunity to conduct a Preliminary Energy data analysis as an extension activity of MOU (Memorandum of Understanding) between Bigeta Energy Solutions and VISAT Engineering College. We are grateful to Dr. Anoop K J, Principal and the other staff members for their support during the Preliminary energy data analysis.

We hope you find the recommendations provided in the report helpful in saving Energy and improving sustainability. While we have made every effort to adhere to high quality standards in both data gathering, analysis and report presentation. We would appreciate any comments from your side on how we may improve even further.

In case of any suggestions or queries:

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List of Abbreviations

APFC	-	Automatic Power Factor Controller
BLDC	-	Brushless Direct current
CFL	-	Compact Fluorescent Lamp
DG	-	Diesel Generator
e-Waste	-	Electronic Waste
KSEB	-	Kerala State Electricity Board
LED	-	Light-Emitting Diode
PF	-	Power Factor
PV	-	Photovoltaic
SEC	-	Specific Energy Consumption

List of Units

kg	-	kilogram
kJ	-	Kilo Joules
kW	-	Kilo watt
kWh	-	Kilowatt hour
kVA	-	Kilovolt Amperes
m	-	Meter
m^3/hr	-	Meter cube per hour
mmWC	-	Millimetres of Water Column
MW	-	Mega Watt
MWh	-	Mega Watthour
TR	-	Tons of Refrigeration

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1.0 Introduction

The working details of assignment are as follows:

Project	**Preliminary Energy Data Analysis**
Client	**VISAT Engineering College**
Industry	Engineering College
Contact	Mrs. Anjana G Quality Assurance Mobile- +91 9747134715 Email: asst-prof-anjana@visat.ac.in
Site	VISAT Engineering College, Elanji, Ernakulam, Kerala
Consultant	Bigeta Energy Solutions LLP Bangalore, India
Duration	7th November 2022
Project Scope	To conduct green Preliminary Energy Data Analysis of VISAT Engineering College
Report	This document gives recommendations, details of findings and the way forward.
Consultants involved	Mr. Benet George V (BEE Accredited Energy AuditorAE0053 & IGBC AP200352) Mr. Suresh. M – Asst. Manager (Energy and Sustainability Services) Mr. Alwar Purushotham – Sr Engineer (Energy and Sustainability Services)
Notes	The suggestions / alternatives in the audit report are based on the present operating conditions of equipment/systems and to the best of our knowledge.

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1.1 About the college

In 2011, the Vijnan Foundation established VISAT Engineering College. The VISAT Engineering College is a fresh and exciting initiative that the foundation has launched in order to expand its educational mission.

More than 200 students are currently pursuing engineering degrees in the fields of computer science, electronics and communication, mechanical engineering, and electrical engineering. In terms of infrastructure, VISAT is comparable to other well-established engineering colleges in the region.

The institution is getting power from the Kerla State Electricity Board (KSEB). Electricity is received at 11 kV, and a 400 kVA transformer is installed in the institution to step down the incoming 11 kV. The contract demand is 20 kVA.

Table 1. Student's details

S. No	Programme Name	Number of students on rollacross all yea				Total number of students on roll in each programme
		1st year	2nd year	3rd year	4th year	
1	B. Tech. Civil Engineering	19	3	0	10	32
2	B. Tech. Computer Science and Engineering	50	40	21	13	124
3	B. Tech. Electrical and Electronics Engineering	9	5	2	0	16
4	B. Tech. Electronics and Communication Engineering	23	4	0	1	28
5	B. Tech. Mechanical Engineering	9	15	3	7	34

Table 2. Teaching Faculty details

S. No	Programme Name	Total number of Faculties
1	B. Tech. Civil Engineering	5
2	B. Tech. Computer Science and Engineering	5
3	B. Tech. Electrical and Electronics Engineering	6
4	B. Tech. Electronics and Communication Engineering	6
5	B. Tech. Mechanical Engineering	6
6	Science and Humanities	7
	Total	35

There are 234 students enrolled in the college's undergraduate programs, which include CSE, ECE, MECH, CIVIL and EEE. There are 35 Teaching faculty members.

2.0 Preliminary Energy Data Analysis

Preliminary energy data analysis involves gathering existing data sources, such as utility bills and smart meters. Explore the data for trends and comparing it with benchmarks. Identify potential energy efficiency opportunities, such as upgrading lighting or optimizing equipment usage. Assess cost-benefit ratios, prioritize recommendations, and present findings to stakeholders. Implement measures and monitor energy usage for ongoing optimization.

2.1 Executive summary

2.1.1 Highlights

Total annual cost savings	=	0.66	Rs. Lakhs
Total investments	=	0.63	Rs. Lakhs
Overall simple payback period	=	11	Months
Annual Electrical Energy Consumption	=	54088	kWh
Annual Electricity cost	=	5.6	Rs. Lakhs

2.2 Impact of proposed Energy conservation measures

Electricity Savings	=	6720	kWh/annum
	=	12	%
CO_2 reduction	=	6	Tonnes/annum

2.3 Summary of Energy Conservation Measures

Table 3. Summary of Energy Conservation Measures

S. No.	Energy Conservation Measures	Annual Savings		Investment	Simple Payback Period
		kWh	Rs. Lakhs	Rs. Lakhs	Months
0-12 Months					
1	**Increase Contract Demand** Present contract demand is 20 KVA and the recorded maximum demand is 39 KVA at the month of October 2021. Hence recommended to increase the maximum demand to 50 KVA	-	0.21	Nil	Immediate
12-24 Months					
2	**Replacement of Energy Efficient Lighting System** Total of 420 light fixtures installed in the facility is florescent lights are installed with rated capacity of 40 W. Replace the fluorescent lights to LED lights of 20 W.	6720	0.45	0.63	17
>24 Months					
3	***Installation of Solar PV** There is potential rooftop space of 3324m^2 available inside the campus, this can be used install Solar PV system to reduce the energy bill	18750	1.26	7	67
	Total	**6720**	**0.66**	**0.63**	**11**

Note: *ECM 3 is not considered for Energy savings and cost savings as it's a CAPEX project.

2.4 Marginal cost of electrical energy

Electrical marginal energy charges typically include the sources of energy and their corresponding charges (like EB, DG, and green energy—wheeled). Since the proportion of annual DG is lower, the cost of energy due to it is neglected.

Table 4. Marginal cost of Energy

Description	Unit	Value
Total units' consumption	kWh	5208
TOD - Off Peak (22hrs to 6hrs)	Rs. /kWh	5.1
	kWh	1059
TOD - Normal (06hrs to 18hrs)	Rs. /kWh	6.8
	kWh	3194
TOD - Peak (18hrs to 22hrs)	Rs. /kWh	10.2
	kVAh	717
*Unit Charge	Rs. /kWh	6.61
Billing Demand	kVA	20
Demand Charges	Rs. /kVA	500
Electricity Duty	%	10%
	Rs. /kWh	**0.10**
Electricity Surcharge	Rs. /kWh	0.025
Marginal Energy Cost	Rs. /kWh	**6.74**

Note: *Based on bill of last month as the charges have been revised (October 22') and average is taken for 3 months

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2.5 Good Practices

- Saplings are planted on the birthdays of the students under "Birthday Tree Planting" to encourage 570 students.
- As a green campus initiative College forestry club was established and inaugurated by the Honourable minister for Forests and Wild Life protection on 13-06/22
- Conducting yearly workshops dedicated to energy savings, promoting awareness, education, and the implementation of sustainable practices
- Student-led projects focusing on renewable energy inspire action toward sustainable energy practices.
- Energy-efficient air conditioners have been installed on the campus.
- Maximizing daylighting in classrooms enhances learning environments, fosters student well-being, and increases energy efficiency.
- The natural landscape remains largely undisturbed, preserving campus intrinsic beauty, ecological balance, and biodiversity.
- Students are provided with reverse osmosis (RO) drinking water to ensure access to clean and safe hydration.

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3.0 Energy Conservation Measures (ECM)

3.1 Increase the contract demand

Background

The institute has a 400 kVA transformer which supplies power to the entire campus including Academic block, hostel, canteen and laboratory blocks.

Findings

- Because of Pandemic, the institute has reduced the contract demand from 80 kVA to 30 kVA initially and then to 20 kVA further as there was less energy consumption or demand required is less during pandemic.
- The contract demand obtained from KSEB by the college is 20kVA.
- From the analysis of electric bill form November 2021 to October 2022, there is an average increase of 135% in recorded demand.
- The maximum demand of 38 kVA was recorded in the month of October 2022.
- The average recorded demand through the year was around 26 kVA.
- Because of this increase in recoded demand an average of Rs.1729 is paid extra every month.

Recommendation

- Since college is currently operating at full capacity, the contract can be increased to 50 kVA.
- This can reduce excess demand charges.

Benefit

Cost benefit analysis is given in the table below

Table 5. Cost benefit analysis of increasing the contract demand

Description	Unit	Value
Present System		
Contract Demand	kVA	20
Minium Billable Contract Demand (75%)	kVA	15
Maximum Recorded Contract Demand	kVA	38
Minimum Recorded Contract Demand	kVA	20
*Cost of 1 kVA contract Demand	Rs. /kVA	500
*Cost of 1 kVA exceeding contract Demand	Rs. /kVA	750

Description	Unit	Value
Average exceeding in contract demand	kVA	6.92
Excess amount paid for exceeding contract demand	Rs/Month	1729
Proposed system		
Contract Demand	kVA	50
Minium Billable Contract Demand (75%)	kVA	38
Estimated cost savings per annum	Rs. Lakhs	0.21
*Investment	Rs. Lakhs	Nil
Simple Payback period	months	Immediate

Note: *The facility had a higher contract demand of 80kVA, which they reduced during pandemic.

3.2 Replacement of existing Tube lights (T8) lights to LED lights

Background

Lighting in colleges serves crucial roles, ensuring safety, enabling effective learning, and enhancing the overall environment. Adequate illumination supports visibility and reduces the risk of accidents, contributing to a secure campus. In classrooms and study areas, well-designed lighting reduces eye strain and fosters a conducive learning atmosphere. Task-specific lighting is employed in specialized areas, while aesthetic considerations enhance the overall appeal of college spaces.

Findings

- At present, institutional existing T8 bulbs (40 W) are around 420 No's.

Recommendation

- Replace the existing T8 lights with LED lights (20W). It will reduce energy consumption without changing the illumination.
- This can be retrofitted in the same lighting fixture of LED bulbs

Benefit

cost benefit analysis is given in the table below

Table 6. Cost benefit analysis for replacement of T8 lights to LED lights

Description	Unit	Value
Present system		
Total no. of Tube lights (T8) in all blocks	No's	420
Average light fitting wattage	W	40
Operating Hours	hrs	4
Annual Operating Days	days	200
Annual Energy Consumption	kWh	13440
Proposed system - CFL lights change to LED lights		
LED lights Average fitting wattage	W	20
Annual Energy Consumption	kWh	6720
Estimated annual Energy savings	kWh/annum	6720
Marginal Energy cost	Rs. /kWh	6.74
Estimated annual cost savings	Rs. Lakhs	0.45
Cost of one bulb	Rs.	150
Total investment	Rs. Lakhs	0.63
Simple payback period	months	17

3.3 Installation of Solar PV

Background

The institute has been situated in a climatic condition such that there is almost 250 days available through the year to cater the requirement of Solar PV panel.

Findings

- There is potential rooftop space of 3324m^2 available inside the campus.
- This can be utilized to install solar PV panel.

Recommendation

- Install PV panel of 15kW capacity to meet the requirement of electrical energy

Benefit

Cost benefit analysis is given in the table below

Table 7. Cost Benefit analysis for Solar PV

Description	Units	Values
Solar Rooftop system		
Area available for installing rooftop solar system	m^2	3324
Considering only 75% of area for installing rooftop system	m^2	2493
Area required for 1kW solar system	m^2	10
Estimated capacity for Rooftop solar system	kW	249
Maximum capacity can be installed on Rooftop	kW	15
Average units generated by 1kW solar system	kWh/day	5
Annual operating days	Days	250
Estimated units generated solar system	kWh/annum	18750
Marginal Energy cost	Rs. /kWh	6.74
Annual Cost savings after installing rooftop solar system	Rs. Lakhs	1.3
MNRE benchmark cost for solar panel	Rs. /Wp	36
Estimated investment cost for rooftop solar system	Rs. Lakhs	7
Simple Payback Period	months	67

Note: This ECM is not considered for Energy savings and cost savings as it's a CAPEX project.

4.0 Observation and Analysis

4.1 Electricity supply and Network

Electricity is one of the energy sources used to meet the demands of the institution. The institution is getting power from Kerala State Electricity Board (KSEB). Electricity is received at 11 kV, and a 400 kVA transformer is installed in the institution to step down the incoming 11 kV supply. The contract demand is 20 kVA. Other than the EB power supply, there are two DG sets of 125 kVA and 25 kVA installed in the institution to generate power in case of EB power failure.

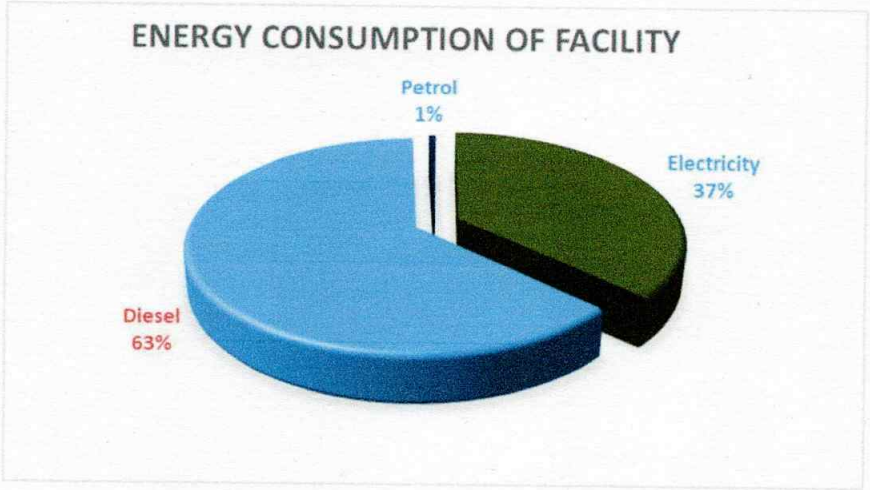
The observations made during the study are given in the following sections.

4.1.1 Tariff structure of the Institution

Tariff structure of the Plant is as follows

- Tariff Code = HT2C(*ii*)
- Supply voltage = 11 kV
- Contracted demand = 20 kVA
- Minimum billing demand = 15 kVA (75% of CD)
- Demand charges = Rs. 500 per kVA
- Excess Demand Charges = Rs. 250 per kVA
- Energy charges = 6.74 Rs. /kWh.

Figure 1. *Energy consumption of the facility*



4.1.2 Electricity Bill Analysis The electricity bill for the 12 months (from Jan- 2022 to Dec- 2023) for the Institution was analysed and the details are tabulated as follows

Table 8. EB Bill Analysis

Month	Power Factor	Contract Demand (kVA)	Recorded Demand (kVA)	Energy Consumption (Normal)	Energy Consumption (Peak)	Energy Consumption (Off peak)	Total Consumption (kWh)	Total kWh Charge	Total Demand Charge	Total Other Charges	Total EB bill
Nov-21	0.75	20	20	2029	480	809	3318	20806	8800	3556	33161
Dec-21	0.95	20	24	1947	470	807	3224	20195	11440	3443	35078
Jan-22	0.83	20	21	2598	631	957	4186	26426	9460	4100	39986
Feb-22	0.80	20	24	2664	669	1043	4376	27588	11440	3052	42081
Mar-22	0.80	20	22	2478	549	936	3963	24822	10120	2788	37730
Apr-22	0.84	20	37	3227	696	1124	5047	31707	20020	3470	55197
May-22	0.79	20	28	2533	487	821	3841	24051	14080	2755	40887
Jun-22	0.86	20	27	3285	681	1048	5014	31574	13420	3497	48490
Jul-22	0.88	20	36	3708	760	1027	5495	35414	16500	3678	55592
Aug-22	0.86	20	22	2655	710	1103	4468	30921	11500	3666	46087
Sep-22	0.9	20	24	3496	892	1343	5731	39721	13000	4325	57046
Oct-22	0.89	20	38	3431	812	1182	5425	37641	23500	4142	65284
Average	**0.85**	**20**	**26.92**	**2837**	**653**	**1016**	**4507**	**29238.80**	**13606**	**3539**	**46384**
Total	-	-	-	**34051**	**7837**	**12200**	**54088**	**350866**	**163280**	**42473**	**556618**

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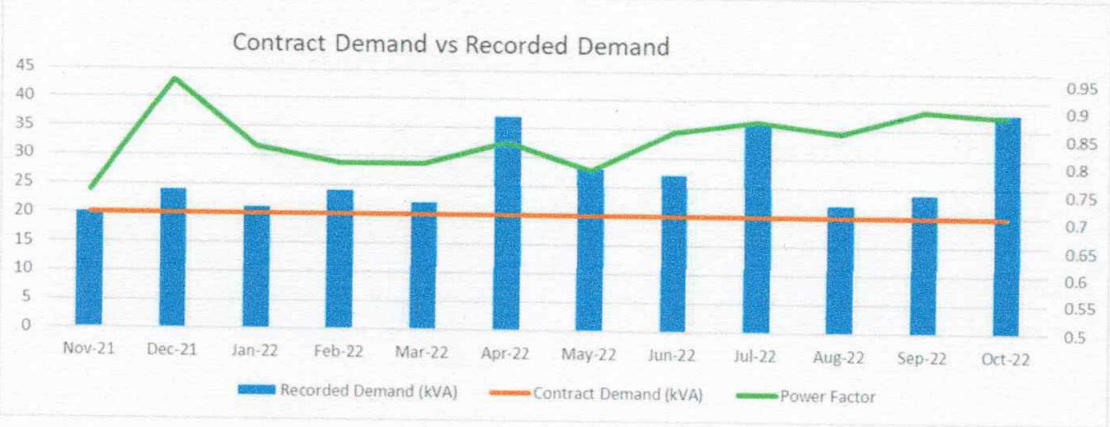
Observation:

- Institutional contract demand is 20 kVA, and billing demand is 15 kVA (75% of CD).
- In the month of October 2022, the recorded maximum demand was 38 kVA which is 195% higher than the contract demand.
- The annual electricity consumption is 54088 kWh.

Figure 2. *Annual Contract demand vs Record Demand*



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5.0 Green Campus

A green campus refers to college campus that prioritizes sustainability and environmental conservation in its operations, infrastructure, and culture. This involves implementing practices and initiatives aimed at reducing environmental impact, conserving resources, and promoting a healthy and eco-friendly environment. Key aspects of a green campus include waste management, water management, sustainable transportation options, green spaces, and environmental education and awareness initiatives.

5.1 Waste Management

Waste management is a process that determines the kind and volume of waste that an organization produces.

Recommendations

- Paper waste from office/class and labs should be stored and sent for recycling to local panchayat
- There should be E-Waste Policy managing e-waste generated inside the campus.
- Separate bins should be there for bio-degradable and non-biodegradable waste.
- Quantification of waste on daily or monthly basis should be done.
- littering of plastic inside the campus should be prohibited.
- Awareness programs are to be conducted among staff and students on effective use of resources and contributing to the environment

5.2 Water Management

Water audits provide qualitative and quantitative data on water usage to help reduce, reuse, and recycle it. A water audit quantifies all water flows in a system to understand use and save water. A college water audit shows how much water is used for handwashing, drinking in labs, watering the garden, and flushing toilets and urinals.

Recommendations

- Install water meters at the bore well and open well side for details on the quantity of water pumped from the source
- Use aerated taps to conserve more water.
- Conduct awareness programs on water conservation for students. Place posters like "Save Water" in all blocks.

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6.0 Biodiversity

Biodiversity within a campus encompasses the variety of living organisms and ecosystems present in that environment. This includes plants, animals, fungi, and microorganisms, as well as the interactions between them and their habitats. Maintaining and promoting biodiversity within a campus is crucial for ecological balance, ecosystem resilience, and overall environmental health. Strategies to support biodiversity on campus may include preserving natural habitats, creating green spaces with native vegetation, implementing sustainable landscaping practices, providing habitat for wildlife, and incorporating biodiversity education and research initiatives into the curriculum.

Observations

- Nearly 52 floral species are seen around the campus.
- Around 150 mature trees of various species are found.
- Birthday Tree Planting initiative and college forestry club are taken by the management to plant tree and preserve forests.

Figure 3. *Initiatives inside the Campus to preserve biodiversity*

Recommendations

- Food and water pots can be kept inside the campus for feeding the animals and birds.
- Plant more native trees rather than exotic species to maintain plant diversity.
- Create awareness of environmental sustainability among students and take actions to ensure environmental sustainability.

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VALIDITY DATE : 21/08/2023 — 2ND SURVEILLANCE DUE ON: 22/07/2022

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GREEN & ENERGY AUDIT REPORT

JAN 2024

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Acknowledgement

Bigeta Energy Solutions is thankful to VISAT Engineering College, Ernakulam for providing us an opportunity to conduct a Green and Energy audit at their institution located in Mutholapuram, Post, Elanji, Kerala. We are grateful to Dr. Anoop K J, Principal, Prof. P.S. Subin, Registrar, Mrs. Anjana G (Quality Assurance), and the other staff members for their active involvement and support during the audit process.

We hope you find the recommendations provided in the report helpful in saving Energy and improving sustainability. While we have made every effort to adhere to high quality standards in both data gathering analysis and report presentation, we would appreciate any comments from your side on how we may improve even further.

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List of Abbreviations

APFC	-	Automatic Power Factor Controller
BLDC	-	Brushless Direct current
CFL	-	Compact Fluorescent Lamp
DG	-	Diesel Generator
e-Waste	-	Electronic Waste
KSEB	-	Kerala State Electricity Board
LED	-	Light-Emitting Diode
PF	-	Power Factor
PV	-	Photovoltaic
SEC	-	Specific Energy Consumption

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List of Units

°C	-	Degree Celsius
CMH	-	Cubic Meter per Hour
Hz	-	Hertz
kCal/kg	-	Kilo Calories per kilogram
kg	-	kilogram
kJ	-	Kilo Joules
kW	-	Kilo watt
kWh	-	Kilowatt hour
kVA	-	Kilo Volt Amperes
m	-	Meter
m^3/hr	-	Meter cube per hour
mmWC	-	Millimetres of Water Column
MW	-	Mega Watt
MWh	-	Mega Watthour
TR	-	Tons of Refrigeration

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1.0 Introduction

The working details of assignment are as follows:

Project	**Green and Energy Audit**
Client	**VISAT Engineering College**
Industry	Engineering College
Contact	Mrs. Anjana G Quality Assurance Mobile- +91 9747134715 Email: asst-prof-anjana@visat.ac.in
Site	VISAT Engineering College, Elanji, Ernakulam, Kerala
Consultant	Bigeta Energy Solutions LLP Bangalore, India
Duration	16th January to 17th January
Project Scope	To conduct green and energy audit at VISAT Engineering College
Report	This document gives recommendations, details of findings and the way forward.
Consultants involved	Mr. Benet George V (BEE Accredited Energy AuditorAE0053 & IGBC AP200352) Dr. Ganapathi A (BEE Certified Energy Auditor EA-34973/23 & IGBC AP232185) Mr.N. Prasanna (BEE Certified Energy Auditor EA-34798/22 & IGBC AP232159) Mr.Sujeesh K – Electrical Engineer
Notes	The suggestions / alternatives in the audit report are based on the present operating conditions of equipment/systems and to the best of our knowledge.

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1.1 About the college

VISAT Engineering College was founded by the Vijnan Foundation in 2011. VISAT Engineering College is an inspired new venture towards the foundation's educational outreach. VISAT Engineering College is focused on delivering excellent standards of education by implementing innovative teaching methodologies, imparted by an esteemed and highly experienced faculty. We cover all disciplines of engineering, including CE, CSE, ECE, EEE, and ME, through the courses offered for undergraduates.

More than 300 students are currently pursuing engineering degrees in the fields of computer science, electronics and communication, mechanical engineering, and electrical engineering. In terms of infrastructure, VISAT is comparable to other well-established engineering colleges in the region.

The institution is getting power from the Kerla State Electricity Board (KSEB). Electricity is received at 11 kV, and a 400 kVA transformer is installed in the institution to step down the incoming 11 kV. Other than the EB power supply, there are two DG's of 125 kVA and 25 kVA in the institution to generate power in case of an EB power failure.

Major Loads in the Institution:

- Fans and Lights
- Air Conditioners
- UPS
- Computers
- Pumps
- Projector
- Printers

Table 1. Student's details

Male	Female	Transgender	Total
217	85	0	302

Table 2. Teaching Faculty details

Male	Female	Transgender	Total
17	31	0	48

Table 3. Non-Teaching Faculty details

Male	Female	Transgender	Total
19	19	0	38

There are 302 students enrolled in the college's 6 undergraduate programs, which include CSE, ECE, MECH, CIVIL and EEE. There are 48 Teaching and 38 Non-Teaching faculty members.

1.2 Vision and Mission

Vision

To be a nationally recognized centre of excellence in engineering education and research for creating professionally competent and socially committed engineers equipped to meet the developing technological and socio-economic needs.

Mission

VISAT is committed to:

1. Impart technical education through value-based holistic teaching and learning integrating innovative practices.
2. Nurture the practice of real-world problem solving, the spirit of entrepreneurship, and critical thinking among the students.
3. Foster a conducive environment for Research, Innovation, and extension services.
4. Develop the potential of human resources to meet the requirements of cutting-edge technology.
5. Prepare all students for successful careers based on a strong moral & ethical foundation

1.3 Infrastructure

Figure 1. *Location of college*

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The college has a total built-up area of 14168.31 square meters, and it has all of the necessary physical amenities.

1.4 Energy and Green audit

On January 16th and 17th, 2024, a detailed green and energy audits were conducted, including precise observations, measurements, and in-depth assessments.

1.5 Energy audit methodology

Phase 1 - Pre-Audit

Campus details, energy consumption details, etc. are collected, analyzed, and planned for field work. Based on the initial details, two days of field work are planned.

Phase 2 - Field work and data collection

On the first day, the opening meeting was done, and key stakeholders and members of the management team were present. The purpose of the audit, methodology, and activities planned were explained. Staff volunteers were selected for data collection. Field visits, interviews, data verification, and spot measurements are done. The closing meeting to discuss the initial findings and observations is done on the final day of the field work.

Figure 2. *Opening meeting*

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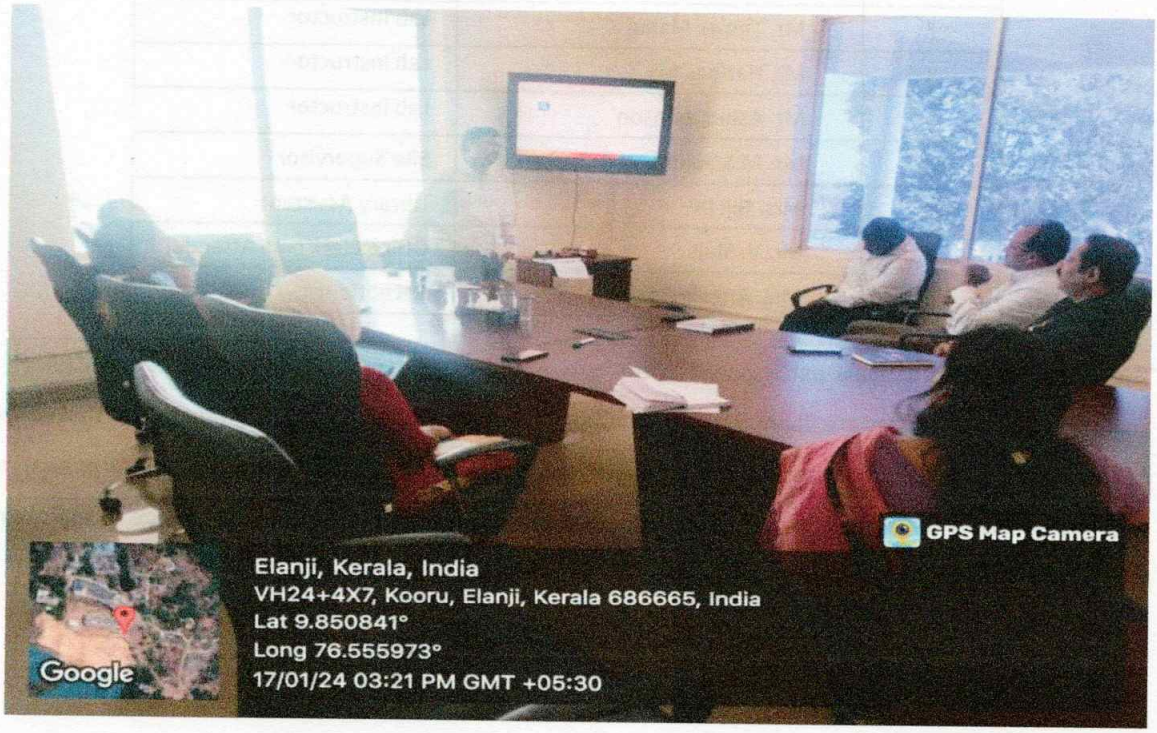
Phase 3 – Closing Meeting

Important findings from two days of exhaustive field data collection were reviewed and deliberated with stakeholders at the conclusion of the Energy and Green Audit. Audit findings, energy consumption trends, environmental impact, and potential green initiatives were subject to substantial discussion during the meeting. The primary objective of the meeting was to foster collaboration and ensure that every member had a unified understanding of the audit's findings. This would enable us to make informed decisions and implement environmentally sustainable practices.

Figure 3. *Closing meeting*



Phase 4 - Report

Analysis of the data and preparation of the report.

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1.6 List of faculties who participated in the audit

Table 4. List of faculty members involved in audit process

S. No.	Name	Designation
1	Dr. Anoop K J	Principal
2	Prof. P.S. Subin	Registrar
3	Mrs. Anjana G	Quality Assurance
4	Mrs. Radhika R	Assistant Professor
5	Mrs. Aiswarya Mohan	Assistant Professor
6	Mr. Athul Joshy	Administration IP Assistant
7	Mr. Thejas Manoj	Lab Instructor
8	Mr. Haridas MS	Lab Instructor
9	Mr. Ashiq Johnson	Lab Instructor
10	Mr. M.S.Sujith	Site Supervisor
11	Mrs. Biji PP	Library Assistant
12	Mr. V. Shiji	Office Clerk cum Attender
13	Mrs. Angelina Santi	Receptionist

The above faculties actively participated in this green and energy audit conducted at VISAT College of Engineering. The faculties are divided into two teams: energy and biodiversity. Each team was tasked with gathering the necessary data for energy management and biodiversity. The collected data was analyzed with the goal of proposing conservation and improvement strategies to enable the college to maintain a green and sustainable campus.

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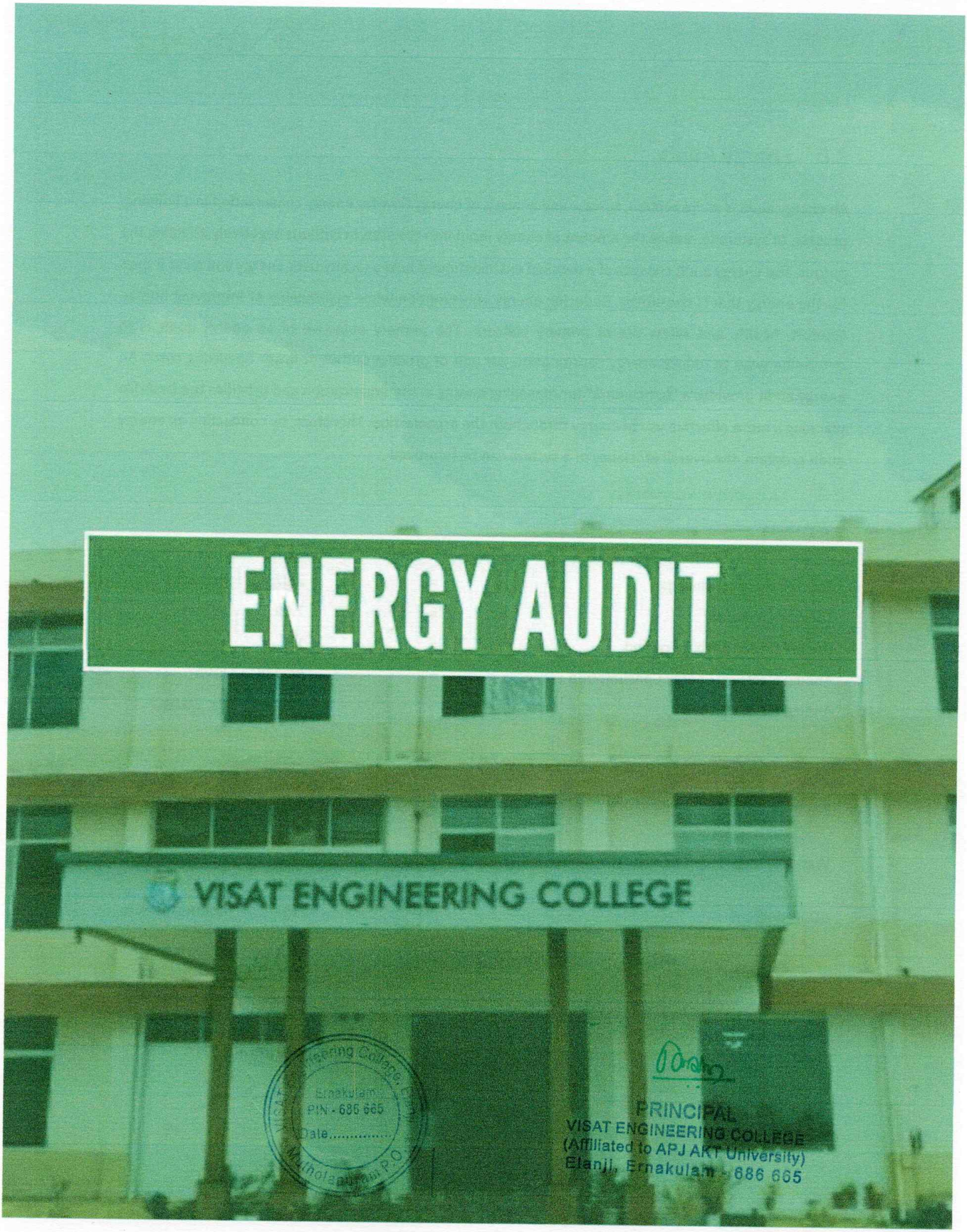
ENERGY AUDIT



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2.0 Energy Audit

An energy audit is an inspection, survey, and analysis of energy flow for energy conservation in a building, process, or system to reduce the amount of energy input into the system without negatively affecting the output. The energy audit consists of a detailed examination of how a facility uses energy and what it pays for the energy that is consumed. Reducing energy consumption while maintaining or improving human comfort, health, and safety are of primary concern. The primary objective of an energy audit is to determine ways to reduce energy consumption per unit of product output or lower operating costs. An energy audit provides a "benchmark" for managing energy in the organization and provides the basis for planning a more effective use of energy throughout the organization. Therefore, by conducting an energy audit program, the overall efficiency of a system can be improved.

2.1 Executive summary

2.1.1 Highlights

Total annual cost savings	=	2.07	Rs. Lakhs
Total investments	=	2.09	Rs. Lakhs
Overall simple payback period	=	12	Months
Annual Electrical Energy Consumption	=	86,448	kWh
Annual Electricity cost	=	9.54	Rs. Lakhs

2.2 Impact of proposed Energy conservation measures

Electricity Savings	=	15645	kWh/annum
	=	22	%
Water Savings	=	1927	m^3/annum
	=	52	%
CO_2 reduction	=	13	Tonnes/annum

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2.3 Summary of Energy Conservation Measures

Table 5. Summary of Energy Conservation Measures

S. No.	Energy Conservation Measures	Annual Savings			Investment	Simple Payback Period
		kWh	Rs.	Water (m^3)	Rs.	Months
0-12 Months						
1	**Increase Contract Demand** Present contract demand is 20 KVA and the recorded maximum demand is 52 KVA at the month of May 2023. Hence recommended to increase the maximum demand to 70 KVA	-	57225	-	Nil	Immediate
2	**Operate water Pumps in off peak billing hours** Daily water pumps are operated maximum of 4 hours. Mostly pumps are operated during peak billing period. Hence recommended to operate pumps during off peak billing hours as maximum as possible.	-	11153	-	Nil	Immediate
3	**Air conditioner Operating Temperature Optimization** Totally 25 AC's are installed in the college campus,12 AC's are operated with a setpoint of <23°C. BEE suggest that for obtaining optimum human comfort, operate the AC's with the set point from 23°C to 25°C	924.48	6481	-	Nil	Immediate
4	**Installation of Water Efficient Aerators or Flow Restrictor in Facility** 78 taps are installed in the campus for water usage. Out of 78 taps 56 taps are having excess flow than prescribed by UPC and NBC guidelines. Hence recommend to install water flow restrictor before pipes.	1558	10918	1050	8400	9
12-24 Months						
5	**Replacement of Energy Efficient Lighting System** Total of 363 light fixtures installed in the facility is florescent lights are installed with rated capacity of 40 W. Replace the fluorescent lights to LED lights of 20 W	5820	40801	-	43560	13

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S. No.	Energy Conservation Measures	Annual Savings			Investment	Simple Payback Period
		kWh	Rs.	Water (m^3)	Rs.	Months
6	**Lighting Optimization of Lighting in Girls Hostel** Common area of girl's hostel is installed with 37 lighting fixtures of rated 40 W each and operated for a minimum of 5 hours per day. Provide occupancy sensor to the common area to optimize the light usage.	1184	8300	-	9800	14
7	**Water conservation in Toilet Flush** In the facility total of 29 toilet flush tanks are installed with average of 8.4 LPF. As per UPC and NBC guidelines maximum of 6 LPF is required for flushing the toilet. Hence recommend to install a toilet flush tank bank.	909	6370	878	9280	17
8	Replace the conventional fans in Girl's hostel to BLDC fans All the fans in the Girls hostel are conventional fans. Replace them with BLDC fans to reduce power consumption	5250	36804	-	36804	63000
	>24 Months					
9	**Improvement of PF by using Automatic PF controller** The average PF maintained for the past 1 year is 0.95. By maintaining more than 0.95 KSEB providing subsidiary of 0.5% for each 0.01 pf improvement	-	29885	-	75000	30
	Total	**15645**	**207937**	**1927**	**182844**	**11**

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2.4 Marginal cost of electrical energy

Electrical marginal energy charges typically include the sources of energy and their corresponding charges (like EB, DG, and green energy—wheeled). Since the proportion of annual DG is lower, the cost of energy due to it is neglected.

Table 6. Marginal cost of Energy

Description	Unit	Value
Average unit consumption	kWh/month	7423
TOD – Off - Peak (22hrs to 6hrs)	Rs. /kWh	5.1
	kWh	1553
TOD - C Peak (06hrs to 18hrs)	Rs. /kWh	6.8
	kWh	4908
TOD - D (18hrs to 22hrs)	Rs. /kWh	10.2
	kWh	963
*Unit Charge	Rs. /kWh	6.89
Billing Demand	kVA	20
Demand Charges	Rs. /kVA	525
Electricity Duty	%	10%
	Rs. /kWh	0.10
Electricity Surcharge	Rs. /kWh	0.025
Marginal Energy Cost	Rs. /kWh	**7.01**

Note: *Based on bill of last month as the charges have been revised (Dec 23') and average is taken for 3 months

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Table 7. Carbon (CO_2) offset

Sl.No	Description	Type of Fuel and their CO_2 Conversion Process		
		Fuel Consumption		
		Electricity kWh	Diesel (Vehicle + DG) Litre	Petrol (Vehicle) Litre
1	Total Annual Consumption	86448	11673	109
2	CO2 Emission (Tons/Annum)	71	28	0.3
3	Total CO2 Emission (Tons/Annum)			99 (↑)
4	No. of Matured Trees Available			200
5	CO_2 offset due to Trees (Tons/Annum)			4.36 (↓)
6	CO_2 Emission per (Tons/Annum) currently			95 (↑)
7	Expected Reduction of Annual Electricity Consumption after Implementing Proposed Energy Conservation Measures (kWh)			15645
8	CO_2 offset after implementing ECM (Tons/Annum)			13 (↓)
9	Per Capita CO_2 emission (Tons/Annum)			0.24

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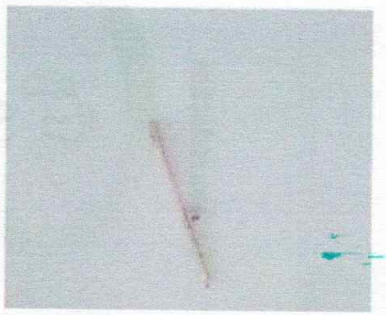
2.5 Good Practices

- Energy conservation practices, such as switching off the AC and fans when not required, are encouraged.
- Faculty and students are encouraged to come by EV and CNG vehicles.
- Conducting seminars every year on energy conservation.
- LED lights are installed in Corridors, Reception Lobby and Street Lights in pathways
- BLDC fans are installed in Reception
- Staffs and students are encouraged to come by EV and by college/public transport
- Awareness projects on Renewable Energy
- Energy Efficient Air Conditioner are installed in the campus
- Power Factor is maintained at 0.95 Lagging

Figure 4. *Good practices in Facility*

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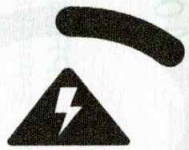
2.6 Carbon emission reduction through ECM

Figure 5. *Carbon emission reduction through ECM*

Annual Energy Savings



18% annual electrical energy savings can be achieved through implementation of energy conservation measures.

Carbon reduction

13% carbon reduction can be achieved through implementation of energy conservation measures.

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Figure 6. *Year-wise split-up of cost savings after implementation of ECM*

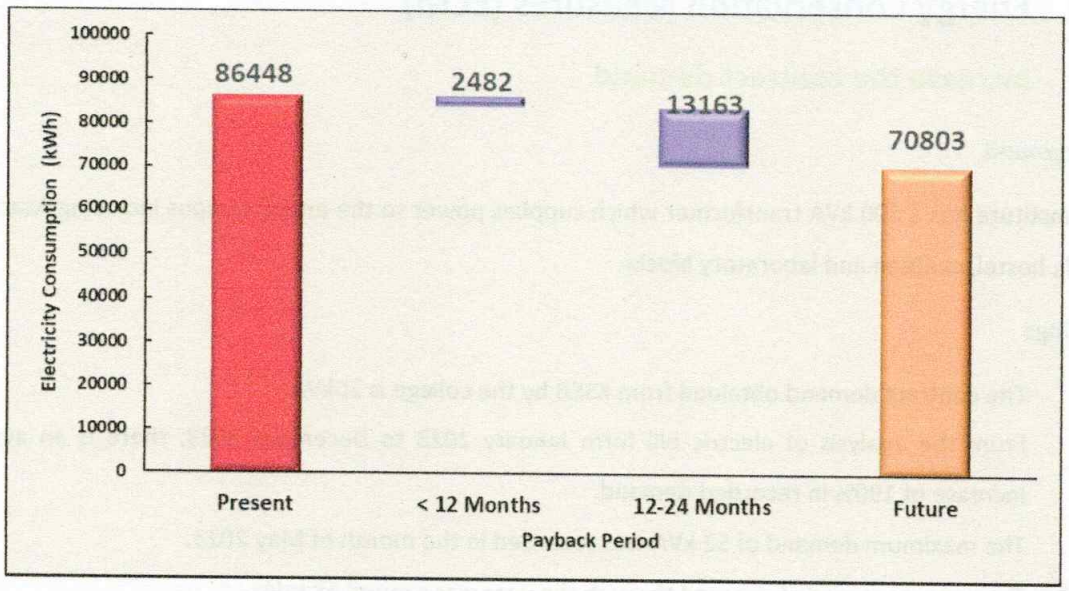
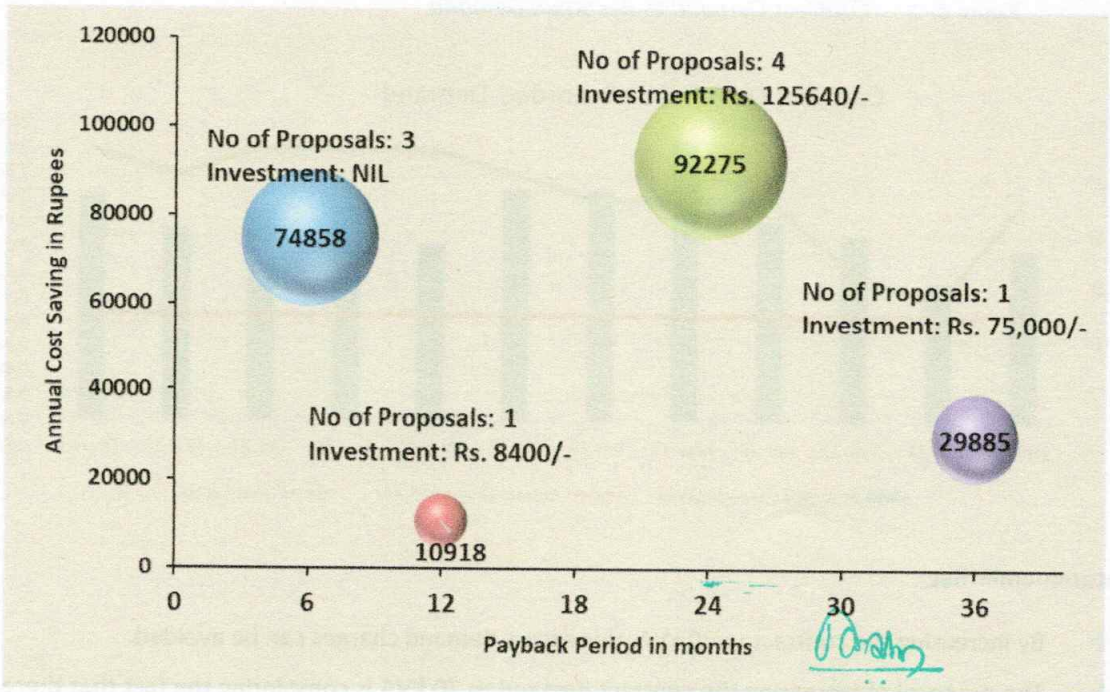


Figure 7. *Year-wise electricity savings after implementation of ECM*



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3.0 Energy Conservation Measures (ECM)

3.1 Increase the contract demand

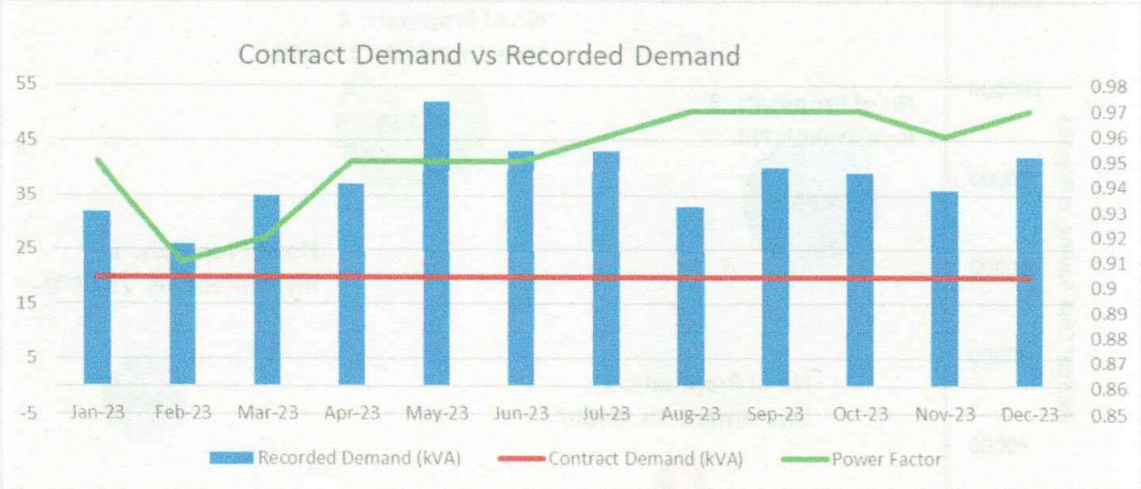
Background

The institute has a 400 kVA transformer which supplies power to the entire campus including Academic block, hostel, canteen and laboratory blocks.

Findings

- The contract demand obtained from KSEB by the college is 20kVA.
- From the analysis of electric bill form January 2023 to December 2023, there is an average increase of 190% in recorded demand.
- The maximum demand of 52 kVA was recorded in the month of May 2023.
- The average recorded demand through the year was around 38 kVA.
- Because of this increase in recoded demand an average of Rs.4769 is paid extra every month.

Figure 8. *Contract Demand vs Recorded Demand*



Recommendation

- By increasing the contract to 70 kVA, this excess demand charges can be avoided.
- The proposal of increasing the contract demand to 70 KVA is considering the fact that there will be additional new boys hostel load from February of 2024.

Benefit

Cost benefit analysis is given in the table below

Table 8. Cost benefit analysis of increasing the contract demand

Description	Unit	Value
Present System		
Contract demand	kVA	20
Minium billable contract demand (75%)	kVA	15
Maximum recorded contract demand	kVA	52
Minimum recorded contract demand	kVA	26
*Cost of 1 kVA contract demand	Rs. /kVA	525
*Cost of 1 kVA exceeding contract demand	Rs. /kVA	787.5
Average exceeding in contract demand	kVA	18.17
Excess amount paid for exceeding contract demand	Rs/Month	4769
Proposed system		
Contract demand	kVA	70
Minium billable contract demand (75%)	kVA	53
Estimated cost savings per annum	Rs	57225
Investment	Rs	Nil
Simple payback period	months	Immediate

3.2 Operate pumps during off peak hours of billing

Background

There are three pumps, one submersible pump in tank, one submersible pump in bore well and one submersible pump in open well in the institution which are operating to cater the water need.

Findings

- The pumps are operated by the security persons.
- The bore well and submersible pumps are operated for 4 hours in day.
- The open well pump is operated for 2 hours in day.
- All the pumps are operated during the normal TOD billing hours of the day.
- During normal TOD, the kWh is charged Rs.6.80 per kWh.

Recommendation

- Operate the pumps during off peaks hours.
- Off peak hours as per KSEB is from 10:00 pm to 6:00 am.
- The TOD billing of Off-Peak hours is Rs.5.10 per kWh.

Benefit

Cost benefit analysis is given in the table below

Table 9. Cost benefit analysis of operating pumps in off peak hours

Description	Unit	Submersible Pump	Borewell pump	Well Pump
Present System				
Power consumed	kWh	1.98	2.43	6.09
Operating hours	Hrs/Day	4	4	2
Operating Time	Time	Normal Hours		
Total power consumption	kWh	7.92	9.72	12.18
Operating Cost	Rs. /kWh	6.8	6.8	6.8
	Rs. /Day	53.856	66.096	82.824
Proposed System: Operate pumps only in off peak hours				
Operating Time	Time	Off-Peak Hours		
Operating Cost	Rs. /kWh	5.1	5.1	5.1
	Rs. /Day	40.392	49.572	62.118
Estimated Cost savings	Rs. /Day	51		
Annual operating Days	days	220		
Annual Cost savings	Rs.	11153		
Investment	Rs.	Nil		
Simple payback period	months	Immediate		

3.3 Optimize the set point of AC temperature

Background

There are 25 AC of various capacities starting from 0.75 TR to 2 TR.

Findings

- Most of the AC's in the campus are star rated.
- AC's are installed in all three floors.

- AC's are seen only in academic block.
- 12 of the AC's are operated below the at a set point below 23°C.

Recommendation

- Operate AC's at a set point above 23°C as Bureau of Energy Efficiency, recommends in Space Cooling through recommended temperature settings of 23-25°C in commercial buildings with 3 Star and above rating.
- It is estimated that by increase in room temperature by 1 degree Celsius (°C), we can save about 6% of electricity.

Benefit

Cost benefit analysis is given in the table below

Table 10. Cost benefit analysis of operating AC's at set point on or above 23°C

Description	Units	Values
Existing system Air conditioner setpoint		
No of AC operating <23°C set point	nos	12
Average Power Consumption of AC operating <23°C set point	kW	1.07
Average operating hours of AC operating <23°C set point	hrs	6
Annual Operating days	days	200
Annual Actual Energy Consumption	kWh/annum	15408
Marginal Energy Cost	Rs/kWh	7.01
Proposed system		
Percentage Energy Saving by operating AC set point between 23°C-25°C	%	6
Annual Energy Saving	kWh/annum	924.48
Annual Cost Saving	Rs.	6481
Investment	Rs.	Nil
Simple payback period	months	Immediate

3.4 Installation of Water Efficient Aerators or Flow Restrictor in Facility

Background

In each floor restrooms are provided to facilitate individuals to maintain personal hygiene, such as washing hands, using toilets and proper sanitation helps prevent the spread of diseases

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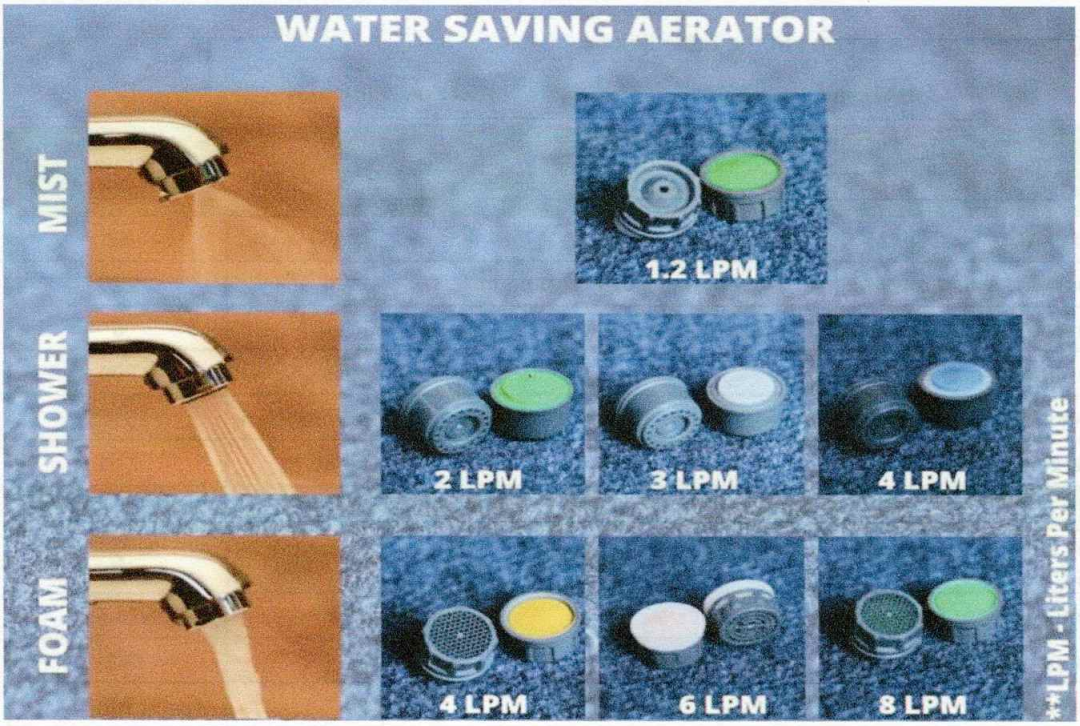
Findings

- 78 taps are installed in the campus for water usage.
- Out of 78 taps 56 taps are having excess flow than prescribed by UPC and NBC guidelines.
- The average flow rate of the taps in the present system is around 7.1 LPM.
- Out of these 56 taps, 49 are in academic block and 7 are in girl's hostel.

Recommendation

- Reduce the flow rate of taps by retrofitting water efficient aerators

Figure 9. *LPM of various water efficient aerators*



Benefit

Cost benefit analysis is given in the table below

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Table 11. *Cost benefit analysis of retrofitting aerators*

Description	Unit	Values
Present system		
Number of Taps in College Campus	Nos.	49
Number of Taps in Girls Hostel	Nos.	7
Water Consumption per day for College Campus	m^3/day	6.96
Water Consumption per day for Girls Hostel	m^3/day	0.37
Annual Water Consumption for College Campus	m^3/annum	1392
Annual Water Consumption for Girls Hostel	m^3/annum	75
Total Annual Water Consumption	m^3/annum	1466
Total Pumping Cost	Rs/m^3	10.4
Marginal Energy Cost	Rs/kWh	7.0
Proposal		
Installation of Water Efficient Taps		
Total Number of Water Efficient Aerators or Flow Restrictor	Nos.	56
Water Efficient Aerators or Flow Restrictor cost for one	Rs.	150
Water Efficient Aerators or Flow Restrictor consumption	LPM	2
Standard Water Consumption per day for College Campus	m^3/day	1.96
Standard Water Consumption per day for Girls Hostel	m^3/day	0.10
Annual Standard Water Consumption for College Campus	m^3/annum	392
Annual Standard Water Consumption for Girls Hostel	m^3/annum	25
Total Annual Standard Water Consumption	m^3/annum	417
Annual Water Savings Consumption	m^3/annum	1050
Annual Water Savings Cost	Rs.	10918
Annual Energy Savings	kWh/annum	1558
Investment	Rs.	8400
Simple Payback Period	months	9

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3.5 Replacement of existing Tube lights (T8) lights to LED lights

Background

Lighting in colleges serves crucial roles, ensuring safety, enabling effective learning, and enhancing the overall environment. Adequate illumination supports visibility and reduces the risk of accidents, contributing to a secure campus. In classrooms and study areas, well-designed lighting reduces eye strain and fosters a conducive learning atmosphere. Task-specific lighting is employed in specialized areas, while aesthetic considerations enhance the overall appeal of college spaces.

Findings

- At present, institutional existing T8 bulbs (40 W) are around 363 No's.
- Existing lights in corridors in academic block have already been replaced with LED lights (12W). It is good practice.

Recommendation

- Replace the existing T8 lights with LED lights (20W). It will reduce energy consumption without changing the illumination.
- This can be retrofitted in the same lighting fixture of T8 bulbs

Benefit

cost benefit analysis is given in the table below

Table 12. Cost benefit analysis for replacement of T8 lights to LED lights

Description	Unit	Value
Present system		
Total no. of Tube lights (T8) in all blocks	No's	363
Average light fitting wattage	W	40
Operating Hours	hrs	4
Annual Operating Days	days	200
Annual Energy Consumption	kWh	11640
Proposed system - CFL lights change to LED lights		
LED lights Average fitting wattage	W	20
Annual Energy Consumption	kWh	5820
Estimated annual Energy savings	kWh/annum	5820
Marginal Energy cost	Rs./kWh	7.01

Description	Unit	Value
Estimated annual cost savings	Rs.	40801
Cost of one bulb	Rs.	120
Total investment	Rs.	43560
Simple payback period	months	13

3.6 Lighting Optimization for Girls Hostel Common Area

Background

In girls' hostels, lighting is crucial for safety, comfort, and study. Well-lit spaces enhance security, reducing potential risks. Adequate and adjustable lighting in study areas promotes a conducive environment for academic pursuits. Thoughtful illumination contributes to a welcoming and comfortable atmosphere, fostering a positive living experience for female students.

Findings

- At present, all bulbs in common area are T8 bulbs (40 W)
- There are 37 such lighting fixtures in the girl's hostel
- At present, hostels (girls) corridors and rest rooms are using lights continuously throughout the night.

Recommendation

- Install motion/occupancy sensor in corridors and rest rooms.
- Management has to create awareness about energy savings among students and staff and provide posters in all class rooms and corridors.

Benefits

Cost benefit analysis is given in the table below

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Table 13. Cost benefit analysis for install motion sensors for Corridors & Rest room in hostel

Description	Unit	Value
Present system		
Number of Lighting Fixtures	nos	37
Rated Power of Lighting Fixtures	kW	0.04
Operating Hours	hrs	5
Annual Operating days	days	200
Annual Actual Energy Consumption	kWh/annum	1480
Marginal Energy Cost	Rs/kWh	7.01
Proposed system- Install Occupancy sensors		
Estimated Operating hours	hrs	1
Annual Estimated Energy Consumption	kWh/annum	296
Annual Energy Saving	kWh/annum	1184
Annual Cost Saving	Rs.	8300
Cost of Occupancy Senor	Rs.	700
Investment	Rs.	9800
Simple payback period	months	14

3.7 Installation of Flush Toilet Tank Bank

Background

College toilets play a vital role in maintaining hygiene and meeting the basic needs of students and staff. These facilities provide a private and sanitary space for individuals to use toilets, wash their hands, and attend to personal hygiene. Accessible and well-maintained restrooms contribute to the overall well-being of the college community, preventing the spread of diseases and ensuring a comfortable environment. They are essential for creating a positive learning and working atmosphere, promoting health, and supporting the daily activities of those on campus

Findings

- In the facility total of 29 toilet flush tanks are installed with average of 8.4 LPF.
- As per UPC and NBC guidelines maximum of 6 LPF is required for flushing the toilet.

Recommendation

- Hence its recommended to install a toilet flush tank bank to optimize the water flow according to NBC/UPC guidelines.

Benefits

Cost benefit analysis is given in the table below

Table 14. Cost benefit analysis installing flush tank bank in toilet

Description	Unit	Values
Present system		
Number of Water Closets in College Campus	nos	15
Number of Water Closets in Girls Hostel	nos	14
Water Consumption per day for College Campus	m^3/day	6.30
Water Consumption per day for Girls Hostel	m^3/day	4.90
Annual Water Consumption for College Campus	m^3/annum	1260
Annual Water Consumption for Girls Hostel	m^3/annum	980
Total Annual Water Consumption	m^3/annum	2240
Total Pumping Cost	Rs/m^3	10.4
Marginal Energy Cost	Rs/kWh	7.0
Proposal		
Install Toilet Tank Bank in Flush Tank		
Total Number of Flush Toilet Tank Bank	Nos.	29
Flush Toilet Tank Bank cost for one piece	Rs.	320
After Installing Water Closets consumption	LPM	5
Standard Water Consumption per day for College Campus	m^3/day	3.75
Standard Water Consumption per day for Girls Hostel	m^3/day	2.45
Annual Standard Water Consumption for College Campus	m^3/annum	750
Annual Water Savings Consumption for Girls Hostel	m^3/annum	613
Total Annual Standard Water Consumption	m^3/annum	1363
Annual Water Savings Consumption	m^3/annum	878
Annual Water Savings Cost	Rs.	6370
Annual Energy Savings	kWh/annum	909
Investment	Rs.	9280
Simple Payback Period	months	17

3.8 Replacement of existing conventional ceiling fans with BLDC fans in Girls hostels

Background

The girl's hostel is situated inside the college campus. They offer proximity to academic facilities, enhance safety, and promote a supportive community. With a dedicated living space, female students can focus on studies, personal development, and networking, contributing to a positive educational experience. There around 30 rooms in girl's hostel.

Findings

- There are around 35 conventional fans in girl's hotel rooms
- Each fan is consuming around 85 watts per hour during operation
- On an average, the fans are operated around 12 hrs per day.

Recommendation

- Replace the existing conventional fans with EC-BLDC fans in hostels in a phased manner and ensure good energy savings.
- BLDC fans operate with less energy and the same air delivery. Similarly, these fans generate less noise, run with an inverter supply, and have remote control-based speed control.
- BLDCF fans consume 1 unit of electricity for nearly 28-29 hours.

Benefit

Cost benefit analysis is given in the table below

Table 15. Cost Benefit analysis for replacement of existing ceiling fans to BLDC fans in hostels

Description	Unit	Value
Present system		
Total no. of conventional fans in all blocks	No's	35
Average light fitting wattage	W	85
Operating Hours	hrs	12
Annual Operating Days	days	250
Annual Energy Consumption	kWh	8925
Proposed system - CFL lights change to LED lights		

Description	Unit	Value
BLDC fans Average fitting wattage	W	35
Annual Energy Consumption	kWh	3675
Estimated annual Energy savings	kWh/annum	5250
Marginal Energy cost	Rs. /kWh	7.01
Estimated annual cost savings	Rs.	36804
Cost of one bulb	Rs.	1800
Total investment	Rs.	63000
Simple payback period	months	21

Note: This Recommendation more beneficial for HT consumer as direct reduction of kVA rating

3.9 Installation of Automatic PF controller

Background

The institute has 400kVA transformer to cater the electrical needs. To Main the power factor, the institute has installed APFC panel system with a capacity of 80 kVAr (5 kVAr, 2X10 kVAr, 15 kVAr, 2X20 kVAr). They act as reactive power generators and provide the needed reactive power to accomplish kW of work. The primary purpose of capacitors is to reduce maximum demand. This reduces the amount of reactive power, and thus total power, generated by the utilities. In the institution,

Findings

- These reactors are isolated from the panel during the audit period
- The average power factor of the institute is 0.95 for the period from January 2023 to December 2023.

Recommendation

- Install an automatic switch over for the APFC banks and operate
- This will make the power factor closer to unity.

Benefit

Cost benefit analysis is given in the table below

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Table 16. Cost Benefit analysis for APFC automatic switch over

Description	Unit	Values
Present system		
Installed Capacitor Bank Rating	kVAr	80
Average Monthly Bill (Jan-Dec 2023)	Rs	79567
Average Monthly PF (Jan-Dec 2023)	-	0.95
Average Recorded Maximum Demand (Jan- Dec 2023)	kVA	38
Average Demand Charges (Jan-Dec 2023)	Rs/kVA	622
Marginal Energy Cost	Rs/kWh	7.0
Proposed system		
Install Automatic PF Controller		
Expected PF after installing proposed system	-	0.99
Incentive by KSEB (on bill amount)	%	2
Monthly cost Saving from Incentive	Rs	1591
Annual cost Saving from Incentive	Rs	19096
Expected Monthly Recorded Maximum Demand	kVA	36.72
Monthly Reduction in Maximum Demand	kVA	1.45
Monthly Cost Saving in Reduction of Maximum Demand	Rs	899
Annual Cost Saving in Reduction of Maximum Demand	Rs	10789
Annual Total Cost Saving	Rs	29885
Investment	Rs	75000
Simple payback period	months	30

3.10 Installation of Solar PV

Background

The institute has been situated in a climatic condition such that there is almost 250 days available through the year to cater the requirement of Solar PV panel.

Findings

- There is proposal in place to install a 10 kWp Solar system in the college campus as a measure of sustainability.
- There is potential rooftop space of 3324m^2 available inside the campus.
- This can be utilized to install solar PV panel.

Recommendation

- Install PV panel of 40kW capacity to meet the requirement of electrical energy

Benefit

Cost benefit analysis is given in the table below

Table 17. Cost Benefit analysis for Solar PV

Description	Units	Values
Solar Rooftop system		
Area available for installing rooftop solar system	m^2	3324
Considering only 75% of area for installing rooftop system	m^2	2493
Area required for 1kW solar system	m^2	10
Estimated capacity for Rooftop solar system	kW	249
Maximum capacity can be installed on Rooftop	kW	40
Average units generated by 1kW solar system	kWh/day	5
Annual operating days	Days	250
Estimated units generated solar system	kWh/annum	50000
Marginal Energy cost	Rs. /kWh	7.01
Annual Cost savings after installing rooftop solar system	Rs.	350500
MNRE benchmark cost for solar panel	Rs. /Wp	36
Estimated investment cost for rooftop solar system	Rs.	1872000
Simple Payback Period	months	64

Note: This ECM is not considered for Energy savings and cost savings as it's a CAPEX project.

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4.0 Observation and Analysis

4.1 Electricity supply and Network

Electricity is one of the energy sources used to meet the demands of the institution. The institution is getting power from Kerala State Electricity Board (KSEB). Electricity is received at 11 kV, and a 400 kVA transformer is installed in the institution to step down the incoming 11 kV supply. Other than the EB power supply, there are two DG sets of 125 kVA and 25 kVA installed in the institution to generate power in case of EB power failure.

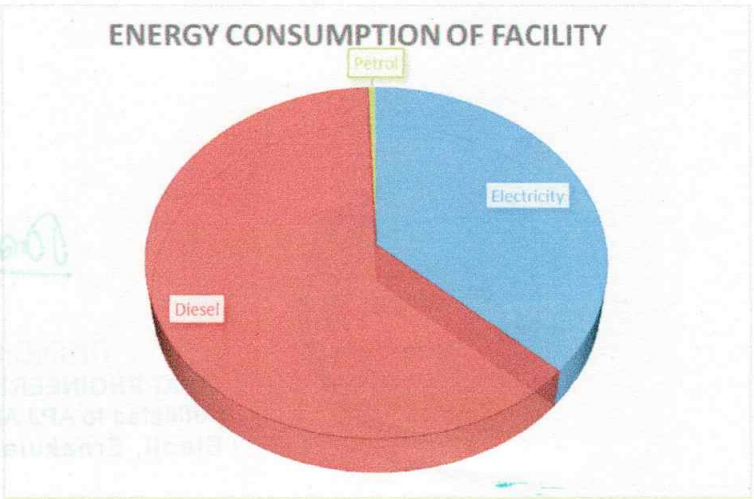
The observations made during the study are given in the following sections.

4.1.1 Tariff structure of the Institution

Tariff structure of the Plant is as follows

- Tariff Code = HT2C(ii)
- Supply voltage = 11 kV
- Contracted demand = 20 kVA
- Minimum billing demand = 15 kVA (75% of CD)
- Demand charges = Rs. 525 per kVA
- Excess Demand Charges = Rs. 262.5 per kVA
- Energy charges = 7.01 Rs. /kWh.

Figure 10. *Energy consumption of the facility*



4.1.2 Electricity Bill Analysis The electricity bill for the 12 months (from Jan- 2022 to Dec- 2023) for the Institution was analysed and the details are tabulated as follows

Table 18. EB Bill Analysis

Month	Power Factor	Contract Demand (kVA)	Recorded Demand (kVA)	Energy Consumption (Normal)	Energy Consumption (Peak)	Energy Consumption (Off peak)	Total Consumption (kWh)	Total kWh Charge	Total Demand Charge	Total EB bill
Jan-23	0.95	20	32	4667	1258	2257	8182	56078	19000	81223
Feb-23	0.91	20	26	3431	824	1362	5617	38682	14500	57643
Mar-23	0.92	20	35	3714	727	1233	5674	38959	21250	64757
Apr-23	0.95	20	37	5406	1031	1639	8076	55636	22750	85364
May-23	0.95	20	52	5323	952	1472	7747	53414	34000	93646
Jun-23	0.95	20	43	5115	855	1489	7459	51097	27250	85999
Jul-23	0.96	20	43	5063	1025	1525	7613	52661	27250	86978
Aug-23	0.97	20	33	3891	909	1514	6314	43452	19750	68470
Sep-23	0.97	20	40	4891	1020	1585	7496	51746	25000	83632
Oct-23	0.97	20	39	4607	958	1481	7046	48652	24250	79041
Nov-23	0.96	20	36	4511	899	1518	6928	47586	22000	75855
Dec-23	0.97	20	42	5606	1031	1659	8296	57098	27825	92192
Average	**0.95**	**20**	**38**	**4685**	**957**	**1561**	**7204**	**49588**	**23735**	**79567**
Total	-	-	-	**56225**	**11489**	**18734**	**86448**	**595061**	**284825**	**954801**

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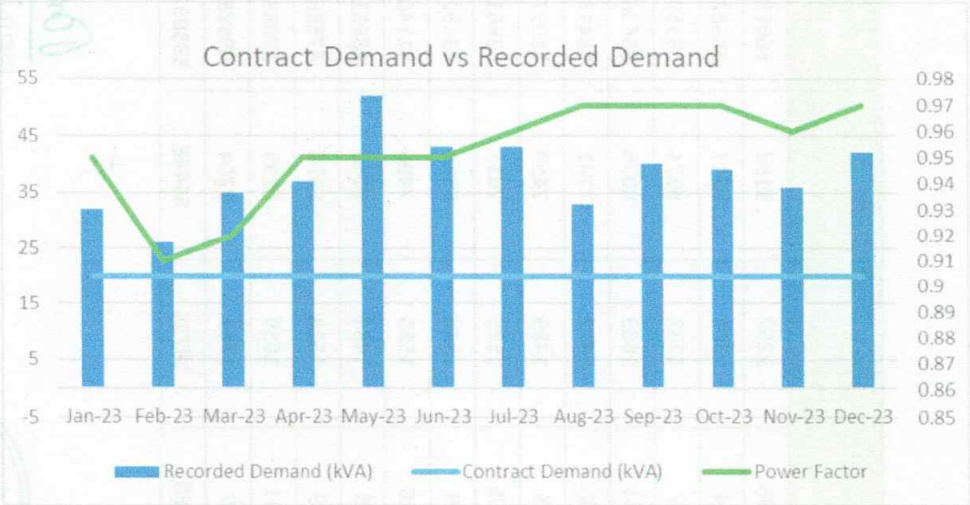
Observation:

- Institutional contract demand is 20 kVA, and billing demand is 15 kVA (75% of CD).
- In the month of May 2023, the recorded maximum demand was 52 kVA which is 260% higher than the contract demand.
- The annual electricity consumption is 86448 kWh.

Figure 11. *Annual Contract demand vs Record Demand*



4.2 Capacitor banks

The solution to improve the power factor is to operate power factor correction capacitors to the institutional power distribution system. They act as reactive power generators and provide the needed reactive power to accomplish kW of work. The primary purpose of capacitors is to reduce maximum demand. This reduces the amount of reactive power, and thus total power, generated by the utilities. In the institution, APFC panel system is installed with a capacity of 80 kVAr (5 kVAr, 2X10 kVAr, 15 kVAr, 2X20 kVAr)

Towards monitoring the health of the capacitors, the current of each phase of the capacitors is measured, and the details are as follows:

Observation:

- Capacitor banks are isolated from the system.
- The present main incomer power factor is maintained at 0.95 average from January 2023 to December 2023.
- Install an automatic APFC switch over to improve the power factor to unity.

4.3 Air Conditioners

To provide cooling load for the work space, conference room, admin building, and server room, 25 units (0.75 TR, 1 TR, 1.5 TR and 2 TR) of individual split-type air conditioners are installed. During the audit, a sample-based performance assessment was done for operating air conditioners.

Table 19. Performance assessment of Air conditioners

		I st Floor			II nd Floor				
Indoor Unit		Chairman Room	Director Room	Principal Room	Registrar Room	Conference Room	AIDB LAB	AIDB LAB	AIDB LAB
Design Parameters	Units	AC-1	AC-2	AC-3	AC-4	AC-5	AC-6	AC-7	AC-8
Type of Air conditioner	-	Split	Split	Split	Split	Split	Split	Split	Split
Make	-	Bluestar	Mitubishi	Bluestar	Panasonic	Samsung	LG Dual Inverter	LG Dual Inverter	Samsung
Model No	-	3HW1BTA	MS-GK24VA	3HW1BTA	CS-YC18RKY3	AR18HC3TFUR	RS-Q18DNXE	RS-Q18DNXE	AR18FCUAEB
Rated Cooling Capacity	TR	1.5	2	1.5	1.6	1.4	1.3	1.3	1.5
Rated Power	kW	1.87	1.85	1.87	1.73	1.61	1.73	1.73	1.86
Rated SEC	kW/TR	1.25	0.98	1.25	1.11	1.13	1.38	1.32	1.25
AC Star rating	-	3	5	3	3	3	3	3	3
Operating Parameters									
Set point	°C	22	21	22	23	16	18	18	18
Operating Hours	hrs.	6	6	6	6	6	6	6	6
Return air									
Return air DBT	°C	25.8	24.4	25.8	26	26.6	31.6	30.6	32.9
Return air RH	%	58.2	57	58.2	60.1	63	44.8	48.1	47.7
Return air WBT	°C	19.88	18.49	19.88	20.35	21.34	22.29	22.14	23.93
Return air enthalpy	kJ/kg/ °C	56.81	52.25	56.81	58.42	61.9	65.21	64.69	71.54

		I st Floor			II nd Floor				
Indoor Unit		Chairman Room	Director Room	Principal Room	Registrar Room	Conference Room	AIDB LAB	AIDB LAB	AIDB LAB
Design Parameters	Units	AC-1	AC-2	AC-3	AC-4	AC-5	AC-6	AC-7	AC-8
Return air density	kg/m^3	1.17	1.18	1.17	1.17	1.17	1.15	1.15	1.15
Supply air									
Supply air DBT	^0C	14.1	20.6	14.1	18.7	15.1	27	26	20.3
Supply air RH	%	90.9	73.8	90.9	88.7	81	62.1	55.9	73.9
Supply air WBT	^0C	13.23	17.47	13.23	17.46	13.18	21.54	19.68	17.21
Supply air enthalpy	kJ/kg/ ^0C	37.22	49.15	37.22	49.18	37.07	62.61	56.12	48.36
Δ Enthalpy	kJ/kg/ ^0C	19.59	3.1	19.59	9.24	24.83	2.6	8.57	23.18
Air velocity	m/s	1.46	3.99	1.46	5.30	1.92	5.42	5.42	1.52
Area	m^2	0.08	0.08	0.08	0.08	0.07	0.07	0.07	0.10
Actual air flow	m^3/s	0.12	0.32	0.12	0.41	0.14	0.38	0.38	0.15
	m^3/hr	421.44	1150.08	421.44	1493.96	490.75	1366.68	1366.68	540.54
	kg/hr	493.08	1357.09	493.08	1747.94	574.18	1571.68	1571.68	621.62
	CFM	247.81	676.25	247.81	878.45	288.56	803.61	803.61	317.84
Input motor power	kW	0.62	0.55	0.62	1.22	0.97	0.66	1.10	0.98
Heat load	TR	0.76	0.33	0.76	1.28	1.13	0.32	1.07	1.14
SEC	kW/TR	0.811	1.653	0.811	0.955	0.860	2.027	1.032	0.860

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		III rd Floor						
Indoor Unit		UPS	CSE FACULTY	CSE FACULTY	Server Room	Comp App Lab	HPCN Lab	HPCN Lab
Design Parameters	Units	AC-9	AC-10	AC-11	AC-12	AC-13	AC-14	AC-15
Type of Air conditioner	-	Split	Split	Split	Split	Split	Split	Split
Make	-	Haier	Samsung	Samsung	Mitsubishi	Skyworth	Blue Star	Bluestar
Model No	-	HSU50V-TBS3BE-INV	AS242UGD	AS242UGD	MS-GK10VA	SMVC24B-4A1A1NA	2HWZ4OA	3HW1BTA
Rated Cooling Capacity	TR	1.3	1.9	1.9	0.8	1.8	1.7	1.5
Rated Power	kW	1.73	2.42	2.42	0.74	1.65	2.25	1.87
Rated SEC	kW/TR	1.32	1.30	1.30	0.96	0.89	1.29	1.25
AC Star rating	-	3	2	2	5	-	2	3
Operating Parameters								
Set point	°C	27	18	Under Maintenance	16	25	19	22
Operating Hours	hrs.	24	6		24	6	6	6
Return air								
Return air DBT	°C	28	32.2		29.8	28	28.8	25.8
Return air RH	%	46.8	48.6		61	45.1	48	58.2
Return air WBT	°C	19.78	23.54		23.81	19.47	20.65	19.88
Return air enthalpy	kJ/kg/°C	61.97	70.01		71.19	55.35	59.36	56.81
Return air density	kg/m³	1.16	1.15		1.15	1.16	1.16	1.17
Supply air								
Supply air DBT	°C	26.7	12.7		22.7	13.2	12.6	14.1
Supply air RH	%	55	92.9		67.4	87.42	89	90.9
Supply air WBT	°C	21.36	12.05		18.52	12.02	11.59	13.23

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		III rd Floor						
Indoor Unit		UPS	CSE FACULTY	CSE FACULTY	Server Room	Comp App Lab	HPCN Lab	HPCN Lab
Design Parameters	Units	AC-9	AC-10	AC-11	AC-12	AC-13	AC-14	AC-15
Supply air enthalpy	kJ/kg/°C	56.38	34.21		52.4	34.13	33.07	37.22
Δ Enthalpy	kJ/kg/°C	5.59	35.8		18.79	21.22	26.29	19.59
Air velocity	m/s	1.71	1.13		1.35	2.20	1.71	1.46
Area	m^2	0.09	0.18		0.11	0.10	0.1368	0.08
Actual air flow	m^3/s	0.15	0.20		0.14	0.23	0.23	0.12
	m^3/hr	533.30	736.44		510.98	819.72	842.14	421.44
	kg/hr	618.63	846.91		587.63	950.88	976.88	493.08
	CFM	313.58	433.03		300.46	482.00	495.18	247.81
Input motor power	kW	0.66	2.82		0.67	1.28	2.74	0.62
Heat load	TR	0.27	2.40		0.87	1.60	2.03	0.76
SEC	kW/TR	2.395	1.176		0.767	0.802	1.349	0.811

		Seminar Hall				
Indoor Unit		AC-1	AC-2	AC-3	AC-4	AC-5
Design Parameters	Units	AC-16	AC-17	AC-18	AC-19	AC-20
Type of Air conditioner	-	Split	Split	Split	Split	Split
Make	-	Panasonic	Panasonic	Panasonic	Panasonic	Panasonic
Model No	-	CS-YC18RKY3	CS-YC18RKY3	CS-YC18RKY3	CS-YC18RKY3	CS-YC18RKY3
Rated Cooling Capacity	TR	1.6	1.6	1.6	1.6	1.6
Rated Power	kW	1.73	1.73	1.73	1.73	1.73
Rated SEC	kW/TR	1.11	1.11	1.11	1.11	1.11

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Indoor Unit		Seminar Hall				
		AC-1	AC-2	AC-3	AC-4	AC-5
Design Parameters	Units	AC-16	AC-17	AC-18	AC-19	AC-20
AC Star rating	-	3	3	3	3	3
Operating Parameters						
Set point	°C	23	23	23	23	23
Operating Hours	hrs.	6	6	6	6	6
Return air						
Return air DBT	°C	26	26	26	26	26
Return air RH	%	60.1	60.1	60.1	60.1	60.1
Return air WBT	°C	20.35	20.35	20.35	20.35	20.35
Return air enthalpy	kJ/kg/°C	58.42	58.42	58.42	58.42	58.42
Return air density	kg/m³	1.17	1.17	1.17	1.17	1.17
Supply air						
Supply air DBT	°C	18.7	18.7	18.7	18.7	18.7
Supply air RH	%	88.7	88.7	88.7	88.7	88.7
Supply air WBT	°C	17.46	17.46	17.46	17.46	17.46
Supply air enthalpy	kJ/kg/°C	49.18	49.18	49.18	49.18	49.18
Δ Enthalpy	kJ/kg/°C	9.24	9.24	9.24	9.24	9.24
Air velocity	m/s	5.30	5.30	5.30	5.30	5.30
Area	m²	0.08	0.08	0.08	0.08	0.08
Actual air flow	m³/s	0.41	0.41	0.41	0.41	0.41
	m³/hr	1493.96	1493.96	1493.96	1493.96	1493.96
	kg/hr	1747.94	1747.94	1747.94	1747.94	1747.94
	CFM	878.45	878.45	878.45	878.45	878.45

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		Seminar Hall				
Indoor Unit		AC-1	AC-2	AC-3	AC-4	AC-5
Design Parameters	Units	AC-16	AC-17	AC-18	AC-19	AC-20
Input motor power	kW	1.22	1.22	1.22	1.22	1.22
Heat load	TR	1.28	1.28	1.28	1.28	1.28
SEC	kW/TR	0.955	0.955	0.955	0.955	0.955

		Reprography			PG Facility	
Indoor Unit		AC-1	AC-2	AC-3		
Design Parameters	Units	AC-21	AC-22	AC-23	AC-24	AC-25
Type of Air conditioner	-	Split	Split	Split	Split	Split
Make	-	Mitubishi	Haier	Haier	Haier	Skyworth
Model No	-	MS-GK24VA	HSU50V-TBS3BE-INV	HSU50V-TBS3BE-INV	HSU50V-TBS3BE-INV	SMVC24B-4A1A1NA
Rated Cooling Capacity	TR	2	1.3	1.3	1.3	1.8
Rated Power	kW	1.85	1.73	1.73	1.73	1.65
Rated SEC	kW/TR	0.98	1.32	1.32	1.32	0.89
AC Star rating	-	5	3	3	3	-
Operating Parameters						
Set point	°C	21	27	27	27	25
Operating Hours	hrs.	6	24	24	24	6
Return air						
Return air DBT	°C	24.4	28	28	28	28
Return air RH	%	57	46.8	46.8	46.8	45.1
Return air WBT	°C	18.49	19.78	19.78	19.78	19.47

		Reprography			PG Facility	
Indoor Unit		AC-1	AC-2	AC-3		
Design Parameters	Units	AC-21	AC-22	AC-23	AC-24	AC-25
Return air enthalpy	kJ/kg/°C	52.25	61.97	61.97	61.97	55.35
Return air density	kg/m³	1.18	1.16	1.16	1.16	1.16
Supply air						
Supply air DBT	°C	20.6	26.7	26.7	26.7	13.2
Supply air RH	%	73.8	55	55	55	87.42
Supply air WBT	°C	17.47	21.36	21.36	21.36	12.02
Supply air enthalpy	kJ/kg/°C	49.15	56.38	56.38	56.38	34.13
Δ Enthalpy	kJ/kg/°C	3.1	5.59	5.59	5.59	21.22
Air velocity	m/s	3.99	1.71	1.71	1.71	2.20
Area	m²	0.08	0.09	0.09	0.09	0.10
Actual air flow	m³/s	0.32	0.15	0.15	0.15	0.23
	m³/hr	1150.08	533.30	533.30	533.30	819.72
	kg/hr	1357.09	618.63	618.63	618.63	950.88
	CFM	676.25	313.58	313.58	313.58	482.00
Input motor power	kW	0.55	0.66	0.66	0.66	1.28
Heat load	TR	0.33	0.27	0.27	0.27	1.60
SEC	kW/TR	1.653	2.395	2.395	2.395	0.802

Observation:

- Most of the AC units are with star ratings. The rating is from 2 to 5 stars.
- The specific energy consumption (SEC) is higher than the rated value for few AC's.
- Most of the AC units are operating at a set point temperature below 23°C.

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4.4 Pumps

- A bore well pump and submersible tank pump is operating 4 hours a day to pump water to the tanks and girl's hostel.
- An open well pump is operating 2 hours a day to pump water to overhead tanks in academic buildings.
- During the audit, pump assessments were done.
- The performance assessment is given below.

Table 20. Performance assessment for Bore well pumps

Design Parameter	Units	Borewell Pump	Open Well Pump	Tank Submersible Pump
Manufacturer	-	Not Available	Not Available	Not Available
Model	-			
Motor Power	kW			
Motor Type (IE2/IE3/IE4)	-			
Year of Manufactured	-			
Flow	$m^3/hr.$			
Head	m			
Speed	rpm			
Motor Efficiency	%			
Actual Measurement				
Operating Hours	hrs.	4	2	4
Actual Power	kW	2.43	6.09	1.93
Current	A	3.64	9	9
Voltage	V	410	410	220
Suction Pressure	kg/cm^2	0	0	0

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Design Parameter	Units	Borewell Pump	Open Well Pump	Tank Submersible Pump
Discharge Pressure	kg/cm^2	15	23	5
Flow	$m^3/hr.$	3.2	4.2	4.2
Throttling				
Suction Control Valve close	%	Full open	Full open	Full open
Discharge Control Valve close	%	Full open	Full open	Full open
Variable Speed Drive				
VFD Installed	(Yes / No)	No	No	No
Frequency	Hz	NA	NA	NA
Calculation				
Head(H)	m	150	230	50
Hydraulic Power	kW	1.3	2.6	0.6
Combined efficiency	%	54%	43%	30%
Marginal Energy Cost	Rs/kWh	7.01	7.01	7.01
Specific Energy Consumption	kWh/m^3	0.75	1.46	0.46
Pumping Cost	Rs/m^3	5.29	10.22	3.21
Pumping Cost for College Campus Overhead Tank	Rs/m^3	10.44		

Observation:

- Open well pump is overloaded.
- The operating head of the open well pump is very high.

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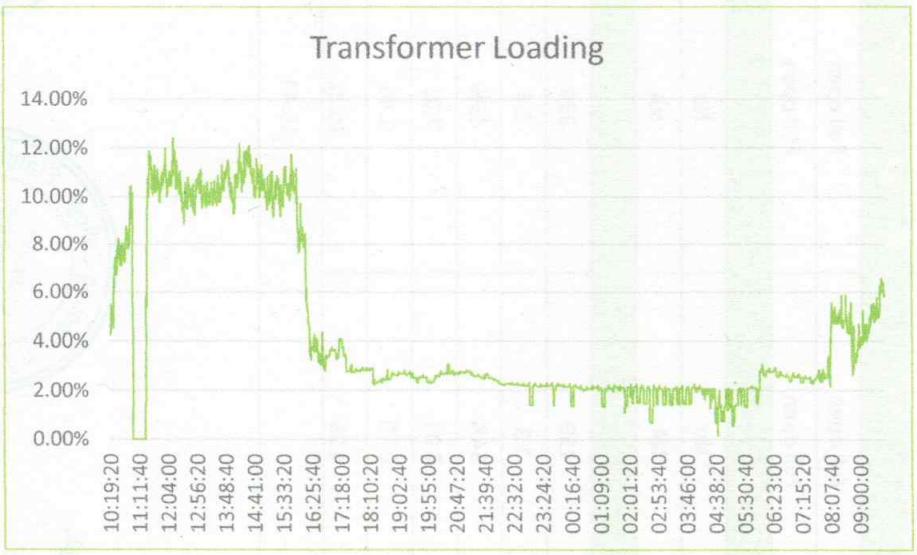
4.5 Transformer Loading

Figure 12. *Capacitor bank individual phase current measurement*

Transformer Loading										
Tr	RATING	PANELS	Max.Lod.Per			Avr.lod.Per			Max.Lod.Per	Avr.lod.Per
	kVA		KVA	KW	P.F	KVA	KW	P.F	%	%
1	400	Main Incomer	50	49	0.989	17	16.4	0.95	12.40%	4.25%

Figure 13. *Transformer Loading*



Observations:

- The main incomer panel voltage varies from 421 V to 452 V. The average voltage is 421 V during recording time

4.6 Diesel Generator

There are two DG sets in the facility. One DG set of 125 kVA capacity. One more DG set of 25 kVA capacity. DG's are operated during the power failure.

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Table 21. Performance assessment for Diesel Generators

Description	Unit	Power Backup DG-1	Power Backup DG -2
Make	-	Mahindra Powerol	Kirloskar Green
Rated capacity	kVA	125	25
Date of trial	Date	17-01-2024	17-01-2024
Duration of trial	mins	28 mins	4 mins
Power (Average)	kW	24.35	17.94
Power (Max)	kW	27.88	20.98
Loading (Max)	kVA	28.71	20.81
Loading (Max)	%	23%	83%
Fuel consumed	litters	4.3	0.38
Electricity generated*	kWh	11.44	1.285
SEGR	kWh/Lt.	2.7	3.4

Observations:

- The DG of 25kVA capacity is mainly operated. If there is excess load connected to system, then 125kVA DG is switched on.

Recommendation

- Operate 125 kVA DG during day time since the load is high
- Operate 25 kVA DG when the load is less during night time.

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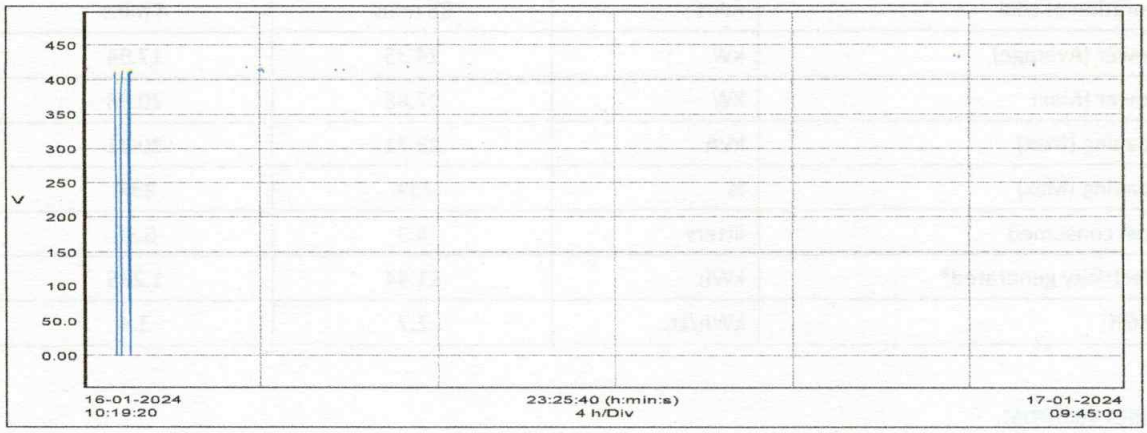
5.0 Electrical Parameter Graphs

5.1 Main incomer 400 KVA Transformer

5.1.1 Voltage profile for main incomer

Figure 14. *Voltage profile for main incomer*

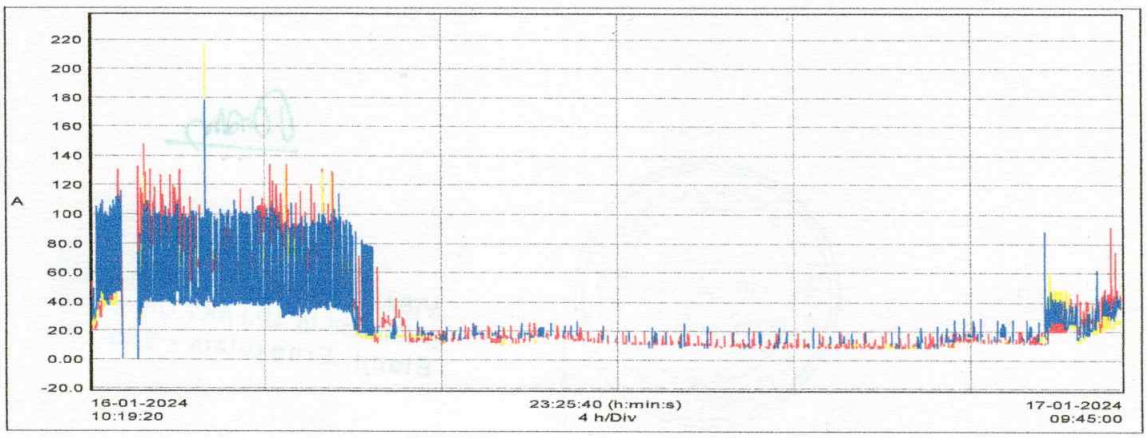


Observations:

- The main incomer panel voltage varies from 421 V to 452 V. The average voltage is 421 V during recording time.
- The main incomer voltage profile value is within the limit specified as per the IEC 60038-2009 (±10%) standard.

5.1.2 Current profile for main incomer

Figure 15. *Current profile for main incomer*



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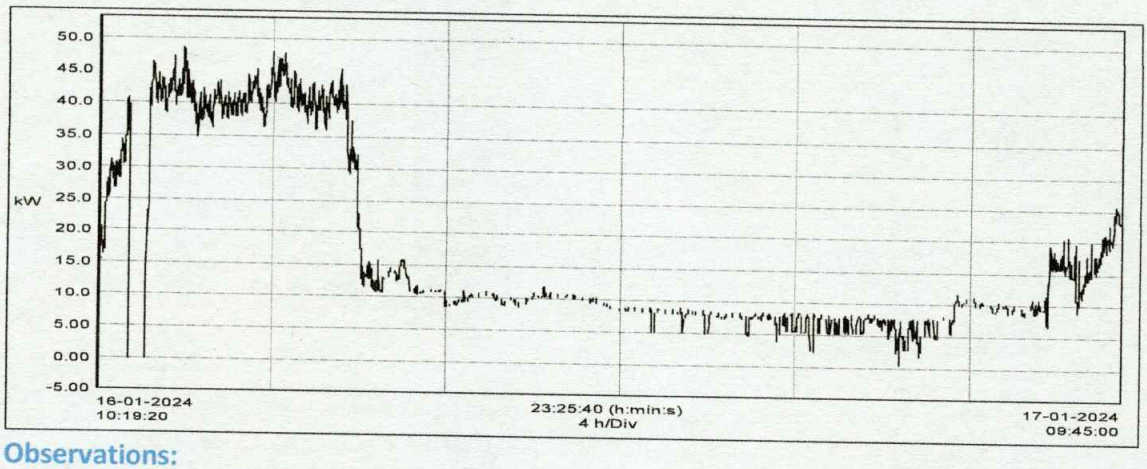
Observations:

- The main incomer the current varies from 8.5A to 216A during recording time.

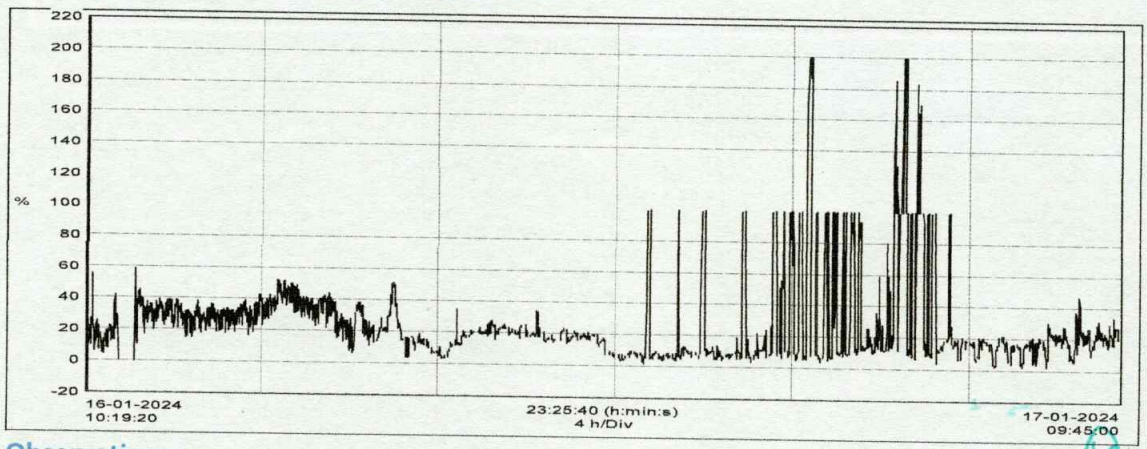
Figure 16. *Power profile for main incomer*



Observations:

- The Power of the main incomer varies from 3.5 kW to 48.5 kW. Average power is 16.4W during recording time.

Figure 17. *Current Unbalance in main incomer*



Observations:

- The main incomer current Unbalance is Average 26.52%.it is high in value.
- Distribute the loads equally in loads side.

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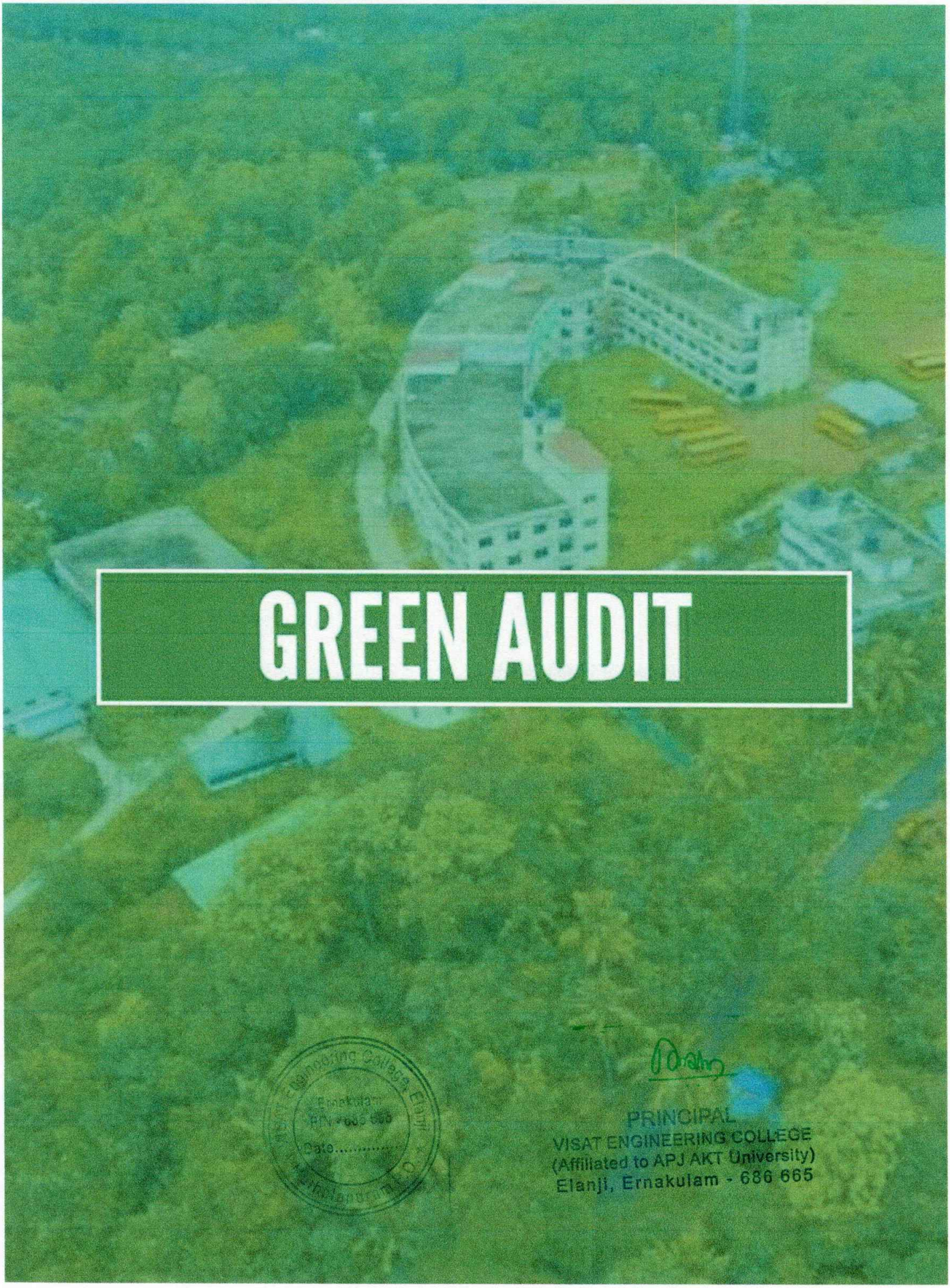

GREEN AUDIT

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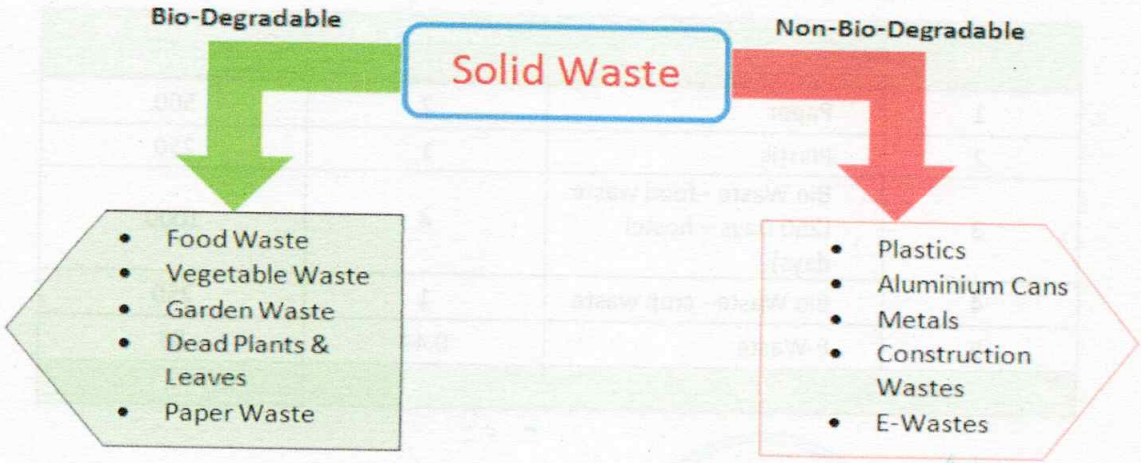
6.0 Green Audit

A green audit is a process of systematic identification, quantification, recording, reporting, and analysis of components of the environmental diversity of an institution. It aims to analyze environmental practices within and outside the concerned sites, which will have an impact on the eco-friendly ambience. A green audit can be a useful tool for a college to determine how and where energy, water, or other resources are used the most. The college can then consider how to implement conservation measures and make savings. It can also be used to determine the type and volume of waste, which can be used for a recycling project or to improve a waste minimization plan. Green audits can be a highly valuable tool for colleges in a wide range of ways to improve their environmental and economic performance and reputation while reducing waste and operating costs. The main objective of the green audit is to promote environmental management and conservation on the college campus.

6.1 Waste Management

Waste management is a process that determines the kind and volume of waste that an organization produces. Different types of waste generated inside the institution are represented in the below block diagram.

Figure 18. *Types of waste generated*



Observations

- Paper waste from office/class and labs are stored and sent for recycling to local panchayat
- E-Waste is collected, stored, and disposed to local venders
- Incinerator is fixed for safe disposal of sanitary waste.
- Separate bins are not there for bio-degradable and non-biodegradable waste.
- No quantification of waste daily or monthly basis.
- Waste from chemistry lab diluted and is let off to common drain.
- Glasses are provided for drinking water.
- Cleaning and collecting wastes at frequent intervals.
- Food waste is being disposed to local pig rearing units.
- Used pens are collected and sent for recycling.
- Bio gas plant is installed
- Vermicompost is installed
- The campus generates nearly 27.94 kg of waste every day, including paper, plastic, e-waste, and bio-waste (food waste, leaves, grass, etc.). According to per-month data, 48% of waste comes from food, 12% organic (both dry and wet leaves), 24% from paper, 12% from plastic, and 4% from e-waste.

Table 22. Waste generation

S.NO	TYPE OF WASTE	QUANTITY IN KG/DAY	QUANTITY IN KG/YEAR
1	Paper	2	500
2	Plastic	1	250
3	Bio Waste - food waste (250 Days – hostel days)	4	1000
4	Bio Waste - crop waste	1	250
5	E-Waste	0.44	88
Total		27.94	2,088

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Figure 19. *Total waste generation*

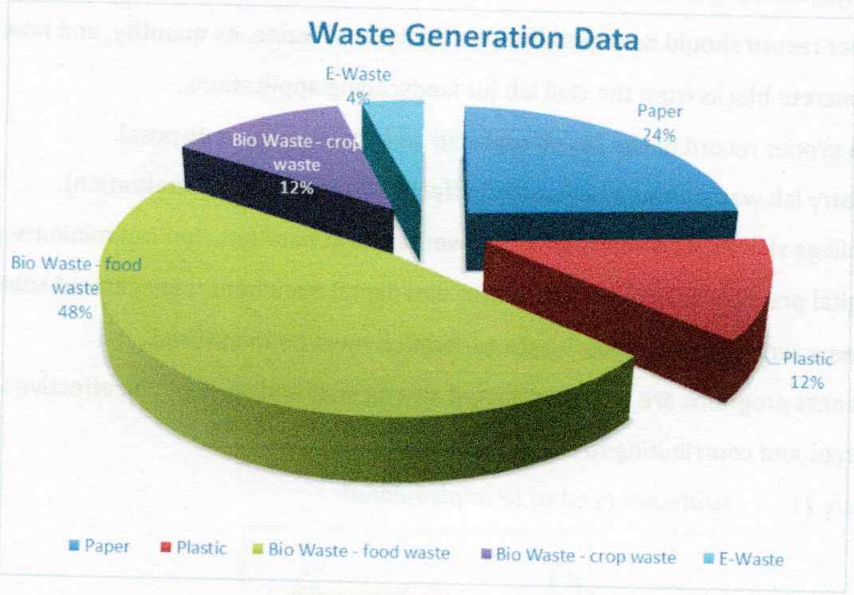

Figure 20. *Good Practices*

Recommendations

- Reduce the amount of waste that is produced in classrooms.
- Keep biodegradable and non-biodegradable waste bins for segregation of waste.

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- Use construction debris waste for landscaping.
- A proper record should be maintained for the type of waste, its quantity, and how it's disposed.
- Use concrete blocks from the civil lab for landscaping applications.
- Keep a proper record of the DG oil replaced and ensure proper disposal.
- Chemistry lab waste should be handled effectively (acid-base neutralization).
- The college should set a yearly goal to lower waste generation. You can minimize paper by going for digital practices (electronic signatures and digital document management solutions). To become a zero-waste campus, waste generation must be monitored.
- Awareness programs are to be conducted among staff and students on effective use of resources and contributing to the environment

Figure 21. *Strategies need to be implemented*

Dust Bins

6.2 Water Management

A water audit is a qualitative and quantitative analysis of water consumption to identify means of reducing, reusing, and recycling water. A water audit is a method of quantifying all the flows of water in a system to understand its usage and improve water conservation. A water audit gives an idea of the amount of water that is consumed in the college for activities like washing hands, drinking in the laboratories, watering the garden, and flushing toilets and urinals. From the results obtained, students and staff will consider better ways to improve water conservation throughout the building and on the college campus. It is therefore essential that any environmentally responsible institution examine its water use practices. A water audit provides an overview of water use trends, the effectiveness of conservation measures, and potential cost and water savings.

Observations

- One borewells and one open well are available on campus to meet the water requirement.
- Tanks of 4X5,000 litters Infront of the Girls hostel to store the water for use.

- The water from tanks in front of girl's hostel are pumped to overhead tanks in main academic building of capacity 4X5,000 litters.
- Quality of Packaged RO water is ensured by periodically validating the water quality test results provided by the vender.
- There are two water tanks of 5,000 litters capacity in girls' hostel
- The total capacity of the installed water tanks is 60,000 litters.
- Exact consumption details are not available as water meters are not installed.
- Rainwater flowing off from all places in the campus is used to recharge an open well.
- A water canes are placed in academic campus for drinking water.
- Many taps in both boys and girls rest rooms in both academic and hostel blocks are not properly closed.
- The approximate water consumption is 19000 litters per day.
- Periodic testing of raw water and drinking water should be done.
- Open-pipe irrigation is used on campus.
- Around 78 taps are installed on the campus.
- Water flow varies from 5 lpm to 12 lpm.
- Potable water is used for all purposes inside the campus.

Figure 22. *Best Practises*

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Figure 23. *Drinking Water test report*

INTERFIELD LABORATORIES

TC - 6338

ADDRESS: XHI/1208, INTERPRINT HOUSE, KARUVELIPADY, KOCHI - 682005, KERALA, INDIA

TEST REPORT

ULR - TC633824000001208F

CUSTOMER NAME & ADDRESS	**Report No. BK648 / 2024**
M/S. RAINBOW PACKAGED DRINKING WATER PALACKAMATTOM, KINGINIMATTOM PO, KOLENCHERY-682 311 KERALA INDIA	Customer Ref. : Not Applicable Code No. : Not Applicable Test Done : IS 14543 : 2016 with amendment No. 1-8

Particulars of Sample

Description of sample by the customer	: Packaged Drinking Water	Lab Sample Code	: KH/24/57669/B51522,KH/24/57669/C31953
Quantity of sample received	: 4 Litres	Sample Received	: 12-01-2024
BIS Seal	: Not Applicable	Analysis Started	: 12-01-2024
Nature of Sample	: Colourless clear liquid without any sediments, suspended particles and extraneous matter	Analysis Completed	: 18-01-2024
Batch No.	:ARD275JY Dated 05.01.2024		

TEST RESULTS

I. CHEMICAL TESTING : Water / Residues in Water

Table 2 General Parameters Concerning Substances Undesirable in Excessive Amounts (Clause 5.3)

Sl. No.	PARAMETERS TESTED	Unit	REQUIREMENTS	RESULTS	LOQ	TEST METHOD
1	ANIONIC SURFACE ACTIVE AGENTS (as MBAS)	mg/l	Max 0.2	< LOQ	0.1	Annex K of IS 13428 : 2005
2	BORATES (as B)	mg/l	Max 5	< LOQ	0.2	Annex H of IS 13428 : 2005
3	MINERAL OIL	mg/l	ABSENT	ABSENT	0.1	IS 3025 (Part 39) : 1991, Reaff. 2003
4	PHENOLIC COMPOUNDS (as C6H5OH)	mg/l	ABSENT	ABSENT	0.001	IS 3025 (Part 43) : 1992, Reaff. 2003
5	ANTIMONY (as Sb)	mg/l	Max 0.005	<LOQ	0.0005	APHA 23rd Ed. 3125
6	BARIUM (as Ba)	mg/l	Max 0.7	<LOQ	0.0005	APHA 23rd Ed. 3125
7	COPPER (as Cu)	mg/l	Max 0.05	<LOQ	0.0005	APHA 23rd Ed. 3125
8	IRON (as Fe)	mg/l	Max 0.1	<LOQ	0.0005	APHA 23rd Ed. 3125
9	MANGANESE (as Mn)	mg/l	Max 0.1	<LOQ	0.0005	APHA 23rd Ed. 3125
10	ZINC (as Zn)	mg/l	Max 5	<LOQ	0.0005	APHA 23rd Ed. 3125

II. BIOLOGICAL TESTING : Water

Microbiological Parameters (Clause 5.2)

Sl. No.	PARAMETERS TESTED	VOLUME OF SAMPLE IN ML	REQUIREMENTS	RESULTS	TEST METHOD
1	FAECAL STREPTOCOCCI	250	ABSENT	ABSENT/250ml	IS 15186 : 2014
2	SALMONELLA	250	ABSENT	ABSENT/250ml	IS 15187 : 2021
3	SHIGELLA	250	ABSENT	ABSENT/250ml	IS 5887 (Part 7) : 1999, Reaff. 2022
4	STAPHYLOCOCCUS AUREUS	250	ABSENT	ABSENT/250ml	IS 5887 (Part 2): 1976, Reaff. 2022

Remarks
LOQ - Limit of Quantification

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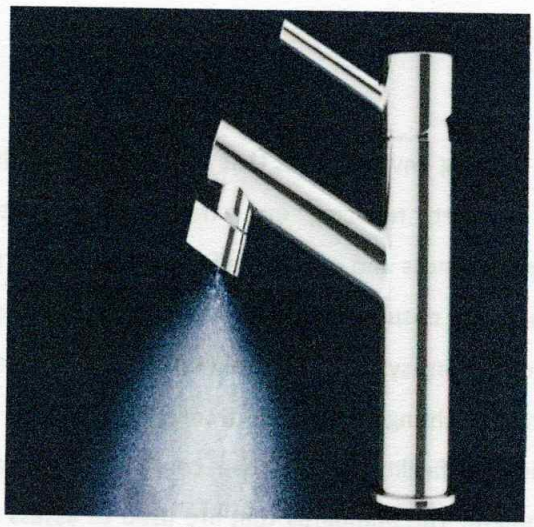
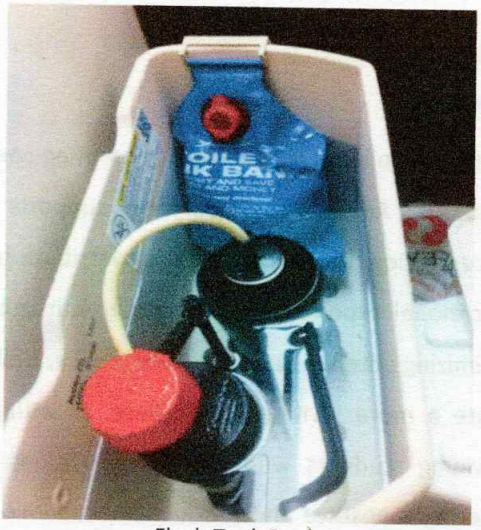
Figure 24. *Improvement Measures*



Mist Aertated Taps



Flush Tank Bank

Recommendations

- Install water meters at the bore well and open well side for details on the quantity of water pumped from the source and on all hostels and academic blocks to monitor the overall consumption of water inside the campus and take necessary actions when required.
- Install an automatic water tank overflow controller to arrest the overflow of water.
- Use aerated taps to conserve more water.
- Conduct awareness programs on water conservation for students. Place posters like "Save Water" in all blocks.
- Adjust the main pipe regulator to reduce the water flow to 5 lpm in handwashing areas.
- Install dishwashing machines and nozzles in the canteen to clean utensils and minimize water consumption.
- Check the option for a drip irrigation system.
- Planting native trees in place of exotic plants will reduce the water requirement for irrigation.
- Replant invasive grass lawns with native grass, which will conserve water.

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6.3 Indoor Environmental Assessment

6.3.1 Indoor Lighting

Background

Lighting in colleges is essential for creating conducive learning environments that adhere to established standards. Adequate illumination supports visual comfort, reducing eye strain and promoting concentration. Properly lit spaces contribute to student alertness and overall well-being, enhancing the educational experience. Compliance with lighting standards ensures safety, preventing accidents and minimizing potential hazards. Additionally, well-designed lighting systems can positively impact mood and create a more inviting atmosphere. Meeting prescribed lighting standards in colleges is critical for providing students with optimal conditions for studying, facilitating effective communication, and fostering a positive and productive academic environment. The Standards that are used to assess the illuminance level is *NBC PART 8, Chapter 4*.

Table 23. Lighting standards

Sl No.	Type of Interior or Activity	Range of Service Illuminance (lux)
21.1	Assembly Halls	200-300-500
21.2	Teaching Spaces	200-300-500
21.3.1	Lecture Halls	200-300-500
21.3.2	Demonstration benches	300-500-750
21.4	Seminar Rooms	300-500-750
21.5	Art Rooms	300-500-750
21.6	Needlework Rooms	300-500-750
21.7	Laboratories	300-500-750
21.8	Libraries	200-300-500
21.9	Music Rooms	200-300-500
21.10	Sports Halls	200-300-500
21.11	Workshops	200-300-500

Findings

- It is found that the lighting levels in all places are as per the requirement.
- Day light is effectively used during the day with the minimal electrical lightening during day time
- Food Lab, S&H room and Third floor corridor lightening has to be improved as its slightly lesser than the required level

Table 24. Lighting lux level in college

Lighting Level inside the Campus					
Sl. No	Building Name	Floor	Room Number / Name	Illuminance Level (Lux)	Remarks
1	Admin (Main)	First Floor	Director Room	320	Within Limit
2	Admin (Main)	First Floor	Chairman Room	246	Within Limit
3	Admin (Main)	First Floor	Food Lab	117	Not Within Limit
4	Admin (Main)	First Floor	Corridor	90	Within Limit
5	Admin (Main)	First Floor	209	292	Within Limit
6	Admin (Main)	First Floor	211	568	Within Limit
7	Admin (Main)	First Floor	Library and Reading Room	489	Within Limit
8	Admin (Main)	Ground Floor	Office	361	Within Limit
9	Admin (Main)	Ground Floor	Lobby	312	Within Limit
10	Admin (Main)	Second Floor	Registrar Room	226	Within Limit
11	Admin (Main)	Second Floor	Principal Room	165	Within Limit
12	Admin (Main)	Second Floor	S&H	139	Within Limit
13	Admin (Main)	Third Floor	Corridor	65	Within Limit
14	Admin (Main)	Third Floor	Robotics Lab	486	Within Limit
15	Admin (Main)	Third Floor	Electrical Measurement Lab	349	Within Limit
16	Admin (Main)	Third Floor	311	515	Within Limit
17	Admin (Main)	Third Floor	308	267	Within Limit
18	Admin (Main)	Third Floor	ECE Faculty Room	222	Within Limit
19	Admin (Main)	Third Floor	EE Faculty Room	262	Within Limit
20	Admin (Main)	Third Floor	404	368	Within Limit
21	Admin (Main)	Third Floor	HPCN	903	Within Limit
22	Admin (Main)	Third Floor	Pace Lab	509	Within Limit
23	Admin (Main)	Third Floor	CSE Faculty room	231	Within Limit
24	Admin (Main)	Third Floor	Seminar Hall	325	Within Limit
25	Admin (Main)	Third Floor	Corridor	502	Within Limit

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6.3.2 Indoor Air Quality

Background

Indoor air quality in college is vital for the health and well-being of students and staff. Poor air quality can lead to respiratory issues and negatively impact concentration and performance. Maintaining a healthy indoor environment is crucial for creating conducive learning spaces, reducing absenteeism, and enhancing overall academic success. Adequate ventilation, pollutant control, and regular maintenance contribute to a safe and comfortable atmosphere, ensuring that colleges prioritize the physical and mental well-being of their community members.

Table 25. IAQ Standards

S.NO	Contaminants	Maximum Allowable Limit	Standards
1	TVOC (Total volatile organic compounds)	500mg/m^3	ISO 16000-6
2	HCHO (Formaldehydes)	27 parts per billion	ISO 16000-3
3	PM_1 (Particulate matters)	50mg/m^3	ISO7708
4	$PM_{2.5}$ (Particulate matters)	60µg/m^3	NBC/ASHRAE/CPCB
5	PM_{10} (Particulate matters)	150µg/m^3	NBC/ASHRAE

Findings

- Intelligent Air quality detector was used to detect the air pollutants like TVOC (Total volatile organic compounds), HCHO (Formaldehydes), PM1, PM2.5, PM10 (Particulate matters)
- Classrooms, Corridors, Laboratories, Office room, Faculty rooms and other common places of the institution were checked for the IAQ standards as per ISO 16000, NBC and ASHRAE.
- All the places have IAQ as per standards except the main building lobby where $PM_{2.5}$ is slightly higher than the standards due to construction activity.

Figure 25. *Intelligent Air Quality Detector*

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Table 26. IAQ Parameters inside the institution

Indoor Air Quality Standard										
Sl. No	Building Name	Floor	Room Number / Name	PM 1 mg/m^3	PM 2.5 $\mu g/m^3$	PM 10 $\mu g/m^3$	HCHO ppb	TVOC mg/m^3	Air Quality	Air Pollution Level
1	Admin (Main)	Ground Floor	Lobby	50	67	77	0.006	0.025	27	Normal
2	Admin (Main)	First Floor	210	46	61	70	0.006	0.025	24	Normal
3	Admin (Main)	First Floor	212	48	64	74	0.006	0.025	25	Normal
4	Admin (Main)	First Floor	Food lab	47	64	73	0.006	0.025	25	Normal
5	Admin (Main)	Second Floor	Office	44	59	67	0.005	0.025	24	Normal
6	Admin (Main)	Second Floor	Exam cell	43	57	67	0.003	0.012	24	Normal
7	Admin (Main)	Second Floor	Civil	44	59	68	0.002	0.02	23	Normal
8	Admin (Main)	Third Floor	Seminar hall	42	55	64	0	0	22	Normal
9	Admin (Main)	Fourth Floor	507	43	57	66	0.006	0.025	22	Normal
10	Lab Block -1	Ground Floor	EEE	39	54	61	0.003	0.024	22	Normal
11	Lab Block -2	Ground Floor	Fluid	42	55	64	0.003	0.025	21	Normal
12	Lab Block -3	First Floor	MT,2,TE	33	45	52	0.002	0.008	18	Normal
13	Lab Block -4	First Floor	System Lab / M E	36	49	59	0.005	0.021	21	Normal
14	Lab Block -2	Ground Floor	Machine	36	48	55	0.003	0.008	19	Normal
15	Lab Block -3	First Floor	Auditorium	35	48	55	0.006	0.024	18	Normal
16	Lab Block -3	Ground Floor	Workshop	38	50	58	0.007	0.038	26	Normal
17	Lab Block -4	Ground Floor	kitchen	38	54	62	0.012	0.042	21	Normal

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7.0 Biodiversity

A biodiversity audit ensures the greenery and sustainability of the campus. The biodiversity audit is conducted to analyze the present biodiversity status of the college and to propose plans to enhance the existing biodiversity. In this audit, the focus has been on the assessment of the present status of diversity, which includes trees, shrubs, birds, and other habitats on and around campus. Efforts are also made by the college authorities to conserve nature. In this audit, student volunteers were involved to identify the flora and fauna present on campus. The focus is also given on pollution control methodology, best practices for environmental conservation, etc. This audit gives recommendations to the college for the conservation and protection of natural vegetation and animal life by involving students and faculty members to make the institute's campus biodiversity rich.

Observations

- Nearly 56 floral species are seen around the campus.
- Around 200 mature trees of various species are found.
- 20 faunal species are found on the campus.
- The faunal diversity is lower compared to the floral diversity.
- Flowering, medicinal, and herbal plants are less common compared to common native plants.
- As a part of NSS activities Tress are planted.

Table 27. Floral species in the campus

List of Matured Tree Available				
Sl. No	Location/Block Name	Common Name	Botanical Name	Quantity
1	Entrance	Teak Wood	Tectona grandis	34
2	Entrance	Mango Tree	Mangifera Indica	4
3	Entrance	Guava Tree	Psidium Guajava	1
4	Entrance	Anjili Tree	Artocarpus hirsutus	3
5	Entrance	Jackfruit Tree	Artocarpus Heterophyllus	4
6	Entrance	Papaya Tree	Carica Papaya	4
7	Entrance	Red Palm Tree	Cyrtostachys renda	7
8	Entrance	African tulip tree	Spathodea campanulata	2
9	Entrance	Vaka Tree	Albizia chinensis	2
10	Entrance	Coconut Tree	Cocos Nucifera	8

List of Matured Tree Available				
Sl. No	Location/Block Name	Common Name	Botanical Name	Quantity
11	Entrance	Turmeric Tree	Curcuma longa	3
12	Entrance	Rubber	Hevea brasiliensis	7
13	Entrance	Mahogany Tree	Swietenia macrophylla	2
14	Entrance	Palm	Arecaceae	3
15	Entrance	Blackboard Tree (Pala Tree)	Alstonia scholaris	1
16	Entrance	Cotton Tree	Ceiba pentandra	1
17	Entrance	Bamboo Tree	Bambusa vulgaris	1
18	Entrance	Sacred fig (Peepal Tree)	Ficus religiosa	2
19	Entrance	Golden shower Tree	Cassia fistula	1
20	Rest Area	Jackfruit Tree	Artocarpus Heterophyllus	1
21	Rest Area	Golden shower Tree	Cassia fistula	2
22	Rest Area	Rose Apple Tree (Chambaka Tree)	Syzygium aqueum	1
23	Rest Area	Red Palm Tree	Cyrtostachys renda	3
24	Rest Area	Red Bottlebrushes	Callistemon citrinus	9
25	Rest Area	Neam Tree	Azadirachta Indica	1
26	Rest Area	Teak Wood	Tectona grandis	1
27	Reception Area	Red Bottlebrushes	Callistemon citrinus	11
28	Reception Area	Red Palm Tree	Cyrtostachys renda	6
29	Reception Area	Custard Apple	Annona reticulata	1
30	Reception Area	Variegated Croton (Garden croton)	Codiaeum Variegatum	1
31	Ladies Hostel Front	Jackfruit Tree	Artocarpus Heterophyllus	1
32	Ladies Hostel Front	Teak Wood	Tectona grandis	1
33	Ladies Hostel Front	Forest Usiri	Phyllanthus emblica	9
34	Ladies Hostel Front	Kolambi	Allamanda	3
35	Ladies Hostel Front	Variegated Croton (Garden croton)	Codiaeum Variegatum	3
36	Ladies Hostel Front	Chetti Plant (Jungle Geranium)	Ixora coccinea	2
37	Ladies Hostel Front	Parakeet flower	Heliconia psittacorum	25
38	Borewell Side	Vetti tree	Aporosa lindleyana	1
39	Ladies Hostel Tree	Indian Gooseberry	Phyllanthus Emblica	1
40	Ladies Hostel Tree	Rambutan	Nephelium Lappaceum	5
41	Ladies Hostel Tree	Jack Fruit	Artocarpus Heterophyllus	3
42	Ladies Hostel Tree	Java Palm	Livistona Rotundifolia	2
43	Ladies Hostel Tree	Spanish Cherry	Mimusops Elengi	1

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List of Matured Tree Available				
Sl. No	Location/Block Name	Common Name	Botanical Name	Quantity
44	Ladies Hostel Tree	Cappota	Manilkara Zapota	2
45	Ladies Hostel Tree	Banana	Musa	10
46	Ladies Hostel Tree	Neem	Azadirachta Indica	1
47	Ladies Hostel Tree	Chembarathi	Hibiscus Rosa-Sinensis	2
48	Ladies Hostel Tree	Teak	Tectona grandis	2
49	Ladies Hostel Tree	Illinois Tree	Quercus bicolor	1
50	Ladies Hostel Tree	Monkey Tamarind	Mucuna pruriens	2
51	Ladies Hostel Tree	Vatta	Macaranga Peltata	2
52	Ladies Hostel Tree	Mango Tree	Mangifera indica	2
53	Ladies Hostel Tree	Paper rose	Bougainvillea glabra	8
54	Ladies Hostel Tree	Passion Fruit	Passiflora edulis	2
55	Ladies Hostel Tree	Rose	Rosa rubiginosa	3
56	Ladies Hostel Front	Flowers with Flowerpot		167
57	PG Block Side	Saplings		10
58	Store's Side	Saplings		50

Figure 26. *Floral species in the campus*

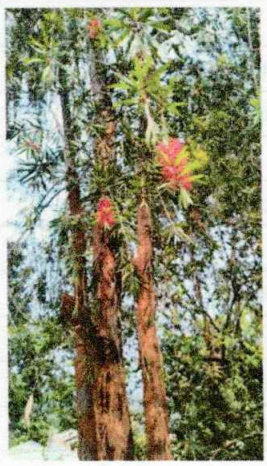


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Table 28. Faunal species in the campus

S.No	Common Name	Scientific Name
1	Common Hawk-Cuckoo	Hierococcyx Varius
2	Asian Koel	Eudynamys Scolopaceus
3	House Sparrow	Passer Domesticus
4	Lizard	Lacertilia
5	Pigeon	Columbidae
6	Ants	Formicidae
7	Butterflies	Rhopalocera
8	Rat	Rattus
9	Snake	Serpentes
10	Beetles	Coleoptera
11	Dragonfly	Anisoptera
12	Indian Myna	Acridotheres Tristis
13	Hummingbirds	Trochilidae
14	Starling	Sturnus Vulgaris
15	Cat	Felis Catus
16	Dog	Canis Lupus Familiaris
17	Frog	Anura
18	Millipede	Diplopoda
19	Common Earthworm	Lumbricina
20	Bug	Hemiptera
21	Crow	Corvus Spp

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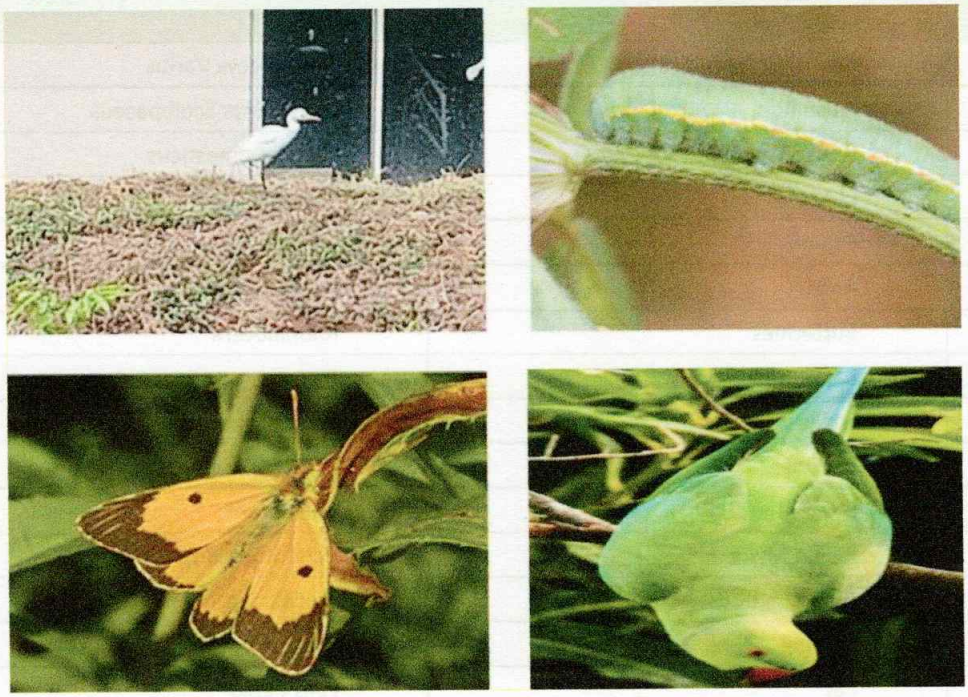
Figure 27. *Faunal species in the campus*



Recommendations

- To maintain the college campus green and eco-friendly, more trees need to be planted so that carbon neutrality can be maintained.
- Food and water pots are kept inside the campus for feeding the animals and birds.
- Plant more native trees rather than exotic species to maintain plant diversity.
- Review the list of trees planted in the garden periodically, allot numbers to the trees and keep records. Assign scientific names to the trees.
- Create awareness of environmental sustainability among students and take actions to ensure environmental sustainability.
- Indoor plantation to be encouraged, Bonsai can be planted in corridor to bond a relation with nature.
- All trees in the campus should be named scientifically.
- Establish drip irrigation system for watering plants and trees to save more water.
- Plant more medicinal plants and fruit bearing trees to maintain plant diversity.
- The faunal diversity is low; however, it can be improved by planting more flowering and fruit bearing plants.

8.0 Carbon Foot Print

Carbon footprint due to transport, energy consumption and internal diesel consumption is analysed, and the details are given below.

Table 29. Carbon Foot Print Analysis

Sl.No	Description	Type of Fuel and their CO_2 Conversion Process		
		Fuel Consumption		
		Electricity kWh	Diesel (Vehicle + DG) Litre	Petrol (Vehicle) Litre
1	Total Annual Consumption	86448	11673	109
2	CO2 Emission (Tons/Annum)	71	28	0.3
3	Total CO2 Emission (Tons/Annum)			99 (↑)
4	No. of Matured Trees Available			200
5	CO_2 offset due to Trees (Tons/Annum)			4.36 (↓)
6	CO_2 Emission per (Tons/Annum) currently			95 (↑)
7	Expected Reduction of Annual Electricity Consumption after Implementing Proposed Energy Conservation Measures (kWh)			15645
8	CO_2 offset after implementing ECM (Tons/Annum)			13 (↓)
9	Per Capita CO_2 emission (Tons/Annum)			0.24

Observations

- The global average of CO_2 emission of per capita is 6.5 tones/annum and Indian per capita emission is 2.5 tones/annum.
- The Per Capita CO2 emission (Tons/Annum) of the college is only 0.24tonnes/annum, which is very well within the limit.
- Major carbon emission is for the electricity usage.
- Encourage carpooling and usage of cycles planting more trees will help to reduce net carbon emission.

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9.0 Annexure

9.1 Authorised Certificates of the Firm

CERTIFICATE

Registered CCPL

Registration Certificate

This is to certify that
The Management Systems of

BIGETA ENERGY SOLUTION LLP

Carried out at following site:

FIRST FLOOR, SRI DATTATREYA COMPLEX, NO. 1489, SY NO. 476/3, SARJAPUR - ATTIBELE ROAD, BANGLORE - 562 125 (KARNATAKA) (INDIA)

Has been found to conform to the occupational health and safety management systems Standard:

ISO 45001:2018

This certificate is valid for the following Product or Service ranges:

CONSULTING, ADVISORY AND TRAINING SERVICES RELATED TO ENERGY EFFICIENCY, ENERGY MANAGEMENT, SAFETY, RELIABILITY, ESG(ENVIRONMENTAL, SOCIAL, GOVERNANCE),DATA ANALYTICS, GREEN BUILDING AND SUSTAINABILITY. DEVELOP AND DEPLOY PRODUCTS AND SOLUTIONS TO INCREASE ENERGY EFFICIENCY, SAFETY, RELIABILITY AND SUSTAINABILITY.
IAF CODE – 35

CERTIFICATE NO. : CCPL/E/OH&S/A1004
ISSUED ON : 18/08/2023 1ST SURVEILLANCE DUE ON: 18/07/2024
VALIDITY DATE : 17/08/2026 2ND SURVEILLANCE DUE ON: 18/07/2025

THE VALIDITY OF CERTIFICATE IS SUBJECT TO REGULAR SURVEILLANCE AUDIT ON OR BEFORE ABOVE MENTIONED DATES AND IT'S ONLY VALID AFTER SUCCESSFUL SURVEILLANCE WITH CONTINUATION LETTER ISSUED BY CCPL.

CHAIRMAN

Care Certification Private Limited

CERTIFICATE

Registered CCPL

Registration Certificate

This is to certify that
The Quality Management System
Of

BIGETA ENERGY SOLUTION LLP

Carried out at following site:

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ISO 9001:2015

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IAF CODE - 35

CERTIFICATE NO. : CCPL/E/QMS/A1020
ISSUED ON : 18/08/2023 1ST SURVEILLANCE DUE ON: 18/07/2024
VALIDITY DATE : 17/08/2026 2ND SURVEILLANCE DUE ON: 18/07/2025

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CHAIRMAN

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9.2 Authorised Certificates of the Auditors

Mr. Benet George V (BEE Accredited Energy AuditorAE0053 & IGBC AP200352)

BUREAU OF ENERGY EFFICIENCY

Certificate of Accreditation

bsi.

BSI Training Academy

Certificate of achievement

Benet George V

has attended and passed the required assessment

CQI and IRCA Certified ISO 50001:2018 Auditor Transition (Energy Management Systems) Training Course (PT260)

Premanand Ramakrishnan, Director Assurance

Date: 01/05/2020 - 02/05/2020 CQI ID: 248409

Certificate Number: EMR 00709168

Course number 2084 certified by CQI and IRCA

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IGBC

CII Confederation of Indian Industry

The Indian Green Building Council

hereby certifies that

Benet George V

has successfully demonstrated knowledge on the Green Building Design & Construction, Building Standards & Codes, IGBC Resources & Processes and Green Design Strategies & their Impacts.

required to be awarded the title of

IGBC Accredited Professional

K S Venkatagiri
Executive Director
CII-Godrej GBC

V Suresh
Chairman
Indian Green Building Council

Gurmit Singh Arora
Vice-Chairman
Indian Green Building Council

206352

17 October 2020

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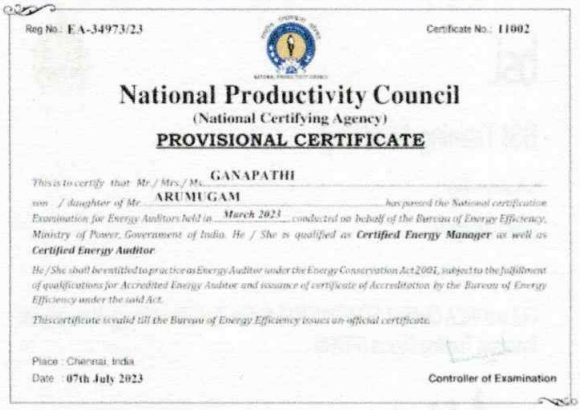
Dr. Ganapathi A (BEE Certified Energy Auditor EA-34973/23 & IGBC AP232185)



Reg No.: EA-34973/23 Certificate No.: 11002

National Productivity Council
(National Certifying Agency)
PROVISIONAL CERTIFICATE

This is to certify that Mr./Mrs./Ms. GANAPATHI
son / daughter of Mr. ARUMUGAM has passed the National certification Examination for Energy Auditors held in March 2023 conducted on behalf of the Bureau of Energy Efficiency, Ministry of Power, Government of India. He / She is qualified as ***Certified Energy Manager*** as well as ***Certified Energy Auditor***.

He/She shall be entitled to practice as Energy Auditor under the Energy Conservation Act 2001, subject to the fulfillment of qualifications for Accredited Energy Auditor and issuance of certificate of Accreditation by the Bureau of Energy Efficiency under the said Act.

This certificate is valid till the Bureau of Energy Efficiency issues an official certificate.

Place : Chennai, India
Date : 07th July 2023 Controller of Examination

IGBC

CII Confederation of Indian Industry

The Indian Green Building Council

hereby certifies that

Ganapathi Arumugam

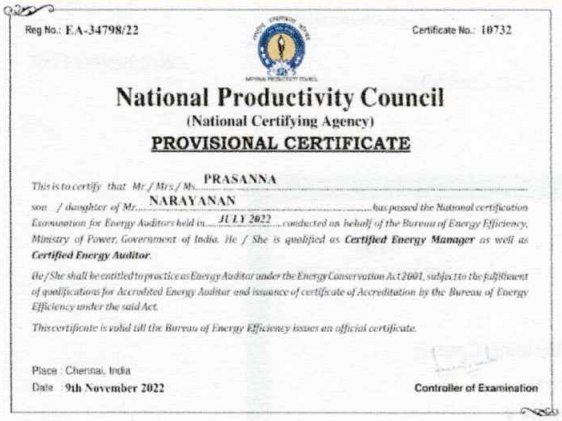
has successfully demonstrated knowledge on the Green Building Design & Construction, Building Standards & Codes, IGBC Resources & Processes and Green Design Strategies & their impacts, required to be awarded the title of

IGBC Accredited Professional

K S Venkatagiri, Executive Director, CII-Godrej GBC
Gurmit Singh Arora, Chairman, Indian Green Building Council
Mr. B Thiagarajan, Vice Chairman, Indian Green Building Council

IGBC AP232185 18 November 2022

Mr.N. Prasanna (BEE Certified Energy Auditor EA-34798/22 & IGBC AP232159)



Reg No.: EA-34798/22 Certificate No.: 10732

National Productivity Council
(National Certifying Agency)
PROVISIONAL CERTIFICATE

This is to certify that Mr./Mrs./Ms. PRASANNA
son / daughter of Mr. NARAYANAN has passed the National certification Examination for Energy Auditors held in JULY 2022 conducted on behalf of the Bureau of Energy Efficiency, Ministry of Power, Government of India. He / She is qualified as ***Certified Energy Manager*** as well as ***Certified Energy Auditor***.

He/She shall be entitled to practice as Energy Auditor under the Energy Conservation Act 2001, subject to the fulfillment of qualifications for Accredited Energy Auditor and issuance of certificate of Accreditation by the Bureau of Energy Efficiency under the said Act.

This certificate is valid till the Bureau of Energy Efficiency issues an official certificate.

Place : Chennai, India
Date : 9th November 2022 Controller of Examination

IGBC

CII Confederation of Indian Industry

The Indian Green Building Council

hereby certifies that

Prasanna N

has successfully demonstrated knowledge on the Green Building Design & Construction, Building Standards & Codes, IGBC Resources & Processes and Green Design Strategies & their impacts, required to be awarded the title of

IGBC Accredited Professional

K S Venkatagiri, Executive Director, CII-Godrej GBC
Gurmit Singh Arora, Chairman, Indian Green Building Council
Mr. B Thiagarajan, Vice Chairman, Indian Green Building Council

IGBC AP232159 21 October 2022

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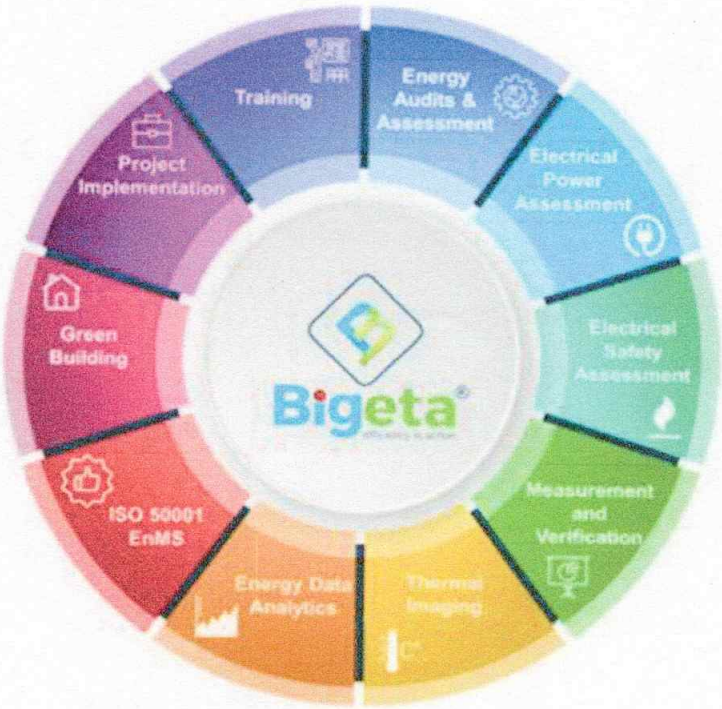

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Registered Office

Bigeta Energy Solutions LLP

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