ENERGY AND GREEN AUDIT REPORT

MARCH 2025

Prepared for:

THE ICFAI FOUNDATION FOR HIGHER EDUCATION (IFHE)

Donthanapally, Shankarapalli Road,
Hyderabad - 501203

Prepared By:

Bigeta Energy Solutions LLP

Bengaluru, Karnataka - 560102

Acknowledgement

Bigeta Energy Solutions is thankful to The ICFAI Foundation for Higher Education, Hyderabad for providing us an opportunity to conduct a Green and Energy audit at their university located in Survey No. 156/157, IFHE-IBS Campus, Donthanapally, Shankarapalli Road, Hyderabad, Telangana 501203. We are grateful to Dr. Sindhuja Menon – Dean IQAC, Col. S.P. Viswanath (Retd) – Director (Administration), Madika Mahender – Chief Engineer, P.V.A. Chandramouli – Deputy Manager 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.

BENET GEORGE VADAKKEMULANJANAL

Digitally signed by BENET GEORGE VADAKKEMULANJANAL
Date: 2025.04.08 16:34:57 +05'30'

In case of any suggestions or queries:

Bigeta Energy Solutions LLP

Mr. Benet George V

BEE Accredited Energy Auditor

Email: benet@bigetaenergy.com

Mobile- +91 99005 91000

3rd Floor, 403, 15th Cross,

5th Main, Sector 6, HSR Layout,

Bengaluru 560102.

Contents

List of Tables

List of Figures

List of abbreviations

ACU	-	Air Conditioning Unit
AHU	-	Air Handling Unit
AIU	-	Association of Indian Universities
ASHRAE	-	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BLDC	-	Brushless Direct Current (Motor)
CD	-	Contract demand
CEA	-	Central Electricity Authority
CFL	-	Compact Fluorescent Lamp
CT	-	Cooling Tower
DG	-	Diesel Generator
DO	-	Dissolved Oxygen
EB	-	Electricity Board
EC fans	-	Electronically Commutated Fans
ETP	-	Effluent Treatment Plant
EV	-	Electric Vehicle
FOL	-	Foot Overhead Lighting
FRP	-	Fiberglass Reinforced Plastic
FSC	-	Forest Stewardship Council
GHG	-	Greenhouse Gas
GWP	-	Global Warming Potential
HCHO	-	Formaldehyde
HNS	-	Hazardous and Noxious Substances
HT	-	High Tension
HVAC	-	Heating, Ventilation, and Air Conditioning
IAQ	-	Indoor Air Quality
IFHE	-	ICFAI Foundation for Higher Education
ISO	-	International Organization for Standardization
IT TCS tax	-	Income Tax Tax Collected at Source
LDR	-	Light Dependent Resistor
LED	-	Light Emitting Diode
LPG	-	Liquefied Petroleum Gas
LPF	-	Low Power Factor
LPH	-	Liters Per Hour
LPM	-	Liters Per Minute
LT	-	Low Tension

Mtoe	-	Metric Tons of Oil Equivalent
NBC	-	National Building Code
OSHA	-	Occupational Safety and Health Administration
PF	-	Power factor
PM	-	Particulate Matter
RO	-	Reverse Osmosis
RPM	-	Revolutions Per Minute
RWH	-	Rainwater Harvesting
SEC	-	Specific Energy Consumption
STP	-	Sewage Treatment Plant
TOD	-	Time of Day (Tariff)
TR	-	Tons of Refrigeration
TSSPDCL	-	Telangana State Southern Power Distribution Company Limited
TVOC	-	Total Volatile Organic Compounds
UGC	-	University Grants Commission
VFDs	-	Variable Frequency Drives

List of units & symbol

%	-	Percentage
A	-	Ampere
CO_2e	-	Carbon Dioxide Equivalent
ΔT	-	Temperature Difference
Hz	-	Hertz
hrs	-	Hours
kA	-	Kiloampere
kg	-	Kilogram
kg/cm^2	-	Kilogram per Square Centimetre
kJ/kg/°C	-	Kilojoule per Kilogram per Degree Celsius
kVA	-	Kilovolt-Ampere
kVAh	-	Kilovolt-Ampere Hour
kVAr	-	Kilovolt-Ampere Reactive
kW	-	Kilowatt
kW/TR	-	Kilowatt per Ton of Refrigeration
kWh	-	Kilowatt Hour
kWp	-	Kilowatt Peak
KV	-	Kilovolt
m^2	-	Square Meter
m^3	-	Cubic Meter
m^3/hr	-	Cubic Meter per Hour
mg/L	-	Milligram per Liter
mg/m^3	-	Milligram per Cubic Meter
mm	-	Millimetre
mmWC	-	Millimetre Water Column
m/s	-	Meters per Second
MW	-	Megawatt
V	-	Volt
°C	-	Degree Celsius

1.0 Authorised ISO 9001-2015 Certificate of the firm.

CERTIFICATE

Registered
CCPL

Registration Certificate

This is to certify that
The Quality 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 Quality Management System Standard:

ISO 9001:2015

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/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

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

TO VERIFY THE STATUS OF THE CERTIFICATE, PLEASE VISIT IAFSEARCH CERT WEBSITE https://www.iafcertsearch.org/

CHAIRMAN

Registered CCPL | EGAC Accredited CAB X012308 | IAF

Care Certification Private Limited
134A, 2nd Floor, Taimoor Nagar,
New Friends Colony, New Delhi-110065 (India)
www.carecertification.com

This is SINGLE site Certification

The certificate Remains the property of CCPL as Per Certification Audit Contract

2.0 Introduction

The working details of assignment are as follows:

Project	**Energy and Green Audit**
Client	**ICFAI Foundation for Higher Education**
Industry	Educational Institution
Contact	Dr. Sindhuja Menon Dean – IQAC Email: sindhuja.menon@ibsindia.org
Site	ICFAI Foundation for Higher Education, Hyderabad
Consultant	Bigeta Energy Solutions LLP Bangalore, India
Duration	03rd March to 07th March
Project Scope	To conduct Energy and Green audit at ICFAI Foundation for Higher Education
Report	This document gives recommendations, details of findings and the way forward.
Consultants involved	Mr. Benet George V (BEE - Accredited Energy Auditor) Mr. Sujesh Vishwanathan (BEE - Certified Energy Auditor) Mr. Jihin – (Engineer – Energy and Sustainability) Mr. Karthick A – (Engineer – Energy and Sustainability) Mr. Ajith K B – (Engineer – Energy and Sustainability) Mr. Manoj Kumar M B – (Engineer – Energy and Sustainability)
Notes	-The notes are marked in blue. -The suggestions / alternatives in the audit report are based on the present operating conditions of equipment/systems and to the best of our knowledge. -Investment figures are estimated values and recommended to obtain costs from vendors.

2.1 About the college

The ICFAI Foundation for Higher Education (IFHE), located in Donthanapally, Shankarapalli Road, Hyderabad, Telangana, 501203 is a distinguished private deemed-to-be university established under Section 3 of the UGC Act, 1956, founded in 1984 by N.J. Yasaswy. ICFAI has established 11 Universities across India. IFHE is one of India's leading multidisciplinary universities, offering a student-centric learning approach that integrates knowledge, practical skills, and a positive attitude. IFHE is a member of the Association of Indian Universities (AIU) and the Association of Commonwealth Universities (ACU).

More than 7125 students are currently pursuing in the fields of Business School, Tech School, Law School, School of Architecture, and School of Social Sciences.

The university is getting power from the Southern Power Distribution Company of Telangana Limited. Electricity is received at 33 kV, and two 2000 kVA transformers are installed in the university to step down the incoming 33 kV. Other than the EB power supply, there are three DGs of 750 kVA, 1010 kVA, and 1500 kVA in the university to generate power in case of an EB power failure.

Major Loads in the University:

- Chillers
- AHU’s
- Fans and Lights
- Air Conditioners
- UPS
- Computers
- Pumps
- Projector

The ICFAI university has 7,125 students enrolled across the Business School, Tech School, Law School, School of Architecture, and School of Social Sciences. There are 404 faculty members.

1.2 Vision and mission

Vision

The vision of the University is to emerge as a university of excellence known for research, teaching and practice.

To be a top-ranking private university of choice for students, staff, and corporates, recognized for excellence in Higher Education and Research specially relevant to social needs.

Mission

The mission of the University is 'Learning for Leadership'. It aims at developing a cadre of professionals possessing specialized skills having a sense of social and moral responsibility and the ability to address problems from a broader perspective.

The mission of the University is to offer world class, innovative, career-oriented professional postgraduate and undergraduate programs through inclusive technology-aided pedagogies to equip students with the requisite professional and life skills as well as social sensitivity and high sense of ethics. The University will strive to create an intellectually stimulating environment for Research, particularly into areas bearing on the socio-economic and cultural development of the state and the nation.

1.3 Infrastructure

Figure 1. Location of college

The college has a total built-up area of 367526 m^2 (90.8 acres), and it has all of the necessary physical amenities.

1.4 Energy and green audit

From March 03rd to 07th, 2025, a detailed energy and green 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, analysed, and planned for fieldwork. Based on the initial details, five days of fieldwork are planned.

Phase 2 - Fieldwork 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 fieldwork.

Figure 2. Opening meeting

Phase 3 – Closing Meeting

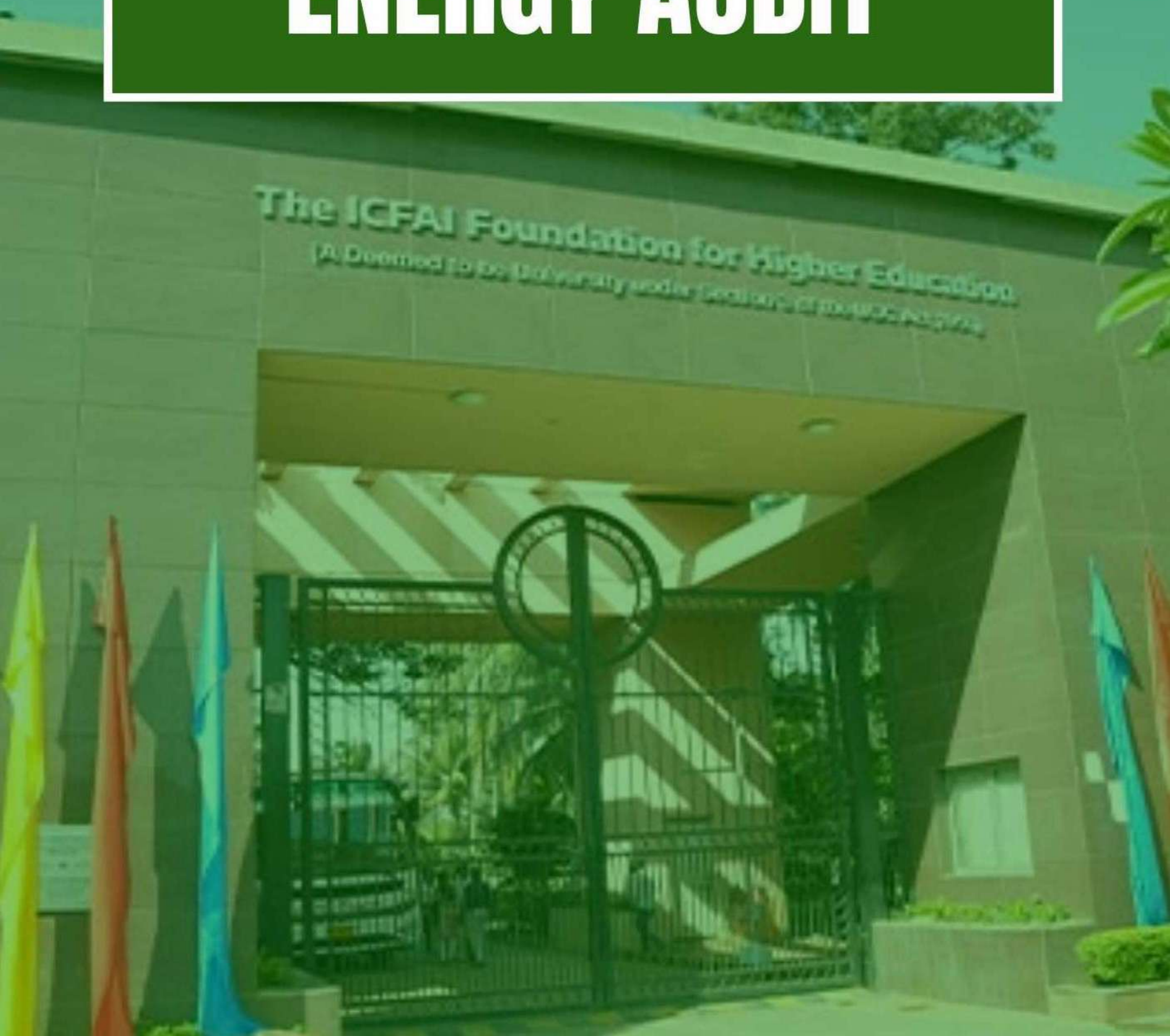
Important findings from five days of exhaustive field data collection were reviewed and deliberated with stakeholders at the conclusion of the Energy and Green Audit. Audit findings, energy consumption trends, environmental impact, and potential green initiatives were subject to substantial discussion 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.

ENERGY AUDIT



3.0 Energy Audit

An energy audit is a structured process involving the systematic inspection, survey, and analysis of energy flows within a building, industrial process, or system. Its primary objective is to identify opportunities to reduce energy consumption without negatively impacting operational output, occupant comfort, health, or safety. The audit provides a comprehensive assessment of how energy is consumed within a facility, alongside an evaluation of the associated costs. It aims to uncover inefficiencies and recommend strategies to optimize energy use, thereby lowering operating expenses and reducing energy consumption per unit of output. Moreover, the energy audit establishes a critical benchmark for energy performance management, serving as a foundational tool for developing and implementing more effective energy efficiency measures. By conducting a thorough energy audit, organizations can enhance overall system efficiency, improve operational sustainability, and contribute to long-term energy cost savings.

3.1 Executive summary

3.1.1 Highlights

Total annual cost savings	=	126	Rs. Lakhs
Total investments	=	205	Rs. Lakhs
Overall Simple payback period	=	20	Months
Annual Electrical Energy Consumption	=	77,17,140	kVAh
Annual Electricity cost	=	738	Rs. Lakhs
Annual Water Consumption	=	3,21,219	m^3/annum

3.2 Impact of proposed energy and water conservation measures

Electricity Savings	=	12,12,403	kVAh/annum
	=	15.7	%
Water Savings	=	43,793	m^3/annum
	=	13.6	%
CO_2 reduction	=	864	Tonnes/annum
	=	10.2	%

3.3 Summary of energy and water conservation measures

Table 1. Summary of energy and water conservation measures

S. No	Energy Conservation Measures	Annual Savings				Investment	Simple payback period
		Electricity	Water	Electricity	Water	Rs. Lakhs	Months
		kVAh	m^3	Rs. Lakhs	Rs. Lakhs		
0-6 Months Payback							
1	**Switch off the chiller 30 minute before actual operation** Turn off the chiller 30 minutes before the actual shutdown time while keeping the respective chiller pump running. This allows for the effective utilization of the already generated chilled water, reducing energy wastage and improving overall system efficiency.	31648	-	2.68	-	Nil	Immediate
2	**Start the chiller operation 30 minute after the actual operational time.** Gradually delay the chiller operation by 30 minutes using a trial-and-error approach to optimize the chiller energy consumption.	18528	-	1.57	-	Nil	Immediate
3	**Adjusting the flow reduction valve for reducing the domestic water use** The facility has 1,440 lavatory taps installed throughout various sections. Adjusting the flow controllers to the standard rate of 1.9 LPM can significantly reduce water consumption, enhance efficiency, and lower operational costs.	-	2107	-	0.43	Nil	Immediate
4	**Increase contract demand** The Institute is powered by two 2000 kVA transformers, supplying electricity to the entire campus. Increasing the contract demand to 2200 kVA can help avoid excess demand charges, reduce penalty costs, and improve overall power management efficiency.	-	-	6	-	Nil	Immediate

S. No	Energy Conservation Measures	Annual Savings				Investment	Simple payback period
		Electricity	Water	Electricity	Water	Rs. Lakhs	Months
		kVAh	m^3	Rs. Lakhs	Rs. Lakhs		
5	**Operate pumps during off peak hours of billing (TOD)** The facility operates 23 borewell pumps, divided into two sets of 11 and 10 pumps, along with two transfer pumps (one currently in operation). Optimizing pump operation during off-peak billing hours can significantly reduce electricity costs, improving energy efficiency and lowering operational expenses.	-	-	1.35	-	Nil	Immediate
6	**Water efficient high-pressure nozzle for canteen** The canteen uses two taps for big vessel cleaning, operating for approximately 3 hours daily. Installing high-pressure water nozzles can significantly reduce water consumption, enhance cleaning efficiency, and lower operational costs.	-	883	-	0.18	0.04	3
7	**Chiller pump operational optimization** Integrate an interlock between the chiller pumps and chillers to optimize pump operation. This ensures that a pump runs only when its corresponding chiller is in operation, maintaining the required flow and eliminating unnecessary pump operation.	55505	-	4.7	-	2.5	6
8	**Condenser pump operational optimization** Interlock between the condenser pumps and chillers to optimize pump operation. This will ensure that each condenser pump runs only when its corresponding chiller is in operation, maintaining the required flow and preventing unnecessary pump operation.	37324	-	3.16	-	1.5	6
7-12 Months Payback							
9	**Chiller flow optimization** Each 374 TR chiller requires one primary pump for operation, with a required flow rate of 195 m^3/hr. Two chiller pumps are supplying chilled water to three operating chillers, even though one chiller is not in operation. This imbalance reduces the flow	31669	-	2.68	-	2	9

S. No	Energy Conservation Measures	Annual Savings				Investment	Simple payback period
		Electricity	Water	Electricity	Water	Rs. Lakhs	Months
		kVAh	m^3	Rs. Lakhs	Rs. Lakhs		
	rate in the operating chillers, leading to a decline in cooling capacity.						
10	**Changing of metal cooling tower fan to FRP blade** The motor load can be reduced by replacing the heavy metal blades with lighter material. Switching to FRP blades can improve efficiency and lead to 15% to 30% power savings, reducing overall energy consumption.	11698	-	0.99	-	1	12
13-24 Months Payback							
11	**Regular cleaning and maintenance of cooling tower** The effectiveness of the cooling tower is observed to be 35%,43% and 32% respectively for cooling tower 1,2& 3. which is slightly low. The effectiveness can be improved by proper maintenance of fills.	21836	-	1.85	-	2	13
12	**Installation of flush toilet tank bank** The facility has 1,210 water closets installed across various locations. Installing flush toilet tank bank with a reduced flush rate of 6 LPF can significantly reduce water consumption, enhance efficiency, and support overall water conservation efforts.	-	8595.418	-	1.76	1.936	13
13	**Use STP water for flushes** The facility generates an average of 350 m^3/day of treated water from its STP plants. Transitioning from borewell water to STP-treated water for flushing systems can significantly reduce borewell water consumption, enhance water efficiency, and optimize resource utilization.	-	29244	-	6.00	8	16
14	**Install VFD for chiller compressor** Installing a Variable Frequency Drive (VFD) on the chillers allows for precise control of compressor speed based on real-time	50818	-	4.31	-	6	17

S. No	Energy Conservation Measures	Annual Savings				Investment	Simple payback period
		Electricity	Water	Electricity	Water	Rs. Lakhs	Months
		kVAh	m^3	Rs. Lakhs	Rs. Lakhs		
	cooling demand. The seasonal and daily variations in cooling requirements can be efficiently managed using VFD compressor.						
15	**Replacement of street lights with solar** 140 number of street lights are installed in the university campus. Converting the existing street lights with solar will reduce EB power consumption.	-	-	7	-	11.2	19
16	**Conversion of conventional fans with BLDC fans** The university has 2,431 conventional fans across its buildings. Replacing them with BLDC fans can significantly reduce power consumption, enhancing energy efficiency and lowering operational costs.	701446	-	59.44	-	97.24	20
25-36 Months Payback							
17	**Install the additional tanks for overflow in RO reject tank to reduce water overflow** The facility operates 23 RO plants to meet its water treatment needs. Installing additional tanks or increasing the capacity of existing RO reject tanks can significantly reduce water overflow, enhance system efficiency, and minimize water wastage.	-	2963.52	-	0.61	1.32	26
18	**Occupancy sensor for hostel bathroom** Hostel bathroom lights operate continuously even when unoccupied. Installing occupancy sensors can optimize their usage, reducing unnecessary energy consumption and enhancing efficiency.	14481	-	1.23	-	2.88	28
19	**STP blower optimization** The institution operates three Sewage Treatment Plants (STPs) to manage wastewater treatment. Installing Dissolved Oxygen (DO) sensors with Variable Frequency Drives (VFDs) and integrating sensor feedback can significantly reduce energy	59528	-	5	-	12	30

S. No	Energy Conservation Measures	Annual Savings				Investment	Simple payback period
		Electricity	Water	Electricity	Water		
		kVAh	m^3	Rs. Lakhs	Rs. Lakhs	Rs. Lakhs	Months
	consumption, enhance operational efficiency, and optimize wastewater treatment performance.						
20	**Kitchen exhaust fan pulley modification on mess 2** The kitchen exhaust fan, with a motor rated at 9.3 kW, plays a vital role in maintaining air quality and ventilation. Converting the belt-driven system to a direct drive configuration can significantly reduce transmission losses, enhance energy efficiency, and lower operational costs.	7201	-	1	-	1.5	31
>36 Months Payback							
21	**Optimization of cooling tower fans based on basin temperature.** Seasonal temperature variations and morning ambient conditions can be effectively utilized to optimize cooling tower fan operation. By controlling the fan based on basin temperature, unnecessary power consumption can be reduced, improving overall efficiency.	14622	-	1.23	-	4	39
22	**EC fans for AHU** The facility operates 19 belt-driven Air Handling Units (AHUs) across its premises to meet cooling requirements. Retrofitting the four high power-consuming AHUs in the auditorium, IT lab, Library (ground floor), and Library (second floor) with EC fans can significantly reduce power consumption, enhance energy efficiency, and lower operational costs.	14856	-	1	-	4	40
23	**Replace the existing chiller with energy efficient chiller** The SEC of chiller-2 is 1.14 kW/TR which is very high replace with high performance chiller with rated SEC of 0.55 kW/TR. Will reduce the energy consumption in chiller.	138066	-	11.7	-	45	46
24	**Replacement of CFL lamps in mess**	3177	-	0.27	-	1.15	51

S. No	Energy Conservation Measures	Annual Savings				Investment	Simple payback period
		Electricity	Water	Electricity	Water	Rs. Lakhs	Months
		kVAh	m^3	Rs. Lakhs	Rs. Lakhs		
	CFL lamps are currently used in the mess hall. Replacing them with LED lights and integrating LDR (light-dependent resistor) control will optimize operational hours and enhance energy efficiency. Despite ample daylight availability, lights are often left on unnecessarily.						
Total		**12,12,403**	**43,793**	**117**	**9**	**205**	**20**

3.4 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). The annual energy cost of the facility is given as follows:

Table 2. Marginal cost of energy

Description	Unit	Value
Energy consumption	kVAh	5,43,147
Energy Cost	Rs. /kVAh	8
TOD 1 Consumption	kVAh	89,533
TOD-2 consumption	kVAh	90,373
TOD charges	Rs. /kVAh	1
TOD -1 Consumption (Incentive)	kVAh	1,30,450
TOD-2 consumption (Incentive)	kVAh	57,840
TOD charges (Incentive)	Rs. /kVAh	-1.00
Electricity duty	%	6.00%
IT TCS Tax	%	0.10%
Marginal Energy Cost without tax	Rs. /kVAh	7.985
Marginal Energy Cost	Rs. /kVAh	**8.47**

Note: *Marginal energy cost is calculated by considering the average energy consumption of last 3 months

3.5 Good practices

- Chiller is installed in the facility to cater cooling requirement in the IBS block
- VRV system is installed in Faculty of Science and Technology (FST) and new buildings.
- Energy efficient LED lights are installed.
- Effective utilization of natural lights is observed in hostels and admin buildings.
- Heat pump is provided for hot water generation in hostels.
- Timer based operation of lights in hostels.
- Power factor is maintained 0.99 which is very good.
- EV vehicle is used inside campus.
- Most of the conventional fans are replaced with BLDC fans.
- Biogas plant is installed.
- Hydro pneumatic pumps (HNS) are installed for water distribution from sump.
- Dual-flush water closets are installed in the office to optimize water usage.

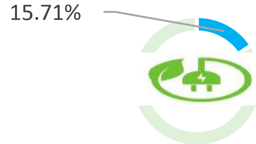
- Water consumption from urinals within the facility remains below the established standards.
- Water metering is implemented at major water source points to monitor and manage consumption effectively.
- Rainwater harvesting pits are installed across the facility to enhance groundwater recharge.
- Water usage is categorized into Domestic Water, RO Water, and Recycled Water, enabling efficient allocation based on specific requirements.
- The effluent treatment plant (ETP) processes an average of 350 m^3 of domestic wastewater daily, which is subsequently reused for gardening. The remaining treated water is stored in a pond for future use.
- Water-efficient aerators are installed in taps to minimize water consumption throughout the facility.
- In the RO plant, reject water is repurposed for domestic use, enhancing overall water efficiency.
- All overhead tanks are connected to an automatic control system to regulate water levels and ensure efficient distribution.

Figure 4. Good practices in the facility

3.6 Carbon emission reduction through ECM

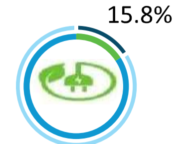
Figure 5. Carbon emission reduction through ECM

Annual electrical savings



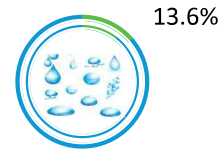
15.71% annual electrical savings can be achieved through implementation of energy conservation measures.

Annual electricity cost savings



15.8% annual electricity cost savings can be achieved through implementation of energy conservation measures.

Annual water savings



13.6% Net water consumption reduction can be achieved through implementation of water conservation measures.

Annual cost savings

14.3% annual energy cost savings can be achieved through implementation of energy conservation measures.

Net carbon reduction

10.2% Net annual carbon reduction can be achieved through implementation of energy conservation measures.

3.7 Summary of carbon footprint

The carbon footprint assessment for IFHE, Hyderabad encompasses both Scope 1 and Scope 2 emissions. Scope 1 emissions originate from direct sources, including the combustion of carbon-containing fuels in stationary equipment (such as diesel generators) and mobile equipment (like buses and tractors), as well as the combustion of LPG for facility heating and CO2 releases from fire extinguishers. Scope 2 emissions reflect indirect greenhouse gas emissions from purchased electricity, which constitutes the primary source of energy consumption across facilities. Emission calculations were derived from verified utility data and meter readings, applying recognized emission factors from CEA 2024. The table presenting the carbon footprint is provided below.

Table 3. Total carbon footprint

S No	Description	Type of Fuel and their CO_2 Conversion Process			
		Fuel Consumption			
		Electricity kWh	Diesel generator	LPG	Vehicle fuel
1	Total Annual Consumption	7717140	1151	65020	15955
2	CO2 Emission (Tons/Annum)	5610	2275	659	52.5
3	Total CO2 Emission (Tons/Annum)				8597 (↑)
4	No. of Matured Trees Available				3107
5	CO_2 offset due to Trees (Tons/Annum)				363.03 (↓)
6	CO_2 Emission per (Tons/Annum) currently				8234 (↑)
7	Expected Reduction of Annual Electricity Consumption after Implementing Proposed Energy Conservation Measures (kWh)				1200279
8	CO_2 offset after implementing ECM (Tons/Annum)				864 (↓)
9	Net CO_2 emission				7370 (↑)

4.0 Energy Conservation Measures (ECM)

4.1 Chiller system

4.1.1 Chiller flow optimization

Background

The university has installed four Dunham-Bush chillers, each with a capacity of 374 TR, to meet the cooling requirements of the IBS block. Each chiller is equipped with two compressors that operate based on the cooling temperature demand. The chiller pump has a rated capacity of 221 m^3/hr at a head of 36 m, driven by a 37kW motor. Two chiller pumps operate continuously throughout the chiller operation. The condenser pump is powered by a 37kW motor and has a rated capacity of 294.8 m^3/hr at a head of 24.2 m. Two condenser pumps operate continuously throughout.

Findings

- Each 374 TR chiller requires one primary pump for operation, with a required flow rate of 209 m^3/hr.
- Two chiller pumps are supplying chilled water to three chillers, even though one chiller is not in operation. This imbalance reduces the flow rate in the operating chillers, leading to a decline in cooling capacity.
- Actual chilled water flow in chiller-2,3&4 are 122m^3/hr,129 m^3/hr and 145m^3/hr respectively.

Recommendation

- Close the evaporator valve of the non-operating chiller to prevent the mixing of non-chilled return water with the chilled water.

Benefit

Cost-benefit analysis is given in the table below

Table 4. Cost-benefit analysis of chiller flow optimization

Description	Unit	Values
Present system		
Cooling capacity of single chiller	TR	374
Rated chiller SEC	kW/TR	0.61
Actual flow requirement for chiller	m^3/hr	209
Present flow in chiller-2	m^3/hr	122

Description	Unit	Values
Chiller outlet temperature	°C	11
Average power consumption in chiller-2	kW	92
Present flow in chiller-3	m^3/hr	129
Chiller outlet temperature	°C	8.0
Average power consumption in chiller-3	kW	113
Present flow in chiller-4	m^3/hr	143
Chiller outlet temperature	°C	7.5
Average power consumption in chiller-4	kW	124
Daily operating hours	hrs	11
Annual operating days	days	280
Proposal		
Close evaporator valve of non-operational chiller		
Total water flow rate	m^3/hr	394
Temperature of chilled water after mixing	°C	8.7
Change in temperature in chiller 3 after flow optimization	ΔT	1.2
Change in temperature in chiller 4 after flow optimization	ΔT	0.7
Expected energy savings in chiller by reduction of 1°C	%	4.00
Estimated power savings in chiller-3	%	4.05
Estimated power savings in chiller-4	%	3.0
Estimated power savings in chiller-3	kW	4.6
Estimated power savings in chiller-4	kW	5.7
Total power savings	kW	10.3
Annual energy savings	kWh	31574
	kVAh	31669
Marginal energy cost	Rs. /kVAh	8.47
Annual cost savings	Rs. Lakhs	2.68
Investment	Rs. Lakhs	2
Simple payback period	months	9

4.1.2 Chiller pump operation optimization

Findings

- The maximum cooling demand in the admin block can be met with up to three chillers during peak summer temperatures.

- During winter, the monsoon season, and low cooling demand time like mornings during chiller startup and in the evenings only one chiller is sufficient to meet the cooling requirements. However, two chiller pumps operate continuously, regardless of the number of chillers in use, leading to unnecessary pump operation.

Recommendation

- Integrate an interlock between the chiller pumps and chillers to optimize pump operation. This ensures that a pump runs only when its corresponding chiller is in operation, maintaining the required flow and eliminating unnecessary pump operation.

Benefit

Cost-benefit analysis is given in the table below

Table 5. Cost-benefit analysis of chiller pump operation optimization

Description	Unit	Values
Present system		
Total number of primary pumps	no's	4
Number of pumps in operation per day	no's	2
Estimated operating hours two chiller will be in operation	hrs	6
Daily operating hours of the chiller	hrs	11
Annual operating days	days	280
Average power consumption of chiller pump	kW	39
Proposal		
Pump optimization		
Annual energy savings	kWh	54950
	kVAh	55505
Marginal energy cost	Rs. /kVAh	8.47
Annual cost savings	Rs. Lakhs	4.70
Investment	Rs. Lakhs	2.5
Simple payback period	months	6.4

4.1.3 Condenser pump operation optimization

Findings

- Two condenser pumps operate continuously throughout the chiller operation, regardless of the number of chillers in use, leading to unnecessary pump operation.

Recommendation

- Implement an interlock between the condenser pumps and chillers to optimize pump operation. This will ensure that each condenser pump runs only when its corresponding chiller is in operation, maintaining the required flow and preventing unnecessary pump operation.

Benefit

Cost-benefit analysis is given in the table below

Table 6. Cost-benefit analysis of condenser pump operation optimization

Description	Unit	Values
Present system		
Total number of condenser pump	no's	4
Number of pumps in operation per day	no's	2
Operating hours two chiller need to run per day	hrs	6
Daily operating hours of chiller	hrs	11
Annual operating days	days	280
Average power consumption of chiller pump	kW	26
Proposal		
Pump optimization		
Annual energy savings	kWh	36951
	kVAh	37324
Marginal energy cost	Rs. /kVAh	8.47
Annual cost savings	Rs. Lakhs	3.16
Investment for interlocking chiller with pump	Rs. Lakhs	1.5
Simple payback period	months	6

4.1.4 VFD for chiller compressor

Findings

- Each 374 TR chiller is equipped with two compressors that are manually operated based on temperature requirements. Manual operation requires continuous monitoring and adjustment to match the cooling demand, which may impact overall system efficiency and responsiveness.

Recommendation

- Installing a Variable Frequency Drive (VFD) on the chillers allows for precise control of compressor speed based on real-time cooling demand. The seasonal and daily variations in cooling requirements can be efficiently managed, ensuring that compressors operate at optimal power levels rather than running at full capacity and when not needed switching off the chiller.

Benefit

Cost-benefit analysis is given in the table below

Table 7. Cost-benefit analysis for installation of VFD for chiller compressor

Description	Unit	Values
Present system		
Chiller cooling capacity	TR	374
Chiller SEC	kW/TR	0.61
Average power consumption in chiller	kW	110
Daily operating hours of chiller	hrs	11
Annual operating days	days	280
Proposal		
Install VFD for compressor		
Estimated energy savings in compressor	%	15%
Estimated power savings	kW	16
Annual chiller energy savings	kWh	50666
	kVAh	50818
Marginal energy cost	Rs. /kVAh	8.47
Annual cost savings	Rs. Lakhs	4.31
Investment	Rs. Lakhs	6
Simple payback period	months	17

4.1.5 Switch off the chiller 30 minutes before the actual shutdown

Background

The operation of the chiller will start from 6.30 AM and the chiller will switch off at 5.30 PM during normal working days.

Findings

- The chiller, along with its respective pumps and cooling tower fans, switches on simultaneously.

- During the shutdown period, the chilled water temperature remains between 10°C and 11°C. However, shutting down the chiller and pumps at the same time prevents the effective utilization of the cooling already generated, leading to potential energy wastage

Recommendation

- Turn off the chiller 30 minutes before the actual shutdown time while keeping the respective chiller pump running. This allows for the effective utilization of the already generated chilled water, reducing energy wastage and improving overall system efficiency

Benefits

Cost-benefit analysis is given in the table below

Table 8. Cost-benefit analysis of switching off the chiller 30 minutes before actual shutdown

Description	Unit	Values
Present system		
Number of chillers in operation	no's	2
Average power consumption in two chillers	kW	102.5
Annual operating days	days	280
Average cooling tower power consumption	kW	9.4
Number of CT in operation	no's	2
Daily operating hours	hrs	11
Proposed system- swich of all chiller 30 minutes before actual operational hours for effective utilization of chilled water		
Annual energy savings	kWh	31332
	kVAh	31648
Marginal energy cost	Rs. /kVAh	8.47
Annual cost savings	Rs. Lakhs	2.68
Investment	Rs. Lakhs	Nil
Simple payback period	months	Immediate

4.1.6 Start the chiller operation 30 minutes after the actual operational time

Background

Some rooms in the admin block are equipped with dedicated split AC units for early cooling requirements, while the rest of the admin building is connected to the chiller load. Occupancy in the admin block typically starts around 9:30 AM, with cooling required until 5:30 PM.

Findings

- Currently, the chiller starts operating at 6:30 AM, even though the actual cooling demand begins only at 9:30 AM. This results in unnecessary energy consumption during the early hours when cooling is not required.

Recommendation

- Gradually delay the chiller operation by 30 minutes using a trial-and-error approach. If the cooling requirement is still met with this adjustment, further extend the delay incrementally up to 1 hour to optimize energy usage without compromising comfort.

Benefit

Cost-benefit analysis is given in the table below

Table 9. Cost-benefit analysis of starting chiller operation 30 minutes after actual operational time

Description	Unit	Values
Present system		
Number of chillers in operation	no's	2
Average power consumption in two chillers	kW	66
Annual operating days	days	280
Daily operating hours	hrs	11
Proposed system- switch ON the chiller after 8.00 Am		
Annual energy savings	kWh	18343
	kVAh	18528
Marginal energy cost	Rs. /kVAh	8.47
Annual cost savings	Rs. Lakhs	1.57
Investment	Rs. Lakhs	Nil
Simple payback period	months	Immediate

4.1.7 Chiller-2 replacement

Background

Currently installed screw chiller has a rated **Specific Energy Consumption (SEC)** of **0.61 kW/TR**.

Findings

- At present average SEC of the chiller is 0.99 kW/TR.

Recommendation

- Replace the existing chiller with in an energy efficient chiller with rated SEC of 0.55 kW/TR.

Benefit

Cost-benefit analysis is given in the table below

Table 10. Cost-benefit analysis for chiller replacement

Description	Unit	Values
Present system		
Chiller cooling capacity	TR	374
Chiller SEC	kW/TR	0.61
Present SEC of chiller	kW/TR	1.14
Actual power consumption in chiller	kW	92
Daily operating hours	hrs	11
Annual operating days	days	280
Proposal		
Replace the existing chiller with high efficient chiller		
Estimated SEC of chiller	kW/TR	0.55
Percentage improvement in efficiency	%	48%
Annual power savings	kW	44.4
Annual energy savings	kWh	136685
	kVAh	138066
Marginal energy cost	Rs. /kVAh	8.47
Annual cost savings	Rs. Lakhs	11.70
Investment	Rs. Lakhs	45
Simple payback period	months	46

4.2 Cooling Tower

4.2.1 Regular cleaning and maintenance of cooling tower

Background

The university has installed three induced draft cooling towers for condenser water heat rejection. The cooling towers begin operation simultaneously with the chiller.

Findings

- Two cooling tower fans operate continuously, with water circulating through all cooling towers.
- Each cooling tower motor has a rated capacity of 10 kW and is an IE2 motor with 89% efficiency.
- Algae and scale formation is observed in the CT water.
- The effectiveness of the cooling tower is slightly low 35%, 43%, and 32% respectively.

Recommendation

- Maintain the cooling tower fills regularly to improve the effectiveness of the cooling tower.

Benefit

Cost-benefit analysis is given in the table below

Table 11. Cost-benefit analysis of regular cleaning and maintenance of cooling tower

Description	Unit	Values
Present system		
Present cooling tower effectiveness	%	32%
Range of cooling	°C	2
Approach of cooling tower	°C	4.3
Average basin temperature	°C	26.2
Ambient wet bulb temperature	°C	22
Average power consumption in chiller	kW	110
Daily operating hours	hrs	11
Annual operating days	days	280
Proposal		
Cooling tower fills cleaning		
Estimated basin temperature after maintenance	°C	23
Estimated effectiveness of cooling tower by cleaning of fills	%	57%
Change in temperature in cooling tower basin temperature	°C	3.2
Estimated power savings in chiller compressor (1°C reduction 3 to 4%)	%	6.4
Annual energy savings	kWh	21617
	kVAh	21836
Marginal energy cost	Rs. /kVAh	8.47
Annual cost savings	Rs. Lakhs	1.85
Investment	Rs. Lakhs	2
Simple payback period	months	13

4.2.2 Changing cooling tower fan to FRP blade

Findings

- The current cooling tower is equipped with metal blades, which have a high weight. The increased weight of the blades may contribute to higher energy consumption, increased wear and tear on the motor, and reduced overall efficiency of the cooling tower fan operation

Recommendation

- The motor load can be reduced by replacing the heavy metal blades with lighter material. Switching to FRP (Fiberglass Reinforced Plastic) blades can improve efficiency and lead to 15% to 30% power savings, reducing overall energy consumption and operational costs.

Benefit

Cost-benefit analysis is given in the table below

Table 12. Cost-benefit analysis of changing the cooling tower fan to FRP blade

Description	Unit	Values
Present system		
Number of cooling tower	no's	3
Total number of cooling tower in operation	no's	2
Rated motor power consumption	kW	10
Daily operating hours	hrs	11
Annual operating days	days	280
Actual power consumption (Average of 3 CT)	kW	9.4
Proposal		
Replacement of cooling tower fans with FRP blade		
Estimated energy savings in cooling tower by replacing the CT fans	%	20%
Annual power savings from two cooling tower	kW	3.76
Annual energy consumption	kWh	11581
	kVAh	11698
Marginal energy cost	Rs. /kVAh	8.47
Annual cost savings	Rs. Lakhs	0.99
Investment	Rs. Lakhs	1
Simple payback period	months	12

4.2.3 Optimization of cooling tower fans based on basin temperature

Findings

- Two cooling towers operate continuously without any control over the operation of the cooling tower fans.

Recommendation

- Seasonal variations in ambient temperature and morning cooling tower operation can be optimized by regulating the cooling tower fan based on the cooling tower basin temperature. The cooling tower will switch off when the basin temperature reaches 24°C and will restart when the temperature rises above 24°C.

Benefit

Cost-benefit analysis is given in the table below

Table 13. Cost-benefit analysis of optimizing cooling tower fans based on basin temperature

Description	Unit	Values
Present system		
Number of cooling tower	no's	3
Daily operating hours	hrs	11
Annual operating days	days	280
Actual power consumption (Average of 3 CT)	kW	9.4
Daily operating hours	hrs	11
Annual operating days	days	280
Operating frequency of CT fan	Hz	50
Proposal		
Operation of Cooling tower based on basin temperature		
The temperature range observed in the cooling tower basin	°C	22°C to 29°C
Estimated energy savings in cooling tower after installation of VFD operated based on basin water temperature	%	25%
Estimated power savings in three cooling towers	kW	4.7
Annual energy savings	kWh	14476
	kVAh	14622
Marginal energy cost	Rs. /kVAh	8.47
Annual cost savings	Rs. Lakhs	1.23

Description	Unit	Values
Investment	Rs. Lakhs	4
Simple payback period	months	39

4.3 AHU

4.3.1 Conversion of belt-driven fan to EC Fan

Background

The facility operates a total of 19 Air Handling Units (AHUs) to meet its cooling requirements. Among these, four AHUs located in the auditorium, IT lab, Library (ground floor), and Library (second floor) are identified as high power-consuming units.

Findings

An analysis of the AHUs revealed that all the cooling units in the auditorium, IT lab, Library (ground floor), and Library (second floor) are equipped with belt-driven fans. The recorded power consumption of these AHUs is 4.56 kW, 5.8 kW, 4.4 kW, and 4.3 kW, respectively. Belt-driven systems are prone to slip losses, reducing overall efficiency and increasing energy consumption. This inefficiency leads to higher operating costs and greater maintenance demands.

Figure 6. Reference Image for belt-driven AHU

Recommendations

To enhance energy efficiency and reduce maintenance costs, it is recommended to retrofit the existing belt-driven fans with Electronically Commutated (EC) fans. EC fans are more efficient as they eliminate slip losses and provide precise speed control, thereby optimizing energy consumption and improving overall system performance.

Benefits

The cost-benefit analysis for replacing conventional fans with EC fans in AHUs is tabulated below.

Table 14. Cost benefit analysis of conversion of belt-driven fan to EC fan

Description	Unit	Auditorium	IT Lab	Library (Ground Floor)	Library (Second Floor)
Present system					
Number of units	no’s	1	1	1	1
Motor Power	kW	9	6	8	8
Average Operating hours in a day	hrs	8.0	8.0	8.0	8.0
Annual operating days	days	280	280	280	280
Measured Power	kW	4.26	5.8	4.4	4.3
Measured air flow rate in AHU	CFM	22716	16467	3267	2903
Annual energy consumption	kWh/annum	9542.4	12992	9856	9632
Proposed system					
Expected energy savings after installing EC fans	%	35%			
Estimated annual energy savings	kWh	3340	4547	3450	3371
	kVAh	14856			
Marginal Energy Cost	Rs. /kVAh	8.47			
Estimated annual cost savings	Rs. Lakhs	1			
Estimated investment for EC fans	Rs. Lakhs	4			
Simple payback period	Months	38			

4.4 Kitchen

4.4.1 Conversion from belt drive to direct drive for kitchen exhaust fan

Background

The kitchen exhaust fan plays a crucial role in maintaining air quality and ventilation within the kitchen environment. It operates using a motor with a rated capacity of 9.3 kW, which is designed to efficiently handle the fan's load and ensure effective removal of kitchen fumes.

Findings

- The exhaust fan currently operates on a belt-driven system.

❖ The diameters of the driver and driven pulleys are 67 mm and 204 mm, respectively.

❖ Transmission losses due to the belt-driven mechanism contribute to increased energy consumption and operational inefficiency.

Figure 7. Image of belt-driven kitchen exhaust

Recommendation

To improve energy efficiency and reduce operational losses, it is recommended to convert the belt-driven system to a direct drive configuration. This transition will eliminate transmission losses, enhance mechanical efficiency, and reduce wear and tear. Additionally, integrating a Variable Frequency Drive (VFD) will enable precise control of fan speed based on actual ventilation requirements, leading to further energy and cost savings. This upgrade is expected to result in approximately 5% energy savings from the direct drive conversion and additional savings from optimized VFD operation.

Benefit

The detailed cost-benefit analysis for converting the exhaust fan to a direct drive system and integrating a VFD is presented in the table below.

Table 15. Conversion from belt drive to direct drive for kitchen exhaust fan

Description	Unit	Exhaust fan
Present system: Driver pulley is smaller than driven pulley for lowering the rotational speed ratio		
Rated power of motor	kW	9.3
Rated motor RPM	rpm	1450
Driver (Motor) Pulley Size	mm	67
Driven (Fan) Pulley Size	mm	204

Description	Unit	Exhaust fan
Rotational speed ratio	-	3.0
Present RPM of motor	rpm	1450
Present Power Consumption	kW	9.1
Present Frequency of VFD	Hz	50
Operating hours	hrs/day	4
Annual Operating Hours	hrs/annum	1120
Proposed System: Replace the belt drive system with a direct drive system and integrate with VFD and operate at 35Hz		
Expected energy saving	%	5
Expected operating frequency	Hz	16
Suggested Operating frequency	Hz	35
Expected power saving for direct drive conversion	kWh/annum	0.46
Expected power consumption for installing VFD	kWh	3.2
Expected power saving after installing VFD	kWh/annum	6
Energy Savings	kW	6.4
	kVAh/annum	7201
Energy cost	Rs. /kVAh	8.47
Annual Cost Savings	Rs. Lakhs	1
Investment	Rs. Lakhs	1.5
Payback	Months	30

4.5 STP

4.5.1 Installation of DO sensor with VFD and integration with sensor feedback for the STP

Background

The institution operates three Sewage Treatment Plants (STPs) to manage wastewater treatment. STP 1 and STP 2 are equipped with three blowers each, all manufactured by Everest Blowers, with a rated flow of 250 m^3/hr per blower. STP 3 (new plant) is equipped with two blowers, each with a rated capacity of 100 m^3/hr. These blowers supply air to the water treatment tanks, supporting the biological treatment process.

Findings

- The actual flow rates of STP 1 blowers 1 and 2 are 531 m^3/hr and 517 m^3/hr, with power consumption of 9.5 kW and 7.6 kW, respectively, operating continuously for 24 hours. The third blower remains on standby.
- The actual flow rates of STP 2 blowers 1 and 2 are 495 m^3/hr and 716 m^3/hr, with power consumption of 7.2 kW and 9.4 kW, respectively, operating continuously for 24 hours. The third blower remains on standby.
- The actual flow rates of STP 3 blowers 1 and 2 are 278 m^3/hr and 258 m^3/hr, with power consumption of 2.5 kW and 2.7 kW, respectively, operating for 8 hours. One blower operates while the other remains on standby.
- The Biochemical Oxygen Demand (BOD) levels for STP 1, STP 2, and STP 3 are 6 mg/L, 7 mg/L, and 6 mg/L, respectively.

Recommendation

To enhance operational efficiency and reduce energy consumption, it is recommended to install Dissolved Oxygen (DO) sensors with Variable Frequency Drives (VFDs) and integrate the sensor feedback into the VFD system. This setup will enable real-time monitoring of DO levels and automatically adjust blower speeds to maintain optimal oxygen levels in the aeration tanks. By dynamically controlling blower operation based on DO sensor feedback, energy consumption can be minimized while maintaining effective wastewater treatment.

Benefit

The detailed cost-benefit analysis for installing DO sensors and VFD integration is provided in the table below.

Table 16. Cost benefit analysis for installing DO sensor and VFD integration

Description	Unit	STP 1	STP 2	STP 3
Present system				
Total no of blowers	Nos	3	3	2
Total no of running blowers	Nos	2	2	1
Blower 1 rated power consumption	kW	9.3	9.3	3
Blower 1 actual power consumption	kW	9.5	7.2	2.5
Blower 1 flowrate	m3/h	531	495	278
Blower 2 rated power consumption	kW	9.3	9.3	3
Blower 2 actual power consumption	kW	7.6	9.4	2.7
Blower 2 flowrate	m3/h	517	716	258

Description	Unit	STP 1	STP 2	STP 3
As per STP reports, BOD level	mg/l	6	7	6
Operating Hours	Hrs	24	24	8
Annual Operating days	days	280	280	280
Annual Operating hours	days/annum	6720	6720	2240
Proposed System: Install DO sensor with VFD and integrate the sensor feedback				
Estimated power savings in percentage	%	25%		
Total energy consumption	kWh/annum	114912	111552	11648
Estimated power savings	kVAh /annum	59528		
Marginal energy cost	Rs. /kVAh	8.5		
Total annual cost savings	Rs. Lakhs	5		
Investment	Rs. Lakhs	12		
Payback	Months	29		

4.6 Lighting System

4.6.1 Lighting optimization for boys' hostel – ABCD block bathroom area

Background

In boys' hostels, keeping bathroom lights ON for 24 hours a day is often unnecessary and leads to excessive energy consumption and higher operational costs. Effective lighting in bathrooms is essential to ensure functionality, enhance user experience, and maintain high standards of hygiene and safety. Proper illumination supports daily routines, reduces the risk of accidents, and facilitates easier maintenance, contributing to overall resident satisfaction and cost-effective management.

Findings

- At present, all 10 LED lights in the boys' hostel bathroom remain ON continuously for 24 hours, even during daytime and when the facility is unoccupied, which is unnecessary and results in avoidable energy consumption.
- There are a total of 320 LED lights across the ABCD hostel bathroom. i.e., each floor has 8 restrooms, 2 for each block.

Recommendation

- Install motion/occupancy sensors in the bathroom.
- Management has to create awareness about energy savings among students and staff and provide posters in all classrooms and corridors.

Benefits

Cost-benefit analysis is given in the table below

Table 17. Cost-benefit analysis for installing motion/occupancy sensors for bathrooms in hostel

Description	Unit	Value
Present system for Boy's Hostel Bathroom		
Total no. of bathrooms on each floor	No's	8
Total no. of floors	No's	4
Number of lights in each bathroom	No's	10
Total no. of LED lights in across ABCD Block Bathroom	No's	320
Number of floors ABCD Block	No's	4
Operating Hours	hrs	24
Annual Operating Days	days	280
Annual Energy Consumption	kWh	21504
Proposed system - Installation of LED light with Occupancy sensor		
Number of 10W LED lights connected with Occupancy sensor	no's	320
Expected operating hours lights will be in operation	hrs	8
Annual Energy Consumption	kWh	7168
Annual energy saving	kWh	14336
	kVAh	14481
Marginal Energy cost	Rs. /kVAh	8.47
Estimated annual cost savings	Rs. Lakhs	1.2
Total investment (Rs.3000 per sensor)	Rs. Lakhs	2.88
Simple payback period	months	28

4.6.2 Replacement of existing CFL to LED lights with LDR sensors

Background

Adequate illumination supports visibility and reduces the risk of accidents, contributing to a secure campus. The university has installed LED and CFL lights in mess 1 and mess 2 halls where 22-24 numbers of lights are in ON condition even during daylight.

Findings

- At present, 22-24 LED and CFL lights in Mess 1 and Mess 2 halls remain ON throughout the day, during periods of sufficient natural daylight also, resulting in avoidable energy wastage.
- Lighting systems are not equipped with daylight-responsive controls, leading to continuous operation regardless of ambient light conditions.

Recommendation

- Replace existing CFL lights with energy-efficient LED lights integrated with LDR (Light Dependent Resistor) sensors to enable automatic control based on natural light availability.
- Conduct awareness campaigns on energy conservation for students and staff, supported by informational posters in classrooms, corridors, and common areas to encourage responsible energy behaviour.

Benefits

Cost-benefit analysis is given in the table below

Table 18. Cost-benefit analysis for installing LDR sensors for mess halls

Description	Unit	Value	Value
Present system for Mess-1&2		**Mess-1**	**Mess -2**
Total no. of lights	No's	24	24
Average light fitting wattage	kW	0.018	0.018
Operating Hours	hrs	18	18
Annual Operating Days	days	280	280
Annual Energy Consumption	kWh	2177	2177
Proposed system - CFL to LED lights			
Number of LED lights connected with LDR sensor	no's	24	24
LED lighting wattage	kW	0.01	0.01
Number of LDR sensors required	no's	6	6
Annual Energy Consumption after replacing CFL to LED	kWh	1210	1210
Estimated % of time light will switch off based on light intensity	hrs	5	5
Estimated energy savings by installing LDR sensor	%	28%	28%
Annual energy saving	kWh	1572	1572
	kVAh	1588	1588
Marginal Energy cost	Rs. /kVAh	8.47	8.47

Description	Unit	Value	Value
Estimated annual cost savings	Rs. Lakhs	0.13	0.13
Total investment (2000 per sensor and 250 For LED considering all hall lights)	Rs. Lakhs	0.58	0.58
Simple payback period	months	51	51

4.6.3 Convert the existing street lights to solar-powered

Background

Adequate outdoor lighting is critical for ensuring campus security and enhancing visibility in open areas such as pathways, roads, and entrances. Currently, the university operates a total of 140 conventional street lights that rely entirely on grid electricity. This practice contributes to high energy consumption and increased operational costs.

Findings

- The campus currently has 140 conventional street lights powered by grid electricity, operating for extended hours, resulting in significant energy consumption.
- There is no integration of renewable energy sources in the existing street lighting system, representing a missed opportunity for reducing the university's carbon footprint and operational costs.
- Also **branches of trees** in certain areas are creating less illumination.

Recommendation

- Install solar-based LED street lights to leverage renewable energy, reduce dependence on grid electricity, and promote sustainable campus operations.
- Conduct periodic maintenance and system checks to ensure optimal performance and longevity of solar installations.
- Integrate automatic dusk-to-dawn sensors in solar street lights to ensure efficient operation and energy conservation.
- Clear the branches for proper illumination across all areas.

Benefits

Cost-benefit analysis is given in the table below

Table 19. Cost-benefit analysis for converting existing street lights to solar-powered

Description	Unit	Values
Present system		
Total number of street lights in the university	no's	140
Power consumption	kW	0.6
Daily operating hours	hrs	12
Annual operating days	days	150
Annual power consumption	kWh	80640
	kVAh	81455
Proposal		
Use solar energy street light application		
Marginal energy cost	Rs. /kVAh	8.47
Annual operational cost savings	Rs. Lakhs	7
Investment for solar lights with sensor, battery, and panel	Rs. Lakhs	11.2
Simple payback period	months	19

4.7 Increase the contract demand

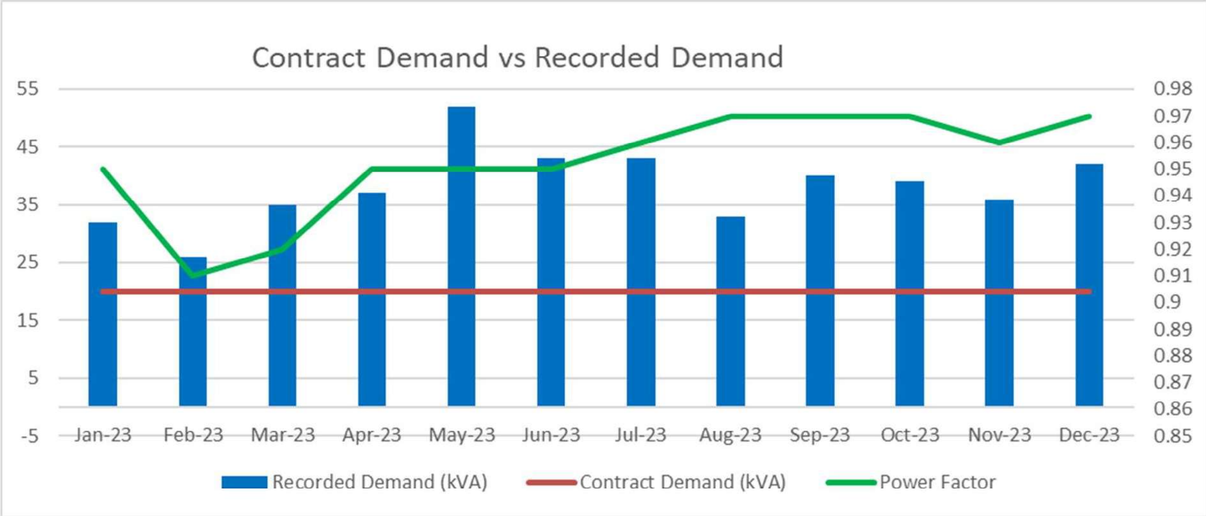
Background

The institute has a two 2000 kVA transformer which supplies power to the entire campus including Business School, Tech School, Law School, School of Architecture, and School of Social Sciences, hostels, canteen, and guest house.

Findings

- The contract demand obtained from TSSPDCL by the college is 2000 kVA.
- An analysis of the electricity bills from March 2024 to February 2025 indicates that the recorded demand exceeded the contract demand in some months.
- The maximum demand recorded was 2281.2 kVA in April 2024.
- The average recorded demand over the last 12 months was approximately 1928 kVA.
- The minimum billing demand is 1600 kVA, which was applicable for four months. Excess billing demand was recorded for five months, while the remaining three months had recorded demand between the minimum and contract demand.

Figure 8. Contract Demand vs Recorded Demand



Recommendation

- To avoid excess demand charges, it is recommended to increase the contract demand to 2200 kVA.
- This adjustment can help reduce penalty charges, resulting in potential savings of up to Rs.6 lakhs per annum.

Benefit

Cost-benefit analysis is given in the table below

Table 20. Cost-benefit analysis of increasing the contract demand

Description	Unit	Value
Present system: contract demand is 2000kVA		
Contract demand (CD)	kVA	2000
Minimum billing demand	kVA	1600
Maximum Recorded demand	kVA	2281
Minimum Recorded demand	kVA	1459
Demand charges upto CD	Rs. /kVA	500
Demand charges above CD (penalty)	Rs. /kVA	950
Total annual exceed demand (for 5 months)	kVA	995.8
Total annual exceed demand charges	Rs. Lakhs	9.460
Proposal system: Increase the contract demand upto 2200kVA		
Proposed contract demand (CD)	kVA	2200
Minimum billing demand	kVA	1760

Description	Unit	Value
Decreased billing demand (for 4 months)	kVA	640
Decreased billing demand Charges	Rs. Lakhs	3.2
Annual cost savings	Rs. Lakhs	6

4.8 Optimizing pump operation during off-peak billing hours

Background

The facility operates a total of 23 borewell pumps, which are divided into two sets — 11 borewell pumps in one set and 10 borewell pumps in the other. Additionally, there are 2 transfer pumps (one of which is in operation) to meet the water supply requirements. Municipal water is also used to fill the sump as part of the institution's water supply system.

Findings

- The pumps are managed by the pump house personnel.
- The borewell and transfer pumps operate for approximately 5 hours per day.
- Currently, all pumps are operated during the evening peak TOD billing hours (7:00 PM to 12:00 AM), which increases operating costs.
- The Time-of-Day (TOD) charges are as follows:
  - Normal TOD: Rs. 8 per kVAh
  - Peak TOD: Rs. 9 per kVAh
  - Incentive TOD: Rs. 7 per kVAh

Recommendation

- It is recommended to shift pump operation to incentive TOD hours (off-peak hours) from 10:00 PM to 6:00 AM as defined by TSSPDCL.
- Operating during incentive TOD hours will reduce electricity costs from Rs.9 per kVAh or 8 per kVAh to Rs. 7 per kVAh, leading to annual savings of approximately Rs. 1.4 lakhs.

Benefit

Cost-benefit analysis of operating pumps during off-peak hours is provided in the table below.

Table 21. Cost-benefit analysis of optimizing pump operation during off-peak billing hours

Description	Unit	Value
Present System		

Description	Unit	Value
Power consumed	kWh	79.645
Total operating hours	hrs/Day	5.00
Operating Time	Time	7-12 pm
Peak time	Time	6-10 pm
Total power consumption	kVAh	402
Total peak time power consumption	kVAh	241
Energy cost	Rs. /kVAh	8.00
Operating energy cost at peak time (6-10 pm)	Rs. /kVAh	9.0
Operating energy cost at after 10 pm	Rs. /kVAh	7.00
Proposed System: Operate pumps only in off peak hours		
Operating Time	Time	Off-Peak Hours
Currently energy consumption cost	Rs. /Day	3298
Switching on after 10pm, energy consumption cost	Rs. /Day	2816
Estimated cost savings	Rs. /Day	483
Annual operating days	days	280
Annual cost savings	Rs. Lakhs	1.4
Investment	Rs. Lakhs	Nil
Simple payback period	months	Immediate

4.9 Onsite solar installation proposal

Background

The facility currently has an average electricity consumption of 632543 kVAh/month. This electricity is sourced from the grid, contributing to GHG emissions.

Findings

- A site assessment has revealed that the facility has ample unused rooftop space, making it suitable for an onsite solar power installation.
- Utilizing this space for solar power generation can significantly reduce dependency on grid electricity, lower operational costs, and support sustainability goals.
- The facility is planning to install a 1 MW solar power plant on its premises.

Recommendations

- Installation of a 1 MW onsite solar power plant to harness renewable energy and transition towards self-sufficiency in electricity consumption.
- Reduction in electricity procurement from the grid, leading to significant cost savings and a lower carbon footprint.
- By implementing this onsite solar project, the facility can significantly enhance its energy efficiency and move toward a more sustainable and environmentally responsible operation.

Benefit

Cost-benefit analysis is given in the table below

Table 22. Cost-benefit analysis of onsite solar installation proposal

Description	Unit	Value
Present system		
Area required for generating 1kW solar system	m^2	10
Area required for generating 1MW solar power	m^2	10000
Estimated capacity for Rooftop system	kWp	1000
Average units generated by 1kW solar system	kWh/day	4
Annual operating days	Days	280
Estimated units generated solar system	kWh/annum	1120000
	kVAh	1123370
Marginal Energy cost	Rs. /kVAh	8.47
Annual Cost savings after installing rooftop solar system	Rs. Lakhs	95.1
Investment only for Solar Roof top installation (MNRE benchmark price 39080/kWp)	Rs. Lakhs	429.9
Simple payback period	months	54

Note: It is a CAPEX project and does not include energy savings.

4.10 Converting existing AC units to VRV units

Background

The university's cooling requirements are met through a combination of chillers, VRV units, and split ACs. Four chillers, each with a capacity of 374 TR, are used in the administrative block, while VRV units serve the Faculty of Science and Technology. Split ACs are installed in the other blocks requiring air conditioning.

Findings

- The specific energy consumption of split AC units is higher than that of VRV units.

Recommendations

- Replacing the existing split ACs with a Variable Refrigerant Volume (VRV) system is recommended to improve energy efficiency, reduce operational costs, and enhance cooling performance. VRV systems use variable-speed compressors that adjust refrigerant flow based on demand, leading to energy savings of 30–40% compared to conventional split ACs.

Benefit

Cost-benefit analysis is given in the table below

Table 23. Cost-benefit analysis of converting existing chiller AC units to VRV units

Description	Unit	Value
Present system		
Total number of split AC considered for converting to VRV system	no's	403
Estimated operating hours of AC (considering minimum operation)	hrs	4
Total design Cooling capacity of existing split AC	TR	1015
Estimated SEC of split AC	kW/TR	1.3
Estimated SEC of VRV units	kW/TR	0.9
Daily operating hours	hrs	11
Annual operating days	days	280
Estimated power consumption from split AC (considering compressor will operate 50% of time only)	kWh	2032030
Proposed system -Replace the existing split AC with VRV units		
Estimated power consumption of VRV units per annum	kWh	1406790
Net energy savings	kWh	625240
	kVAh	631556
Marginal energy cost	Rs. /kVAh	8.47
Annual cost savings	Rs. Lakhs	52.96
Investment	Rs. Lakhs	120.9
Simple payback period	months	27

Note: It is a CAPEX project and does not include energy savings.

5.0 Water Conservation Measures (WCM)

5.1 Conversion to water-efficient pressure nozzle for faucets in canteen

Background

In the canteen, two taps are used to fill a large vessel for cleaning, and subsequently, they are used for cleaning other vessels. These taps operate for approximately 3 hours per day.

Findings

- Each tap has a flow rate of 8.55 LPM (litres per minute).
- Combined, these taps consume approximately 11.5 m^3 of water per day.

Figure 9. Tap photo in canteen

Recommendation

- Install high-pressure water nozzles in the canteen for vessel cleaning.
- High-pressure nozzles operate at lower pressure while maintaining effective cleaning, potentially reducing water consumption by up to 50%.
- This measure will enhance water efficiency and contribute to overall water conservation within the facility.

Figure 10. High-pressure water nozzles

Benefit:

The cost benefit analysis of water efficient pressure nozzle is given below

Table 24. Cost benefit analysis of water efficient pressure nozzle

Description	Unit	Value
Present System		
No of taps for cleaning big vessel in canteen	Nos	2
Flow rate of water	lpm	8.55
Average opening time	mins	180
Water consumption per day	Liters	15395
Annual water consumption	m^3/annum	4311
Water Cost	Rs/m^3	20.5
Proposal		
Install a water efficient high pressure nozzles valves on canteen		
Number of Water taps	Nos.	2
One water efficient high pressure nozzle cost	Rs.	2000
Standard water consumption per day	m^3/day	12.24
Annual standard water consumption	m^3/annum	3427
Annual water savings	m^3/annum	883
Annual water cost savings	Rs. (Lakhs)	0.18
Investment	Rs. (Lakhs)	0.04
Simple payback period	months	3

5.2 Adjusting the flow controller on lavatory taps

Background

The facility is equipped with a total of 2,400 taps, of which approximately 1,440 are installed in lavatories strategically located throughout various sections of the facility.

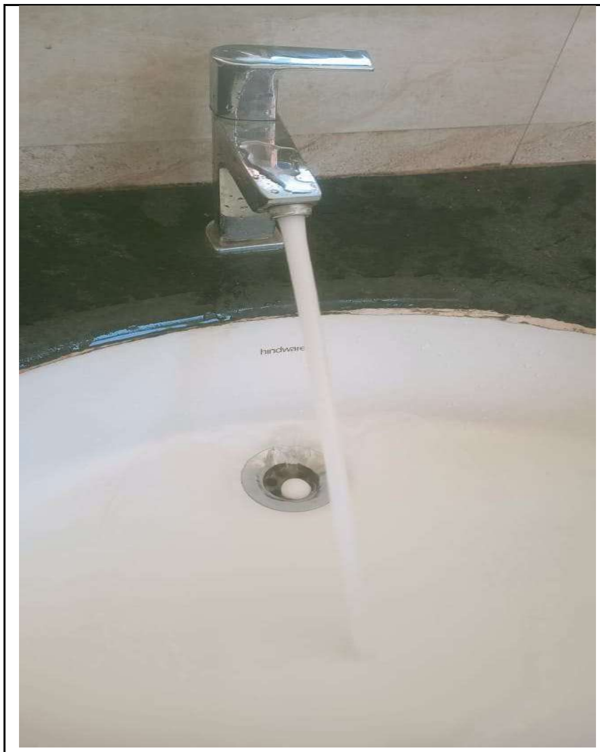
Findings

- Most of the lavatories are equipped with aerators.
- Among the 1,440 lavatory taps, water consumption levels are slightly higher than the standard.
- The current water flow rate for a lavatory tap is 10.5 LPM (Liters per minute).

Recommendation

The current system in some locations shows elevated water consumption levels. Therefore, it is recommended to adjust the flow controllers on the water-efficient taps in each lavatory. The standard requirement for lavatories is 1.9 LPM. Adjusting the flow controllers to this level will help meet the standard and significantly reduce overall water usage throughout the facility.

Figure 11. Lavatory faucet and flow controller



Benefits:

The cost-benefit analysis is shown in the below table

Table 25. *Cost-benefit analysis flow reduction by adjustment of valve.*

Description	Unit	Values
Present system		
Number of taps	-	2400
Number of lavatories (consider 60%)	-	1440
Flow rate of water	litres	10.5
Annual water consumption of lavatory	m^3/annum	2573
Water cost	Rs/m^3	20.52
Proposed System		
Adjusting the water flow control valve at water usage points		
Standard flow rate of water as per UPC	litres/day	1.6625
Annual standard water consumption of lavatory with 1440 taps	m^3/annum	466
Thus, annual excess water consumed in usage points	m^3/annum	2107
Annual cost saving	Rs. (Lakhs)	0.43
Investment	Rs. (Lakhs)	Nil
Simple payback period	months	Immediate

5.3 Installation of flush toilet tank bank

Background

Water closets in the facility are essential for faculty use. The facility has installed 1,210 water closets in various locations to accommodate this need.

Findings

- The facility has approximately 968 water closets with flush tanks, each operating at an average flush rate of 9 litres per flush (LPF).
- Additionally, there are 242 concealed flush tanks with a dual flush mode, averaging 8 LPF.
- According to UPC and NBC guidelines, the recommended maximum flush rate is 6 LPF.

Recommendation

To optimize water usage in water closets, it is recommended to install toilet flush tanks with a reduced flush rate. Aligning with the standard requirements will help reduce water consumption and contribute to overall water conservation.

Figure 12. Flush toilet tank bank

Benefits:

Cost benefit analysis is given in the table below

Table 26. Cost benefit analysis installing flush tank bank in toilet

Description	Unit	Value
Present system		
Total number of water closets	Nos	1210.0
Total water consumption in water closets per day	m^3/day	100.2
Total annual water consumption	m^3/annum	28046.7
Water cost	Rs/m^3	20.5
Proposal		
Install toilet tank bank in flush tank		
Total number of concealed water closets (consider 20%)	Nos.	242
Total number of required flush toilet tank bank	Nos.	968.0
Flush toilet tank bank cost for one piece	Rs.	200.0
After installing water closets consumption	LPM	6.0
Total standard water consumption in water closets per day	m^3/day	69.5
Total annual standard water consumption	m^3/annum	19451.3
Annual water savings	m^3/annum	8595.4
Annual water cost savings	Rs. (Lakhs)	1.8
Investment	Rs. (Lakhs)	1.9
Simple payback period	months	13

5.4 Installation of additional tanks or capacity adjustment for RO reject tank overflow

Background

The facility operates 23 RO plants to meet its water treatment requirements, playing a crucial role in supplying treated water for both domestic and operational needs. The system includes 10 RO plants with a capacity of 1000 LPH (Liters per hour), 12 RO plants with a capacity of 500 LPH, and 1 RO plant with a capacity of 250 LPH. Although the system is equipped with controls to manage water overflow, certain issues related to reject tank overflow were identified during the audit.

Findings

- During the audit, it was observed that the reject tank of the 1000 LPH RO plant in Mess 2 overflows at a rate of 18 LPM (litres per minute).
- Similarly, the reject tank of the 500 LPH RO plant in the Girls' Hostel overflows at a rate of 6 LPM.
- The overflow from the reject tanks is currently being utilized for flushes and domestic use during full occupancy.

Recommendation

- To reduce water wastage and improve system efficiency, it is recommended to install additional tanks or increase the capacity of existing RO plant reject overhead tanks.
- This measure will help regulate the water flow, minimize overflow, and reduce energy consumption associated with water treatment and management.

Benefits

The Cost benefit analysis is shown in below table

Table 27. Cost-benefit analysis of installing additional tanks or adjusting capacity for RO reject tank overflow

Description	Unit	Value
Total RO Plant	Nos	23
Total number of 1000 LPH RO plant	Nos	10
Total number of 500 LPH RO plant	Nos	12
Reject overflow rate of water in 1000 LPH RO Plant	lpm	18
Reject overflow rate of water in 500 LPH RO Plant	lpm	6
Average Time of overflow in 1000 LPH RO Plant	mins	60
Average Time of overflow near 500LPH RO Plant	mins	60

Description	Unit	Value
Total over flow of water for 22 RO plants	litres	15120
Water cost	Rs/m^3	20.52
Install additional tanks or modify the tank capacity for overflow in the RO reject tank to minimize water overflow.		
Utilizing reject water on flushes and domestic usage (consider 60%)	litres	9072
Full occupancy days	days	140.0
Annual overflow of RO reject water after utilizing for usages with full occupancy	m^3/annum	846.7
Annual overflow of RO reject water with non-occupancy days	m^3/annum	2116.8
Annual water savings	m^3/annum	2963.5
Annual water cost savings	Rs. Lakhs	0.61
Investment	Rs. Lakhs	1.32
Simple payback period	Months	26

5.5 Transitioning from borewell water to STP water for flush systems

Background

The facility operates three STP plants with a combined average daily treated water generation capacity of 350 m^3/day. This treated water is currently used solely for gardening purposes. Expanding its application to include flushing systems can help reduce the dependency on borewell water and enhance overall water efficiency.

Findings

- The estimated daily water consumption flow rate for urinals and water closets is approximately 0.6 Liters and 9 litres per flush per day, respectively.
- The estimated water consumption per flush in urinals and water closets is 4 m^3 and 100 m^3 per day, respectively.
- Currently, domestic water is being used for flushing, which increases borewell water consumption.

Recommendation

It is recommended to transition from using borewell water to STP-treated water for flushing urinals and water closets. This shift will reduce the facility's reliance on borewell water, conserve domestic water, and make more efficient use of the treated water from the STP.

Benefits

The cost-benefit analysis is shown in the below table,

Table 28. Cost-Benefit analysis for switching from borewell water to STP water for flush systems

Description	Unit	Values
Present system		
Standard water consumption for urinals	LPF	2
Standard water consumption for water closets (Full Flush)	LPF	6
No of persons using urinals	no's	3563
No of persons using water closets	no's	7125
Flowrate of urinals	LPF	0.60
Flowrate of water closets	LPF	9
Total estimated water consumption in urinals	m^3/day	4
Total estimated water consumption in water closets	m^3/day	100
Annual operating days	days	280
Annual water consumption	m^3/annum	29244
Total water cost	Rs/m^3	20.5
Proposal System		
Use STP water for toilet and urinal flushes		
Average STP water generation	m^3/day	350
Annual STP water consumption for toilet and urinal flushes	m^3/annum	29244
Annual domestic water Savings	m^3/annum	29244
Annual water cost savings	Rs. (Lakhs)	6.0
Investment (For piping and motor)	Rs. Lakhs	8
Simple payback period	months	16

5.6 Recommendations

1. **Installation of recirculation pumps for hot water conservation in hostels**

   To reduce water wastage in hostels, it is recommended to install recirculation pumps on hot water pipelines equipped with temperature and time-based sensors. Currently, 32 heat pumps are installed to meet the hot water demand, but students often drain 30–40 litres of water initially before receiving hot water, leading to an estimated annual wastage of 268.8 m^3. Installing recirculation pumps with temperature sensors will maintain the hot water distribution pipes at an optimal temperature, ensuring immediate hot water availability during peak hours (5:00 AM – 8:00 AM and 5:00 PM – 9:00 PM).

2. For future installations in new buildings, it is recommended to install waterless urinals to eliminate water consumption entirely. **Waterless urinals** use a sealing liquid or membrane to prevent Odors and maintain hygiene, significantly reducing water usage and maintenance costs. Additionally, it is recommended to install a mesh in urinals to facilitate easier cleaning and prevent blockages, enhancing overall maintenance efficiency. A capital expenditure (CAPEX) project recommendation for retrofitting existing urinals to waterless models is outlined below:

Figure 13. Waterless urinal

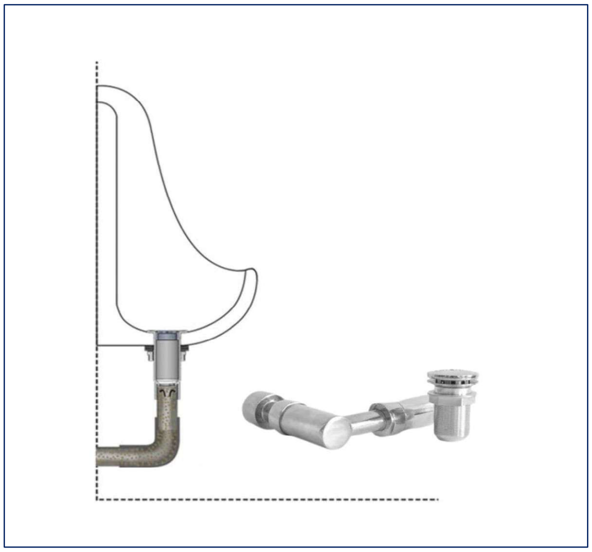


Table 29. Replacement of conventional urinals to waterless urinals

Description	Unit	Values
Present system		
Number of Urinals	Nos.	960
Water Consumption per day	m^3/day	4.28
Annual Water Consumption	m^3/annum	1197
Total Water Cost	Rs/m^3	20.5
Proposal		
Replace a Waterless Urinal		
Number of Urinals	Nos.	960
One Urinal cost	Rs.	5000
20% of Water used for Clean the Urinals.	m^3/annum	239
Annual Water Savings	m^3/annum	958
Annual Water Savings Cost	Rs. (Lakhs)	0.20
Investment	Rs. (Lakhs)	48.00

Note: It is a CAPEX project and does not include water savings.

3. **To enhance rainwater utilization** and improve overall water sustainability, it is recommended to install additional pond or construct a larger rainwater harvesting pit with a capacity of 8,878 m^3. This will enable the facility to capture and store excess rainwater more effectively, reducing runoff and increasing groundwater recharge. Additionally, expanding the use of harvested rainwater for domestic purposes, such as flushing and cleaning, will help decrease dependency on borewell and municipal water, leading to significant water savings and improved resource efficiency.

6.0 Observation and Analysis

6.1 Electricity supply and network

Electricity is one of the major energy sources used to meet the demands of the university. The university is getting power from Southern Power Distribution Company of TG Limited**.** Electricity is received at 33 kV, and two 2000 kVA transformers are installed in the university to step down the incoming 33 kV supply. Other than the EB power supply, there are three DG sets of 750 kVA, 1010 kVA, and 1500 kVA installed in the university to generate power in case of EB power failure.

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

6.1.1 Tariff structure of the University

Tariff structure of the Plant is as follows

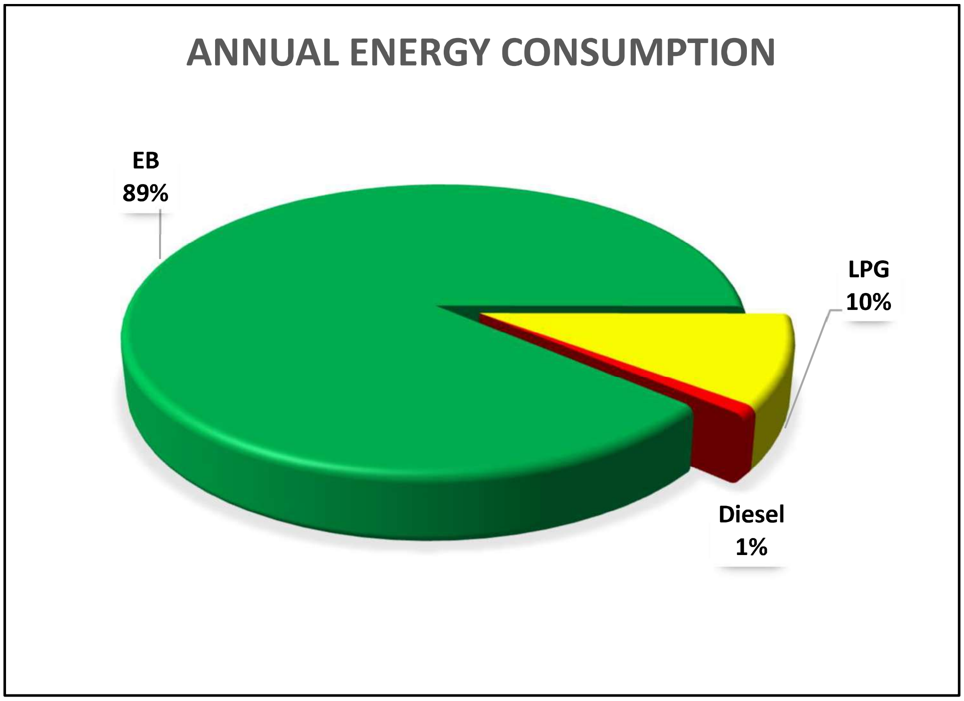
- Tariff Code = HT 2A
- Supply voltage = 33 kV
- Contracted demand = 2000 kVA
- Minimum billing demand = 1600 kVA (80% of CD)
- Demand charges = Rs. 500 per kVA
- Excess Demand Charges = Rs. 1000 per kVA
- Energy charges = Rs. 8.47 / kVAh.

Table 30. Annual energy consumption in MTOE

Month	EB Energy consumption	LPG Consumption	Diesel consumption	Tons of Oil Equivalent (MTOE)			Total
	kWh	Kg	Liters	EB	LPG	Diesel	MTOE
Jan-24	6,43,740	5,560	140	55.36	6.39	0.15	61.91

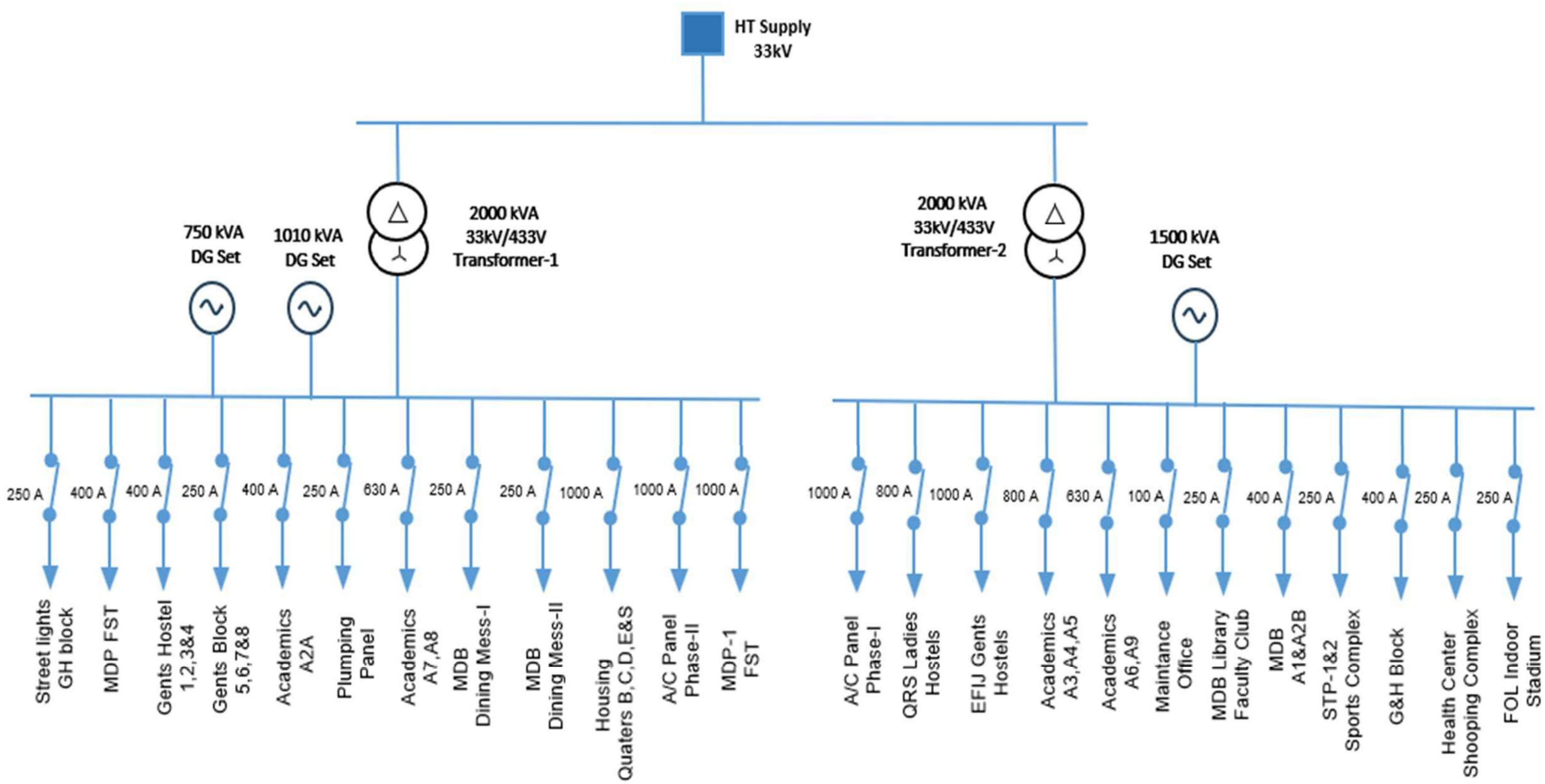
Month	EB Energy consumption	LPG Consumption	Diesel consumption	Tons of Oil Equivalent (MTOE)			Total
	kWh	Kg	Liters	EB	LPG	Diesel	MTOE
Feb-24	5,53,940	4,340	135	47.64	4.99	0.15	52.78
Mar-24	5,99,480	4,300	495	51.56	4.95	0.53	57.03
Apr-24	5,96,440	4,100	233	51.29	4.72	0.25	56.26
May-24	6,63,160	5,580	455	57.03	6.42	0.49	63.94
Jun-24	6,76,680	5,580	1,671	58.19	6.42	1.80	66.42
Jul-24	6,72,560	5,580	195	57.84	6.42	0.21	64.47
Aug-24	7,21,420	5,580	410	62.04	6.42	0.44	68.90
Sep-24	6,84,160	6,100	900	58.84	7.02	0.97	66.82
Oct-24	7,07,160	6,100	365	60.82	7.02	0.39	68.22
Nov-24	6,24,920	6,100	445	53.74	7.02	0.48	61.24
Dec-24	5,58,560	6,100	1,595	48.04	7.02	1.72	56.77
Average	**6,41,852**	**5,418**	**587**	**55.20**	**6.23**	**0.63**	**62**
Total	**77,02,220**	**65,020**	**7,039**	**662.39**	**74.77**	**7.60**	**745**

Figure 14. Annual energy consumption



6.1.2 Electrical supply network

Figure 15. Single Line Diagram



6.1.3 Electricity bill analysis

The electricity bill for the 12 months (from Mar- 2024 to Feb- 2025) for the University was analysed and the details are tabulated as follows.

Table 31. EB Bill analysis

Month	Contract Demand	Minimum Billing Demand	Recorded Demand	kVAh Consumption	kWh Consumption	Power Factor	Net EB Consumption	TOD 1 Consumption	TOD 2 Consumption	Demand Charges
	(kVA)	(kVA)	(kVA)	kVAh	kWh		kVAh	kVAh	kVAh	Rs.
Mar-24	2000	1600	1865.9	6,00,760	5,99,480	0.998	6,00,760	93,847	81,040	8,86,288
Apr-24	2000	1600	2281.2	5,98,820	5,96,440	0.996	5,98,820	1,00,060	69,920	9,50,000
May-24	2000	1600	2203.6	6,67,320	6,63,160	0.994	6,67,320	1,12,080	81,000	9,50,000
Jun-24	2000	1600	1975.4	6,77,640	6,76,680	0.999	6,77,640	1,11,160	94,520	9,38,315
Jul-24	2000	1600	1695.2	6,73,400	6,72,560	0.999	6,73,400	1,17,200	99,080	8,05,220
Aug-24	2000	1600	2146.4	7,22,320	7,21,420	0.999	7,22,320	1,18,100	1,09,100	9,50,000
Sep-24	2000	1600	2127.8	6,84,980	6,84,160	0.999	6,84,980	1,10,860	1,05,740	9,50,000
Oct-24	2000	1600	2236.8	7,08,260	7,07,160	0.998	7,08,260	1,17,140	1,05,940	9,50,000
Nov-24	2000	1600	1804.4	6,25,800	6,24,920	0.999	6,25,800	1,00,520	1,01,800	9,02,200
Dec-24	2000	1600	1655.4	5,59,180	5,58,560	0.999	5,59,180	92,280	97,640	8,27,700
Jan-25	2000	1600	1459.2	5,43,440	5,42,980	0.999	5,43,440	85,200	96,640	8,00,000
Feb-25	2000	1600	1684.0	5,28,600	5,27,900	0.999	5,28,600	91,120	76,840	8,42,000
Average	**2000**	**1600**	**1928**	**632543**	**631285**	**0.998**	**6,32,543**	**1,04,131**	**93,272**	**9,10,972**
Total	-	-	-	**75,90,520**	**75,75,420**		**75,90,520**	**12,49,567**	**11,19,260**	**91,09,723**
Maximum	-	-	**2236.8**	**7,22,320**	**7,21,420**		**7,22,320**	**1,18,100**	**1,09,100**	**9,50,000**
Minimum	-	-	**1459.2**	**5,28,600**	**5,27,900**		**5,28,600**	**85,200**	**69,920**	**8,05,220**

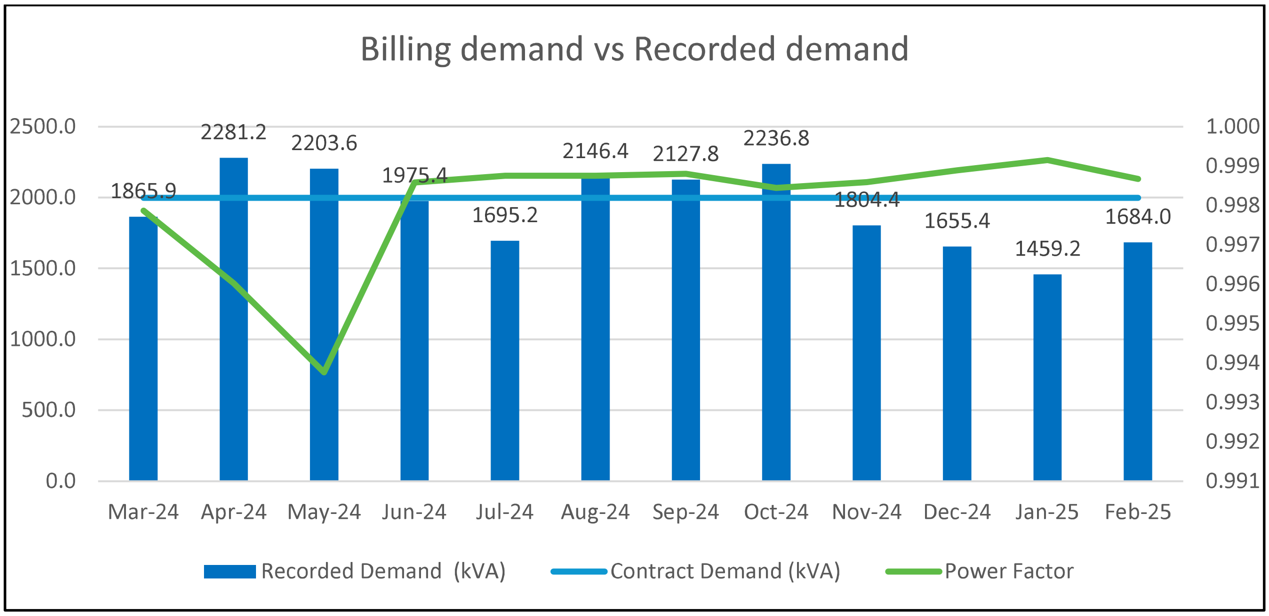
Table 32. EB Bill analysis (contd.)

Month	Energy Charges	Electricity Duty Charges	TOD Charges	Demand Penalty	Sub Total	Customer Charges	TOD Incentives 1	TOD Incentives 2	ICD for FY 2024-25	IT TCS Tax @0.1%	Total EB Bill
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs. Lakhs
Mar-24	48,06,080	36,045.60	1,74,887	-	59,03,300.9	3,500.00	-87,140	-35,520	-	5,784.00	57.899
Apr-24	47,90,560	35,929.20	1,69,980	2,67,140	62,13,609.2	3,500.00	-77,020	-30,440	-6,63,331.37	5,446.00	54.463
May-24	53,38,560	40,039.20	1,93,080	1,93,420	67,15,099.2	3,500.00	-89,500	-36,140	-	6,593.00	65.996
Jun-24	54,21,120	40,658.40	2,05,680	-	66,05,773.4	3,500.00	-1,07,340	-44,100	-	6,458.00	64.643
Jul-24	53,87,200	40,404.00	2,16,280	-	64,49,104	3,500.00	-99,080	-43,180	-	6,310.00	63.167
Aug-24	57,78,560	43,339.20	2,27,200	1,39,080	71,38,179	3,500.00	-1,12,100	-47,500	-	6,982.00	69.891
Sep-24	54,79,840	41,098.80	2,16,600	1,21,410	68,08,949	3,500.00	-1,09,200	-46,220	-	-	66.570
Oct-24	56,66,080	42,495.60	2,23,080	2,24,960	71,06,616	3,500.00	-1,07,380	-46,060	-	6,957.00	69.636
Nov-24	50,06,400	37,548.00	2,02,320	-	61,48,468	3,500.00	-1,44,300	-65,730	-	5,942.00	59.479
Dec-24	44,73,440	33,550.80	1,89,920	-	55,24,611	3,500.00	-1,35,060.0	-61,770.0		5,331.00	53.366
Jan-25	43,47,520	32,606.40	1,81,840	-	53,61,966	3,500.00	-1,29,840.0	-61,080.0	-	5,175.00	51.797
Feb-25	42,28,800	31,716.00	1,67,960	-	52,70,476	3,500.00	-1,26,450.0	-50,670.0	-	5,097.00	51.020
Average	**50,60,347**	**37,953**	**1,97,402**	**78,834**	**64,61,371**	**3,500**	-	-	**-60303**	**5,506**	**62.5**
Total	**6,07,24,160**	**4,55,431**	**23,68,827**	**9,46,010**	**6,46,13,709**	-	-	-	**-6,63,331**	**66,075**	**625.11**
Maximum	**57,78,560**	**43,339**	**2,27,200**	-	**71,38,179**	-	-	-	-	**6,982**	**69.89**
Minimum	**42,28,800**	**31,716**	**1,67,960**	-	**55,24,611**	-	-	-	**-6,63,331**	-	**53.37**

Observation:

- Institutional contract demand is 2000 kVA, and billing demand is 1600 kVA (80% of CD).
- In April 2024, the recorded maximum demand was 2281.2 kVA which is 14.06% higher than the contract demand.
- **Rs. 9,46,010** Penalty was incurred for exceeding the contract demand.
- The average monthly electricity bill was around Rs. 62 lakhs
- The annual electricity consumption is **75,90,520** kVAh.

Figure 16. Annual Contract Demand vs Record Demand



Observation:

- Contract demand of 2000 kVA was exceeded in April, May, August, September and October.

6.2 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 university, two APFC panel system is installed with a capacity of 500 kVAr for each of the transformers (6X50 kVAr and, 8X25 kVAr in each panel)

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

Table 33. Individual phase current measurements for bank-1

Sl. No.	Capacitor bank Rating (kVAr)	Rated Current (A)	Phase Currents (A)			Unbalance %	Remarks
			R	Y	B		
1	25	32.84	26.3	28.8	23.2	29%	Derated
2	50	65.69	64.3	60.8	62.9	7%	OK
3	50	65.69	61.5	62.3	60.9	7%	OK
4	50	65.69	60.2	62.6	60.8	8%	OK
5	25	32.84	-			-	Unable to Measure
6	25	32.84	31.5	31.2	31.9	5%	OK
7	25	32.84	32.1	31.8	30.9	6%	OK
8	25	32.84	29.5	29.7	29.4	10%	Derated
9	50	65.69	63.7	62.4	63.1	5%	OK
10	50	65.69	62.6	63.2	62.5	5%	OK
11	50	65.69	60.2	61.4	60.8	8%	OK
12	25	32.84	30.9	31.5	31.9	6%	OK
13	25	32.84	30.7	29.9	28.6	13%	Derated
14	25	32.84	31.1	30.1	29.7	10%	Derated

Observation:

- When the capacitor banks were turned off the power factor was 0.91 in the transformer-1 LT side.
- Phase currents for one 25 kVAr capacitor could not be measured.
- When capacitor banks are derated, they are unable to provide their full rated kVAr capacity, capacitor banks having higher unbalance should be replaced.

Table 34. Individual phase current measurements for bank-2

Sl. No.	Capacitor bank Rating(kVAr)	Rated Current (A)	Phase Currents (A)			Unbalance %	Remarks
			R	Y	B		
1	25	32.84	29.8	30.1	32.3	9%	OK
2	50	65.69	57.6	52.7	48.8	26%	Derated
3	50	65.69	56.7	53.2	55.5	19%	Derated
4	50	65.69	64.5	62.8	63.3	4%	OK
5	25	32.84	29.7	30.2	31.2	10%	Derated
6	25	32.84	30.2	29.9	31.8	9%	OK
7	25	32.84	25.8	33.2	25.7	22%	Derated
8	25	32.84	33.1	29.8	29.9	9%	OK
9	50	65.69	56.7	55.4	58.9	16%	Derated
10	50	65.69	61.2	64.1	63.7	7%	OK
11	50	65.69	62.3	62.5	63.7	5%	OK
12	25	32.84	30.9	33.1	30.1	8%	OK
13	25	32.84	32.7	33.2	30.1	8%	OK
14	25	32.84	32.1	32.3	32.2	2%	OK

Observation:

- When the capacitor bank was turned off the power factor was 0.89 in the transformer-2 LT side.
- When capacitor banks are derated, they are unable to provide their full rated kVAr capacity, existing capacitor banks have to be replaced with new capacitors which can withstand higher unbalance.
- Capacitor banks show slightly higher unbalance percentages, ranging from 5% - 9%

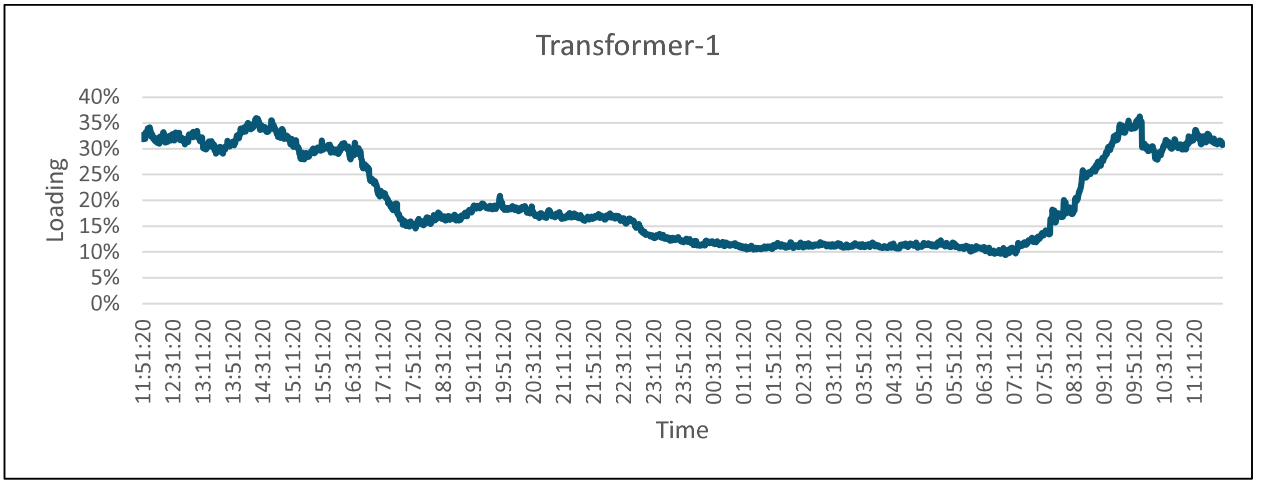
6.3 Transformer loading

Two 2000 kVA transformers are installed in the facility. The details of power recorded are given as follows: The efficiency of the transformers not only depends on the design, but also, on the effective operating load. The variable losses depend on the effective operating load to the transformer. The maximum efficiency of the transformer occurs at a condition when constant loss is equal to variable loss. For distribution transformers, the core loss is 15% to 20% of full load copper loss. Hence, the maximum efficiency of the distribution transformers occurs at a loading between 40% – 60%. For power transformers, the core loss is 25% to 30% of full load copper loss. Hence, the maximum efficiency of the power transformers occurs at a loading between 60%– 80%.

Table 35. Transformer loading

Transformer	Rating	Maximum Loading			Average Loading			Maximum Loading Percentage	Average Loading Percentage
	kVA	kVA	kW	P. F	kVA	kW	P. F	(%)	(%)
Transformer-1	2000	725.3	706.7	0.974	396.59	394.8	0.996	36.3%	19.8%
Transformer-2	2000	744.3	735.5	0.988	357.21	355.8	0.996	37.2%	17.9%

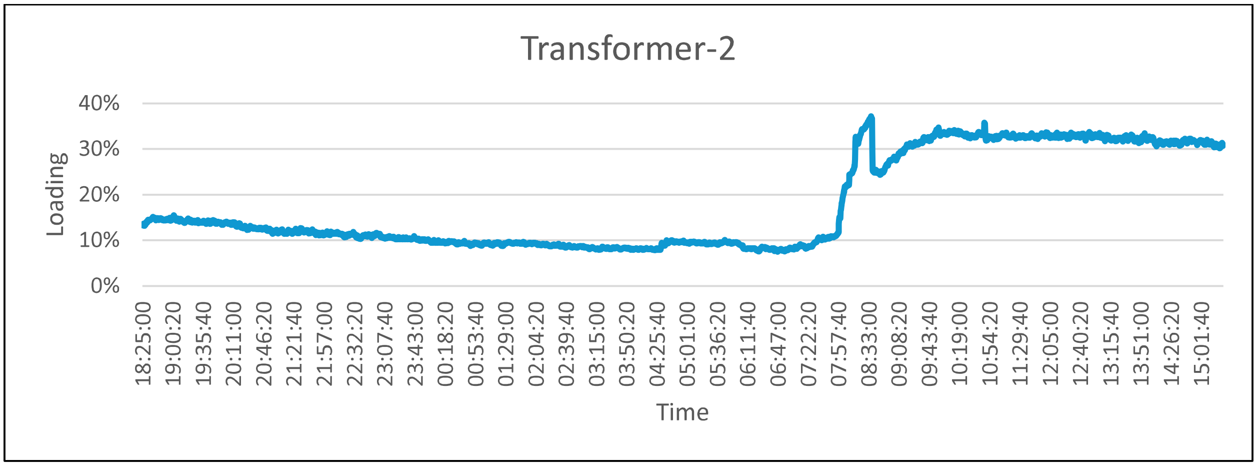
Figure 17. Transformer-1 loading



Observations:

- The maximum loading of the Transformer-1 is 725.3 kVA and the average loading of the transformer-5 is 396.5 kVA.
- During recording maximum loading is 36.3 %.
- The average loading of the transformer is 19.8 %.
- The average power factor found as maintained at 0.99 during the recording time.

Figure 18. Transformer-2 loading



Observations:

- The maximum loading of the Transformer- 2 is 744.3 kVA and the average loading of the transformer-2 is 357.2 kVA.
- During recording maximum loading is 37.2 %.
- The average loading of the transformer is 17.9 %.
- The average power factor found as maintained at 0.99 during the recording time.

6.4 UPS

The facility is equipped with various UPS systems of different capacities. The performance evaluation of the UPS systems in the FST building and academic block is presented in the following table.

Table 36. Performance assessment for UPS

Description	Unit	FST Building					
Location		2nd floor computer lab	2nd floor	FST Block 2nd floor	1st floor Lab 116	Ground Floor - G25 Centre for VLSI Lab	G11- Computer Lab
Capacity	kVA	40	25	20	10	80	80
UPS I/P Power	kW	3.58	2.43	2.47	1.30	2.60	1.87
UPS O/P Power	kW	3.31	2.20	2.22	1.10	2.32	1.63
Power factor	-	0.90	0.90	0.90	0.83	0.80	0.88
Results							
Loading	%	9.20	9.78	12.33	13.25	3.63	2.32
Efficiency	%	93%	91%	90%	85%	89%	87%

Description	Unit	FST Building					
Location		2nd floor computer lab	2nd floor	FST Block 2nd floor	1st floor Lab 116	Ground Floor - G25 Centre for VLSI Lab	G11-Computer Lab
Losses	kW	0.27	0.23	0.25	0.20	0.28	0.24

Table 37. Performance assessment for UPS (contd.)

Description	Unit	Academics Block					
Location		Ground floor	Wing E (Ground Floor)	Wing D-Ground floor	NJ Yashasvy Library	IT Computer Lab	Faculty Club
Capacity	kVA	20	60	40	20	60	20
UPS I/P Power	kW	4.30	7.40	4.30	0.90	14.70	1.80
UPS O/P Power	kW	3.70	7.00	3.91	0.79	12.70	1.60
Power factor	-	0.90	0.89	0.88	0.90	0.90	0.80
Results							
Loading	%	20.56	13.11	11.11	4.39	23.52	10.00
Efficiency	%	86%	95%	91%	88%	86%	89%
Losses	kW	0.60	0.40	0.39	0.11	2.00	0.20

Observations:

- The UPS units were partially loaded during the measurement.
- The efficiency of the UPS units was found to be between 85% and 95%, which is considered good.

6.5 Diesel generator

There is three DG sets installed in the facility. All the DG sets are made by Cummins with capacities of 750kVA, 1010 kVA and 1500 kVA. DGs are operated during the power failure.

Table 38. Performance assessment for diesel generators

Description	Unit	750 kVA DG	1010 kVA DG	1500 kVA DG
Make	-	Cummins	Cummins	Cummins
Model	-	HC634W2	HC634Y2	S7L1D-C41
Rated capacity	kVA	750	1010	1500
Date of trial	Date	13-12-2024	13-12-2024	13-12-2024
Duration of trial	mins	240	240	240
Power (Average)	kW	239.5	332.75	495.75
Fuel consumed	litres	335.0	395.0	615.0
Electricity generated	kWh	958.0	1331.0	1983.0
SEGR	kWh/Lt.	2.9	3.4	3.2
Diesel Cost	Rs. /lt.	97.5	97.5	97.5

Note: The performance analysis for DG was done using previously recorded data

Observations:

- The SEGR of DG sets available in the facility is 2.9 kWh/Lt., 3.4 kWh/Lt, and 3.2 kWh/Lt for 750kVA, 1010kVA, 1500kVA respectively.

6.6 Chillers

The facility's cooling requirements are met through water-cooled chillers. Four Dhanam Bush-brand chillers, each with a capacity of 374 TR, are installed, with each unit containing two compressors. During the audit, the chillers were operating at a setpoint of 6.5 –7°C, with two chillers in operation and one chiller under maintenance. The number of chillers in operation is adjusted based on demand. All pumping systems are direct-driven. A performance evaluation of the chillers is provided below.

Table 39. Performance assessment for chiller

Design Parameter	Units	Chiller -1	Chiller -2	Chiller -3	Chiller -4
Manufacturer	-	Dunham Bush	Dunham Bush	Dunham Bush	Dunham Bush
Model	-	EF 28147H353HAJ	EF 28147H353HAJ	EF 28147H353HAJ	EF 28147H353HAJ

Design Parameter	Units	Chiller -1	Chiller -2	Chiller -3	Chiller -4
Type of fluid	-	Water cooled	Water cooled	Water cooled	Water cooled
Serial number	-			-	-
Cooling capacity	TR	374	374	374	374
Selected cooling load power	kW	230	230	230	230
No of compressor	Nos	2	2	2	2
Refrigerant	-	R-134a	R-134a	R-134a	R-134a
Specific Energy Consumption	kW/TR	0.61	0.61	0.61	0.61
Chilled Water Measurement					
Operating hours	hrs.	Under maintenance	Variable	Variable	Variable
Evaporator inlet temperature	^{0}C		12.3	12.4	11.8
Evaporator outlet temperature	^{0}C		10.3	9.0	7.9
Set temperature	^{0}C		7	6.5	7
ΔT	^{0}C		2.0	3.4	3.4
Water flow	m^3/hr		122	129	143
Condenser Water Measurement					
Inlet temperature	^{0}C		26.6	26.1	27.4
Outlet temperature	^{0}C		28.7	28.6	25.1
Water flow	m^3/hr		238	96	261
Refrigerant					
Evaporator pressure	kg/cm^2		2.5	2.5	2.7
Refrigerant saturation temperature	°C		6.8	6.1	5
Condenser pressure	kg/cm^2		3.3	3.2	3.2
Refrigerant saturation temperature	°C		32	33.9	32
Compressor					
Compressor power	kW		92	113	124
Calculation					
TR Generated	TR		81	145	161
Evaporator approach	°C		3.5	2.9	2.9
Condenser approach	°C		3.3	5.3	6.9

Design Parameter	Units	Chiller -1	Chiller -2	Chiller -3	Chiller -4
Specific Energy Consumption	kW/TR		1.14	0.78	0.77
COP	-		3.08	4.51	4.56
Lift	-		0.8	0.7	0.5
Loading	%		22%	39%	43%

Observation:

- The Loading of chiller during audit time was between 81 TR to 161 TR.
- The SEC of chillers ranges from 0.77 to 1.14 kW/TR.
- The COP of chillers ranges from is 3.08 to 4.56.
- Condenser approach for chillers is 3.3°C,5.3 °C and 6.9 °C respectively which is very high.
- Evaporator approach for chillers is 2.9°C for chiller-3 and 4, 3.5°C for chiller-2 which is high.

6.7 AHU

Air Handling Units (AHUs) are installed to meet the cooling, comfort, and ventilation requirements across various facilities, including the auditorium, seminar halls, IT labs, libraries, and lecture theatres. The operating hours of the AHUs vary based on occupancy levels and demand. A performance analysis of the AHUs is provided below.

Table 40. Performance assessment for AHU

Description	Unit	Auditorium	IT Lab	Library (Ground Floor)	Library (Second Floor)	Lecturer Theatre - H (First Floor)	Lecturer Theatre - M
Design Parameters							
AHU Make	-	Divyasree Associates	Divyasree Associates	Divyasree Associates	Divyasree Associates	Sagar Air Pvt Ltd	Sagar Air Pvt Ltd
Rated CFM	CFM	24000	10400	11600	11600	3000	5600
	m^3/hr	40776	17670	19709	19709	5097	9514
Motor Power	kW	9	6	8	8	1.5	NA
SEC	kW/CFM	0.0004	0.0005	0.0006	0.0006	0.0005	-
Efficiency	-	87%	87%	87%	87%		87%
Type of AHU fan	-	Belt-driven	Belt-driven	Belt-driven	Belt-driven	Direct-driven	Belt-driven

Description	Unit	Auditorium	IT Lab	Library (Ground Floor)	Library (Second Floor)	Lecturer Theatre - H (First Floor)	Lecturer Theatre - M
Operating Parameters							
Operating hours	hrs.	8.0	3.0	8.0	8.0	8.0	8.0
Return air							
Return air DBT	^{0}C	23.7	21.2	24.5	26.1	25.2	23.9
Return air RH	%	53.2	64.1	56.7	56.1	57.4	44.8
Return air WBT	^{0}C	17.3	16.7	18.5	19.7	19.2	16.2
Return air enthalpy	kJ/kg/^{o}C	48.6	46.9	52.4	56.4	54.7	45.1
Return air density	kg/m³	1.2	1.2	1.2	1.2	1.2	1.2
Supply air							
Supply air DBT	^{0}C	16.1	16.7	19.4	19.8	16.7	19.6
Supply air RH	%	72.1	90.8	78.4	68.4	66.7	56.5
Supply air WBT	^{0}C	13.1	15.8	16.9	16.1	13.1	14.3
Supply air enthalpy	kJ/kg/^{o}C	37.0	44.1	47.5	45.0	36.8	40.1
Δ Enthalpy	kJ/kg/^{o}C	11.6	2.8	4.9	11.4	17.9	5.0
Air velocity	m/s	2.8	3.7	2.6	2.6	2.7	3.0
Area (L X W)	m2	3.9	2.1	1.1	1.1	0.9	0.7
Input motor power	kW	4.6	5.8	4.4	4.3	1.2	1.8
Calculation							
Actual air flow	m³/s	11	8	3	3	2	2
	m³/hr	38594	27977	10058	9929	8528	7875
	kg/hr	45541	33568	11934	11718	10095	9363
	CFM	22716	16467	5920	5844	5020	4635
Cooling load generated	TR	41.9	7.5	4.6	10.6	14.3	3.7
SEC	kW/CFM	0.0002	0.0004	0.0007	0.0007	0.0002	0.0004

Table 41. Performance assessment for AHU (Contd.)

Description	Unit	Lecturer Theatre -N	Seminar Hall 1	Seminar Hall 2	Auditorium backside (left)	Auditorium backside (right)
Design Parameters						
AHU Make	-	Sagar Air Pvt Ltd	Sagar Air Pvt Ltd	Sagar Air Pvt Ltd	Sagar Air Pvt Ltd	Sagar Air Pvt Ltd
Rated CFM	CFM	5600	5600	5600	4400	4400
	m³/hr	9514	9514	9514	7476	7476
Motor Power	kW	NA	1	1	2	2
SEC	kW/CFM	-	0.0001	0.0001	0.0005	0.0005
Efficiency	-	87%	87%	87%	87%	87%
Type of AHU fan	-	Belt-driven	Direct-driven	Direct-driven	Belt-driven	Direct-driven
Operating Parameters						
Operating hours	hrs.	8.0	2.0	Not Working	2.0	2.0
Return air						
Return air DBT	°C	23.7	24.1		23.8	24.2
Return air RH	%	44.1	45.2		44.1	44.8
Return air WBT	°C	15.9	16.4		16.0	16.4
Return air enthalpy	kJ/kg/°C	44.3	45.8		44.5	45.8
Return air density	kg/m³	1.2	1.2		1.2	1.2
Supply air						
Supply air DBT	°C	16.8	18.1		17.8	17.9
Supply air RH	%	70.2	60.0		68.7	70.1
Supply air WBT	°C	13.6	13.5		14.3	14.6
Supply air enthalpy	kJ/kg/°C	38.1	37.8		40.0	40.7
Δ Enthalpy	kJ/kg/°C	6.2	7.9		4.5	5.1
Air velocity	m/s	2.2	1.0		3.5	3.6
Area (L X W)	m2	0.8	0.7		0.7	0.7
Input motor power	kW	1.3	0.8		1.9	2.1
Calculation						
Actual air flow	m³/s	2	1		2	2
	m³/hr	6524	2647		8505	8644
	kg/hr	7762	3145		10115	10266
	CFM	3840	1558		5006	5088

Description	Unit	Lecturer Theatre -N	Seminar Hall 1	Seminar Hall 2	Auditorium backside (left)	Auditorium backside (right)
Cooling load generated	TR	3.8	2.0		3.6	4.1
SEC	kW/CFM	0.0003	0.0005		0.0004	0.0004

Observation:

- The performance evaluation of eight belt-driven AHUs and three direct-driven AHUs was conducted during the audit. However, due to space constraints, access to some of the AHU's measurement was not possible.
- All AHU filters should be cleaned at regular intervals to maintain optimal performance.
- The range of Specific Energy Consumption (SEC) values for AHUs was observed to be between 0.0002 and 0.0007 kW/CFM, which is good.

6.8 AC

The facility has air conditioning systems installed at various locations with different capacities. Additionally, FCUs have been installed in different areas with varying capacities. To provide cooling load for the Seminar halls, six tower air conditioners are installed with a rated capacity of 4TR. During the audit, a sample-based performance assessment was done for operating air conditioners. During the audit, a sample-based performance assessment was conducted for the operating air conditioners.

Table 42. Performance assessment for AC

Design Parameters	Units	Seminar Tower AC-1	Seminar Tower AC-2	FCU-272(F - wing 101)	B Quarters Guest House 3B
Make	-	Midea	Bluestar	NA	Lloyd
Type of AC	-	Floor-standing	Floor-standing		Split AC
Model No	-	MFGA-48CR-R	BI-VE42SEU		-
Cooling load	kW	14	12		-
	TR	4.0	3.5		2
Motor Power	kW	4	4		-
Operating Parameters					
Indoor Unit Set point	°C	20	21	-	23
Return/Exhaust air					
Return air DBT	°C	24.7	24.8	25	23

Design Parameters	Units	Seminar Tower AC-1	Seminar Tower AC-2	FCU-272(F - wing 101)	B Quarters Guest House 3B
Return air RH	%	40.7	40.9	40	53
Return air WBT	°C	16.1	16.2	17	17
Return air enthalpy	kJ/kg	44.9	45.1	46	47
Return air density	kg/m³	1.18	1.18	1.18	1.19
Supply/Ambient air					
Supply air DBT	°C	12.4	15.8	18	11.1
Supply air RH	%	86.3	82.1	59	87.0
Supply air WBT	°C	9.6	14.0	14	9.8
Supply air enthalpy	kJ/kg	38.9	39.1	38	28.9
Δ Enthalpy	kJ/kg	6.0	6.0	8	18
Air velocity	m/s	6.2	5.4	4	5
Area	m²	0.4	0.4	0.05	0.06
Actual air flow	m³/s	2	2	0	0
	m³/hr	8036	7035	732	1212
	kg/hr	9483	8301	866	1444
	CFM	4730	4140	431	714
Input motor power	kW	3.6	3.1	0.25	1.90
Results					
Effective TR	TR	4.5	4.0	0.6	2.0
	kW	16	14	2	7
SEC	kW/TR	0.80	0.78	0.45	0.93
Cooling load	kJ/hr	13635	11995	1678	6148

Observation:

- The SEC of Seminar Tower AC 1 is 0.80 kW/TR.
- The SEC of Seminar Tower AC 2 is 0.78 kW/TR.
- The SEC of FCU 272 is 0.45 kW/TR.
- The SEC of the B Quarters Guest House 3B air conditioners is 0.93 kW/TR.

6.9 VRV

A VRF (Variable Refrigerant Flow) system is an air conditioning solution that consists of an outdoor unit connected to multiple indoor units. It adjusts the refrigerant flow to each indoor unit based on current demand, providing precise temperature control. In the FST block, VRF systems are installed to meet different cooling loads. The performance evaluation of the VRF system is outlined below.

Table 43. Performance assessment for VRV

Description	Unit	VRF-1	VRF-2
Design Parameters			
AHU make	-	Daikin	Daikin
Rated amps	A	22.5	22.5
Rated cooling capacity	kW	9	9
	TR	2.5	2.5
Operating Parameters			
Operating hours	hrs.	10.0	10.0
Exhaust air			
Exhaust air DBT	^{0}C	39.6	39.8
Exhaust air RH	%	19.5	18.9
Exhaust air WBT	^{0}C	21.6	21.6
Exhaust air enthalpy	kJ/kg/^{0}C	62.4	62.2
Exhaust air density	kg/m³	1.2	1.1
Ambient air			
Ambient air DBT	^{0}C	35.1	33.5
Ambient air RH	%	25.0	23.0
Ambient air WBT	^{0}C	20.3	18.8
Ambient air enthalpy	kJ/kg/^{0}C	57.9	53.0
Δ Enthalpy	kJ/kg/^{0}C	4.5	9.2
Air velocity	m/s	8.9	3.7
Area (L X W)	m2	0.3	0.3
Input motor power	kW	3.7	3.1
Calculation			
Actual air flow	m³/s	3	1
	m³/hr	9088	3805
	kg/hr	10724	4294

Description	Unit	VRF-1	VRF-2
	CFM	5349	2239
Cooling load generated	TR	3.8	3.1
SEC	kW/TR	0.96	0.99

Observation:

- The SEC of VRF units 1 and 2 is 0.96 kW/TR and 0.99 kW/TR, respectively, indicating that the VRV units are operating efficiently.

6.10 Blowers

The facility is equipped with a total of eight blowers, installed in various Sewage Treatment Plants (STPs) across the site, which are responsible for supplying air to the water treatment tanks. The blowers, manufactured by Everest and Akash, have a rated flow of 250 m^3/hr for the Everest models and 100 m^3/hr for the Akash models. The Everest blowers are powered by 9 kW motors, while the Akash blowers are driven by 3 kW motors. During the audit, it was observed that Blower 2 in both STP-1 and STP-2 were on standby. A detailed performance analysis of the blowers is presented below.

Table 44. Performance assessment for STP blower

Description	Unit	STP 1			STP 2			STP 3	
		Blower -1	Blower -2	Blower -3	Blower -1	Blower-2	Blower -3	Blower-1	Blower-2
Design Parameters									
Make	-	Everest blower	Everest blower	Everest blower	Everest blower	Everest blower	Everest blower	Akash	Akash
Model	-	M5125	M5125	M5125	M5125	M5125	M5125	AB-44	AB-44
Flow	m3/h	250	250	250	250	250	250	100	100
Static Pressure	mmWC	4000	4000	4000	4000	4000	4000	4079	4079
Power	kW	9.3	9.3	9.3	9.3	9.3	9.3	3.0	3.0
Speed	Rpm	1250	1250	1250	1250	1250	1250	1165	1165
Motor efficiency	%	89%	89%	89%	89%	89%	89%	86%	86%
Operating parameters									
Operating hours	Hrs	24	Standby	24	24	Standby	24	8	8
Static pressure at fan suction side	mmWC	1		1	1		1	1	2

Description	Unit	STP 1			STP 2			STP 3	
		Blower -1	Blower -2	Blower -3	Blower -1	Blower-2	Blower -3	Blower-1	Blower-2
Static pressure at fan outlet	mmWC	4588		4894	4682		4792	3670	3772
Fan static pressure	mmWC	4587		4893	4681		4791	3669	3770
Discharge air temperature	^0C	50		49	49		50	49	50
Ambient temperature	^0C	31		31	31		31	29	29
Air density	kg/m^3	1.16		1.16	1.16		1.16	1.17	1.17
Velocity	m/s	0.84		1.30	1.25		1.14	1.02	1.00
Cross sectional area of duct	m^2	0.18		0.11	0.11		0.18	0.07	0.07
Quantity	m^3/min	9		9	8		12	4	4
	m^3/hr	531		517	495		716	264	258
	CFM	318		310	297		430	158	155
Input power to fan motor	kW	9.5		7.6	7.2		9.4	2.5	2.7
Results									
Static efficiency	%	70%		91%	88%		99%	105%	98%
Specific energy consumption	kW/CFM	0.030		0.025	0.024		0.022	0.016	0.017
Motor loading	%	91%		73%	69%		90%	72%	78%

Observation:

- All the blowers are motor-driven systems, with static efficiencies of 70% and 91 % for the blowers in STP-1, 88% and 99% for the blowers in the STP-2 and 105% and 98% for STP-3.
- The SEC values are in the range of 0.016 kW/CFM to 0.030 kW/CFM

6.11 Cooling towers

As part of the chiller system, induced draft cooling towers (CTs) have been installed. The system is equipped with three Paharapur-brand cooling towers, located on the terrace of the HVAC plant. Each cooling tower is powered by an 11-kW motor that drives the fans. Water from the cooling tower basins is collected and pumped back into the chillers for cooling purposes. During the audit, it was observed that two of the cooling towers were in operation. A performance assessment of the cooling towers was conducted, with the fans operating at a constant frequency.

Table 45. Performance assessment for cooling tower

Description	Units	Cooling Tower-1	Cooling Tower-2	Cooling Tower-3
Design				
Make	-	Paraphur	Paraphur	Paraphur
Motor rated power	kW	11	11	11
Motor rated current	Amps	21	21	21
Motor speed	rpm	1460	1460	1460
Motor efficiency	%	89%	89%	89%
Operating hours	hrs	12	12	12
Measured Values				
CT water inlet temperature	^0C	28.2	29.1	28.4
CT water outlet/Basin temperature	^0C	26.2	26.1	26.4
Air Velocity	m/s	7.8	9.2	9.5
Area of CT Fan	m^2	3.42	3.42	3.42
CT air flow	m^3/hr	95285	113042	116309
Ambient air-Dry bulb temperature	^0C	28	28	28
Ambient air Wet bulb temperature	^0C	22	22	22
Results				
CT range	^0C	2	3	2
CT approach	^0C	4.2	4.1	4.4
Motor input power	kW	7.5	10.3	10.4
Effectiveness	%	32%	42%	31%

Observation:

- The effectiveness of cooling towers ranges from 31% to 41% which is slightly low.
- Scale and algae formations were observed in the Cooling towers.

6.12 Pumps

The chiller system comprises four chiller pumps and four condenser pumps, all manufactured by Kirloskar. The operating hours of the pumps vary based on the chiller's operation and the scheduling requirements. The chilled water system is equipped with four primary pumps, each with a rated capacity of 37 kW, and four condenser water pumps, also rated at 37 kW, installed in the condenser water line. During the audit, one of the condenser pumps was found to be under maintenance. A performance evaluation of the pumps is provided below.

Table 46. Performance assessment for chiller pumps

Design Parameter	Units	Chiller Pump 1	Chiller Pump 2	Chiller Pump 3	Chiller Pump 4
Manufacturer	-	Kirloskar	Kirloskar	Kirloskar	Kirloskar
Model	-	UP125/308	UP125/308	UP125/308	UP125/308
Motor power	kW	37	37	37	37
Motor type (IE2/IE3/IE4)	-	-	-	-	-
Flow	m^3/hr.	221	221	221	221
Head	m	36	36	36	36
Speed	rpm	1450	1450	1450	1450
Motor efficiency	%	92.8%	92.8%	92.8%	92.8%
Actual Measurement					
Operating hours	hrs.	12	12	12	12
Actual power	kW	34.6	37.7	40.8	43.9
Current	A	60	63	66	69
Voltage	V	390	393	396	398
Suction pressure	kg/cm^2	1	1	1.2	1.1
Discharge pressure	kg/cm^2	4.1	4.1	4	4.2
Flow	m^3/hr.	198	194	214	198
Throttling					
Suction control valve close	%	0%	0%	0%	0%
Discharge control valve close	%	0%	0%	0%	0%
Calculation					
Head(H)	m	31	31	28	31
Hydraulic power	kW	16.7	16.4	16.3	16.7
Combined efficiency	%	48%	43%	40%	38%
Pump efficiency	%	52%	47%	43%	41%
Motor loading	%	87%	95%	102%	110%

Observation:

- The flow rate of the primary pumps is 198 m^3/hr for primary pump-1 and 4, 194 m^3/hr, 214 m^3/hr for primary pumps 2 and 3 respectively.

- The pump efficiency of primary pump-1,2 & 3 are in the range of 41% to 50 % which is satisfying.
- The combined efficiency of primary pumps is in the range of 38% to 47% which is satisfying.

Table 47. Performance assessment for condenser pumps

Design Parameter	Units	Condenser Pump 1	Condenser Pump 2	Condenser Pump 3	Condenser Pump 4
Manufacturer	-	Kirloskar	Kirloskar	Kirloskar	Kirloskar
Model	-	UP125/308	UP125/308	UP125/308	UP125/309
Motor power	kW	37	37	37	37
Motor type (IE2/IE3/IE4)	-	-	-	-	-
Flow	m^3/hr.	294.8	294.8	294.8	294.8
Head	m	24.2	24.2	24.2	24.2
Speed	rpm	1450	1450	1450	1450
Motor efficiency	%	92.8%	92.8%	92.8%	92.8%
Actual Measurement					
Operating hours	hrs.	Under Maintenance	12	12	12
Actual power	kW		25.1	27.8	26.3
Current	A		45	50.3	46.8
Voltage	V		382	380	382
Suction pressure	kg/cm^2		0.8	0.8	0.8
Discharge pressure	kg/cm^2		2.8	2.8	2.8
Flow	m^3/hr.		242	261	282
Throttling					
Suction control valve close	%		0%	0%	0%
Discharge control valve close	%		0%	0%	0%
Calculation					
Head(H)	m		20	20	20
Hydraulic power	kW		13.2	14.2	15.4
Combined efficiency	%		53%	51%	58%
Pump efficiency	%		57%	55%	63%
Motor loading	%		63%	70%	66%

Observation:

- The flow rate of the condenser pumps is 242 m^3/hr, 254m^3/hr and 264 m^3/hr for condense pumps 2,3 and 4 respectively.

- The pump efficiency of condenser pump-2,3 & 4 are in the range of 55% to 63% which is good.
- The combined efficiency of condenser pumps is in the range of 53 % to 58% which is good.

GREEN AUDIT

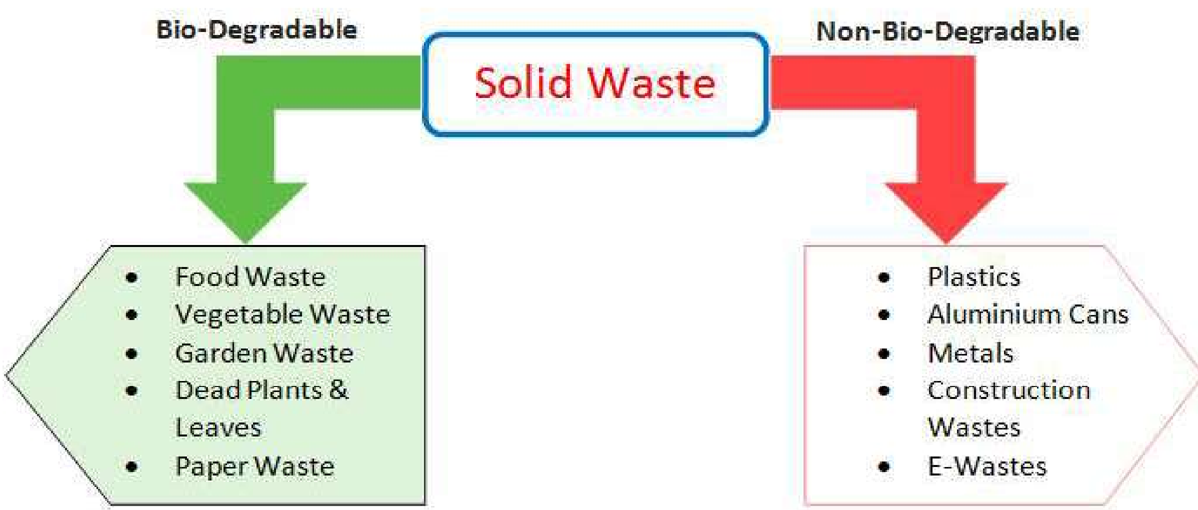
7.0 Green Audit

A biodiversity audit ensures the greenery and sustainability of the campus. The biodiversity audit is conducted to analyse 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. This audit gives recommendations to the university for the conservation and protection of natural vegetation and animal life by involving students and faculty members to make the university's biodiversity rich.

7.1 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 university are represented in the below block diagram.

Figure 19. 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 vendors
- Separate bins are not there for bio-degradable and non-biodegradable waste.

- 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 collected by third party.
- Kitchen waste is collected by third party vendor.
- Bio gas plant is installed.
- Vermicompost is installed.
- The campus generates nearly 420 kg of plastic per month.

Figure 20. Good Practices

Recommendations

- All wastes including e- waste should be disposed to registered recyclers and a record has to be kept.
- Reduce the amount of waste that is produced in classrooms through usage of PDF softcopies unless print is really required.
- Keep biodegradable and non-biodegradable waste bins for segregation of waste.

- Use construction debris waste for landscaping.
- A proper record should be maintained for the type of waste, its quantity, and how it's disposed.
- 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

7.2 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 university for activities like washing hands, drinking, water usage 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 university. It is therefore essential that any environmentally responsible university 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.

7.2.1 Water circuit of the facility

The primary water supply at IFHE is sourced from a combination of borewells and Telangana Corporation water. The system includes 23 borewells and a main supply from the Manju Corporation water, which serves the entire site. The water management system is structured into three distinct circuits: the Raw Water Circuit, the RO Water Circuit, and the Recycled Water Circuit.

Water is primarily sourced from two sets of borewells, with the 23 borewells supplementing the supply as needed. The operation of borewell sets is alternated daily. If one set is operational today, the other set will be activated the following day. Borewell water is collected and transferred to the sump tank using transfer pumps. Simultaneously, municipal water from the corporation is also directed to the sump tank.

Once the sump tank is filled, the water is pumped to the overhead tank using HNS pumps. From the overhead tank, water is distributed throughout the facility. A portion of this water is supplied to the RO plant for treatment and conversion into drinking water.

Domestic wastewater is collected and treated at the Sewage Treatment Plant (STP). The treated water is recycled and primarily used for gardening purposes.

7.2.1.1 Water metering system

A flow meter is an essential component of the water metering system, designed to accurately measure the flow rate of water within pipelines. During the field study, five flow meters were identified at the water sourcing site. To ensure data accuracy, the flow rates (in m^3/hr) displayed on these meters were cross-verified using portable ultrasonic flow meters.

The water metering system includes four meters installed at the sump inlet, which monitor the inflow from the 23 borewells, and a separate meter dedicated to measuring municipal corporation water intake. Water from the sump is subsequently pumped to the overhead tanks for distribution throughout the facility. There are a total of 142 overhead tanks within the facility.

An automatic sensor system is integrated to monitor water levels across various applications, such as tanks, reservoirs, and distribution systems. All overhead tanks are connected to an automatic control system to optimize water management and prevent overflow.

7.2.1.2 Water usage consumption

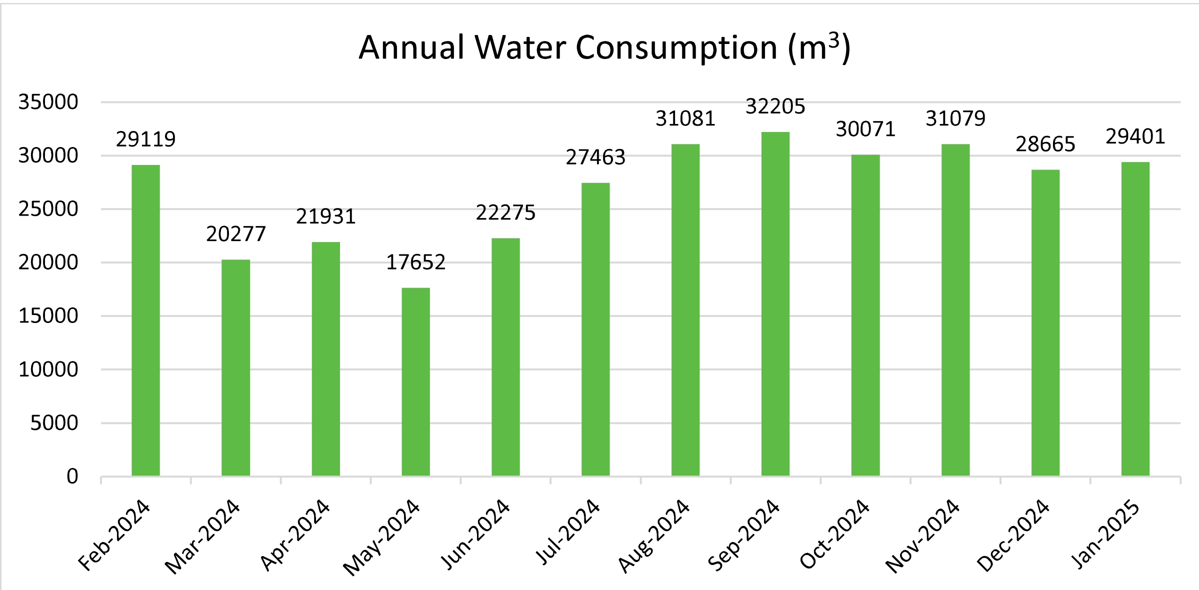
During the audit, the facility provided monthly water intake data for the past 12 months, which is summarized in the table below. Based on this data, the average daily water usage was calculated to be m^3/day. The facility recorded its lowest monthly consumption in May 2024 at 17,652 m^3, with an average daily consumption of 569 m^3/day. The highest monthly consumption was recorded in September 2024 at 32,205 m^3, with an average daily consumption of 1,074 m^3, as shown in the table and figure.

Table 48. Water consumption data

S No	Month	Monthly Water Consumption	Average daily water consumption
		m^3	m^3
1	Feb-2024	29119	1040
2	Mar-2024	20277	654
3	Apr-2024	21931	731
4	May-2024	17652	569
5	Jun-2024	22275	743
6	Jul-2024	27463	886
7	Aug-2024	31081	1003
8	Sep-2024	32205	1074
9	Oct-2024	30071	970
10	Nov-2024	31079	1036

S No	Month	Monthly Water Consumption	Average daily water consumption
		m³	m³
11	Dec-2024	28665	925
12	Jan-2025	29401	948

Figure 22. Annual water consumption of the facility.



The institution experiences two distinct occupancy periods, full occupancy and partial occupancy, which directly influence water consumption patterns. During full occupancy, all departments are active, leading to higher water usage. In contrast, during partial occupancy, some departments are on vacation while others remain operational, resulting in reduced consumption.

7.2.1.3 Water costing

The costs associated with water at the facility include expenses for extraction and pumping. The facility relies exclusively on groundwater sourced from borewells and getting from the water by municipal corporation. The table below details the annual water extraction costs from various borewells within the facility.

Table 49. Facility water cost

SL. No	Water Source	Water Cost (Rs/m³)
1	Average domestic water pumping cost	18.72
2	Corporation water cost	1.8

SL. No	Water Source	Water Cost (Rs/m^3)
Total Water cost		20.52

Borewell water is collected by its individual pump and transferred to the sump tank using transfer pumps. Simultaneously, municipal water from the corporation is also directed to the sump tank.

Once the sump tank is filled, the water is pumped to the overhead tank using HNS pumps. From the overhead tank, water is distributed throughout the facility. The overall domestic water cost at Rs.20.52 during audit time.

7.2.1.4 Overall pumping cost

The following table presents a detailed assessment of the operational performance and associated costs of various water pumping systems, including borewells and sump transfer systems, observed during the audit.

For Borewell to Sump (Set 1), the pump operates at a power consumption of 69.14 kW with a flow rate of 45.4 m^3/hr, delivering approximately 227 m^3/day of water at a pumping cost of 12.90 Rs/m^3, resulting in a total daily cost of Rs.2,928.64

For Borewell to Sump (Set 2), the pump consumes 90.15 kW of power with a flow rate of 39.0 m^3/hr, supplying around 195 m^3/day at a pumping cost of 19.58 Rs/m^3, leading to a total daily cost of Rs.3,818.58.

For water transfer from the Sump to Overhead Tanks, the combined pumping system operates at a total power consumption of 10.30 kW with a flow rate of 35.2 m^3/hr, delivering approximately 211 m^3/day at a pumping cost of 2.48 Rs/m^3, resulting in a total daily cost of Rs.523.55.

This analysis, conducted during the audit period, provides valuable insights into the efficiency and cost-effectiveness of the pumping systems, enabling better decision-making for operational improvements and cost optimization.

Table 50. Overall pumping cost

Sl No	Water source	Water delivered to	Power Measured (kW)	Flowrate (m^3/hr)	Amount of water(m^3/day)	Pumping Cost (Rs/m^3)	Total Cost/Day
1	Borewell to sump (set 1)	sump	69.14	45.4	227	12.90	2928.64
2	Borewell to sump (set 2)	sump	90.15	39.0	195	19.58	3818.58
3	Sump	Overhead tank	10.30	35.2	211	2.48	523.55

7.2.2 Water observation and analysis

7.2.2.1 Rainwater harvesting

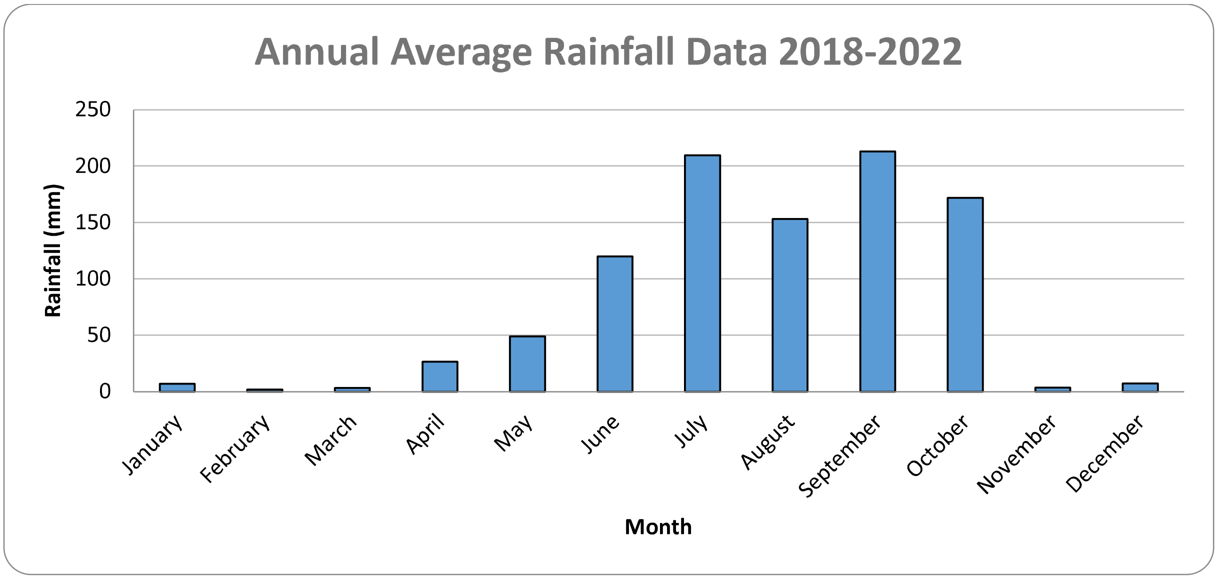
Rainwater harvesting is a sustainable practice that involves the collection, filtration, and storage of rainwater for various uses. This method captures rainfall from rooftops, land surfaces, or other catchment areas and channels it through gutters and downpipes into storage containers. Filtration processes remove debris and contaminants to ensure the collected water is suitable for its intended purposes. By storing rainwater in tanks or cisterns, this approach provides an alternative water source for activities such as gardening, cleaning, and toilet flushing, thereby reducing reliance on traditional water supplies. Rainwater harvesting not only conserves water but also helps minimize soil erosion, flooding, and strain on drainage systems, offering a sustainable solution for regions facing water scarcity while promoting eco-friendly practices.

Data collected over the past five years reveals that the annual rainfall in this area is 966 millimeters. This data provides a comprehensive understanding of the precipitation trends in the region. The consistent annual rainfall of 966 mm highlights the stability and reliability of the climatic conditions in Hyderabad over the study period. These findings are essential for understanding and predicting the region's weather patterns, offering valuable insights into environmental dynamics and water resource management.

Table 51. Average rainfall for 5 years

Month	Average rainfall (mm)
January	7
February	2
March	3
April	27
May	49
June	120
July	210
August	153
September	213
October	172
November	4
December	7
Total annual rainfall	**966**

Figure 23. Annual average rainfall data 2018-2022



7.2.2.1.1 Rainwater harvesting for plant utilization

The facility places high importance on rainwater harvesting as a core element of its sustainability strategy and actively practices it on-site. Currently, the facility operates 15 rainwater harvesting (RWH) pits strategically located across various sections to facilitate groundwater recharge.

The total rainwater harvesting potential for all catchment areas within the facility is estimated at 9,271.8 m^3, highlighting a significant opportunity to enhance groundwater recharge through improved rainwater collection and utilization strategies. Presently, approximately 42% of the harvested rainwater is used for groundwater recharge.

Recommendation

To maximize rainwater utilization and improve overall water sustainability, it is recommended to:

- Install additional ponds or construct a larger rainwater harvesting pit with a capacity of 8,878 m^3 to capture and store excess rainwater.
- Expand the use of harvested rainwater for domestic purposes, such as flushing and cleaning, to reduce reliance on borewell and municipal water.
- Enhance the collection infrastructure by installing more efficient drainage systems and optimizing runoff pathways to increase capture efficiency.

Benefits

Enhancing the rainwater harvesting system will:

- Increase groundwater recharge, supporting long-term water sustainability.
- Reduce dependency on external water sources, leading to cost savings.
- Improve water availability for domestic and operational use.

By implementing these recommendations, the facility can significantly increase rainwater harvesting efficiency, reduce water costs, and advance its sustainability goals.

Figure 24. Rainwater harvesting pit

Table 52. Rain water harvesting of the plant.

Description	Surface Area (m^2)	Maximum Rainfall (m)	Run off Co-efficient	Run off Volume (m^3)
College Gym	942.65	0.213	0.9	180.67
ICFE guest house	1400.75	0.213	0.9	268.47
B1 quarters	2655	0.213	0.9	508.87
E block	677	0.213	0.9	129.76
Scholars' residence	3046	0.213	0.9	583.81
ICFAI law school	1981.28	0.213	0.9	379.74
5-star building	1281.7	0.213	0.9	245.66
Maal road building	5407	0.213	0.9	1036.33
H-Block	2819	0.213	0.9	540.30
IBS campus 1	5604	0.213	0.9	1074.09
IBS campus 2	7201	0.213	0.9	1380.17
Library	1615	0.213	0.9	309.54
Seminar hall	415	0.213	0.9	79.54
ICFAI university	7433	0.213	0.9	1424.64

Description	Surface Area (m^2)	Maximum Rainfall (m)	Run off Co-efficient	Run off Volume (m^3)
ICFAI tech school	5368	0.213	0.9	1028.85
Entrance	198	0.213	0.9	37.95
AC plant	331	0.213	0.9	63.44
Non-building area	27,340	0.213	0.6	3493.37
Rainwater Harvesting				
Potential for rain water harvesting				9271.82
Actual rain water harvesting				393.75
Percentage of rain water harvesting				42%

7.2.2.1.2 Domestic water consumption

The facility's domestic water consumption is associated with the use of six specific fixtures, each contributing to the overall water usage. Water Closets (full flush) use 6 litres per flush (LPF), with an average daily usage of 1 flush per unit. Urinals consume 4 LPF and are flushed twice daily. Faucets and taps have a flow rate of 6 litres per minute (LPM) and are used approximately 4 times a day, while health faucets, also at 6 LPM, are used once daily. Shower heads discharge water at 10 LPM, with a daily usage of 0.1 times per unit, and kitchen faucets have a flow rate of 6.8 LPM and are used twice a day.

These fixtures collectively contribute significantly to the facility's indirect water consumption, underscoring the need for effective management. Adopting targeted water conservation strategies is crucial for optimizing water efficiency throughout the facility.

Table 53. Standard water flow in fixtures

SL. No	Fixture Type	Units	Maximum Flow rate/Consumption
1	Water Closets (Full flush)	LPF	6
2	Urinals	LPF	4
3	Faucets/Taps	LPM	6
4	Health Faucets	LPM	6
5	Lavatory	LPM	1.9
6.	Kitchen Faucets	LPM	6.8

Source: Universal Plumbing Code

7.2.2.1.3 Water fixtures and standard consumption in the facility

The facility is equipped with a range of water fixtures to effectively meet user needs and support operational efficiency. It includes 1,210 water closets (full flush), each consuming a maximum of 6 litres per flush, ensuring efficient waste disposal. Additionally, there are 960 urinals with a maximum consumption of 4 litres per flush, contributing to water conservation efforts. In the kitchen area, 4 kitchen faucets dispense water at a rate of 6.8 litres per minute, supporting food preparation and cleaning tasks. The facility is also equipped with 1,210 health faucets or user point valves, each operating at a maximum flow rate of 6 litres per minute, enhancing user convenience and hygiene. Moreover, 2,400 taps are installed throughout the facility, each with a flow rate of 6 litres per minute, ensuring adequate water availability for various needs. Lastly, the facility features 1,440 lavatory fixtures with a consumption rate of 1.9 litres per use, which are essential for personal hygiene and grooming. Collectively, these fixtures form a critical part of the facility's water management strategy, emphasizing the importance of monitoring and optimizing usage to promote sustainability and conserve resources.

Table 54. Water usage points

SL. No	Fixture Type	Units	Maximum Flowrate/Consumption
1	Water Closets (Full Flush)	1210	6
2	Urinals	960	4
3	Kitchen Faucets	4	6.8
4	Health Faucets/User Points Valves	1210	6
5	Taps	2400	6
6	Lavatory	1440	1.9

7.2.2.1.4 Measurement conducted in domestic water usage areas

A detailed assessment of water consumption was conducted on a sample basis, covering urinals, water closets, taps, kitchen faucets, and lavatories throughout the facility. The analysis identified key areas of high consumption, highlighting opportunities for improving water efficiency.

The table below provides a detailed analysis of water consumption across various facility sections, highlighting high-usage areas and their impact on total water consumption.

Kitchen Faucets

Water consumption in kitchen faucets is particularly high in dishwashing and plate washing areas. The Dishwash Area and Cooking section records a daily water consumption of 15,395 litres over 280 usage days, leading to an annual consumption of approximately 4,311 m³. Similarly, Plate Washing with Hot Water consumes 28,983 litres daily, contributing to an annual usage of 8,115 m³. Plate Washing with Normal Water results in a daily consumption of 24,604 litres, translating to 6,889 m³ annually.

Table 55. Water consumption in kitchen faucets

Location	Time (Sec)	Litre	LPM	No. of Counts	Full Time Equivalent	Duration of Use(mins)	Water Consumption per Day (Litres)	Usage Days	Annual Water Consumption (m³)
Dishwash area and cooking	9.12	1.3	8.6	2	3	60	15395	280	4311
Plate wash using hot water	4.72	1.2	15.3	1	5	1	28983	280	8115
Plate wash using normal water	5.56	1.2	12.9	1	5	1	24604	280	6889

Water Closets

The facility's water closets contribute significantly to overall water usage. Female dual flush type (half flush) water closets consume 14,963 litres daily, totalling 4,190 m³ annually, while female full flush units consume 7,481 litres daily, resulting in 2,095 m³ annually. Male full flush water closets use 5,985 litres daily, contributing to 1,676 m³ annually. Conventional male water closets consume 24,952 litres daily, leading to an annual usage of 6,987 m³, whereas conventional female water closets record a daily consumption of 46,786 litres, resulting in 13,100 m³ annually.

Table 56. Water consumption in water closets

Location	Litre	LPF	No. of Water Closets	Full Time Equivalent	Uses per person per Day	Water Consumption per day (Litres)	Usage Days	Annual Water Consumption (m^3)
Dual flush type water closets (Female -half flush)	10.5	8	242	891	2	14963	280	4190
Dual flush type water closets (Female -Full flush)	10.5	8	242	891	1	7481	280	2095
Dual flush type water closets (Male -Full flush)	10.5	8	242	713	1	5985	280	1676
Conventional type water closets (male)	10.9	9	968	2850	1	24952	280	6987
Conventional type water closets (female)	10.9	9	968	2672	2	46786	280	13100

Health faucets

Water consumption from health faucets also contributes to the facility's total usage. Dual flush type water closets with health faucets consume 11,002 litres daily, amounting to 3,081 m^3 annually, while conventional type water closets with health faucets consume 10,478 litres daily, translating to 2,934 m^3 annually.

Table 57. Water consumption in health faucets

Location	Time (Sec)	Litre	LPM	No. of Counts	Full Time Equivalent	Duration of Use(mins)	Uses per person per Day	Water Consumption per Day (Litres)	Usage Days	Annual Water Consumption (m^3)
Dual flush type water closets	3.4	0.35	6.2	242	3563	0.5	1	11002	280	3081

Location	Time (Sec)	Litre	LPM	No. of Counts	Full Time Equivalent	Duration of Use(mins)	Uses per person per Day	Water Consumption per Day (Litres)	Usage Days	Annual Water Consumption (m^3)
Conventional type water closets	3.57	0.35	5.9	968	3563	0.5	1	10478	280	2934

Lavatories

Water consumption in lavatories varies based on location and usage frequency. In Mess 2, the total daily consumption is approximately 9,188 litres, leading to an annual usage of 2,573 m^3. The FOL section records a lower daily consumption of 244 litres, contributing to an annual consumption of 68 m^3.

Table 58. Water consumption in lavatory

Location	Time (Sec)	Litre	LPM	No. of Lavatory	Full Time Equivalent	Duration of Use(mins)	Uses per person per Day	Water Consumption per Day (Litres)	Usage Days	Annual Water Consumption (m^3)
Mess 2	2	0.35	10.5	1	3500	0.08	3	9188	280	2573
FOL	4.3	0.35	4.9	1	300	0.08	2	244	280	68

Urinals

The facility operates 960 urinals, with a daily consumption of 4,275 litres across all units. This results in an annual consumption of approximately 1,197 m^3.

Table 59. Water consumption in urinals

Location	Litre	LPF	No. of Urinals	Full Time Equivalent	Uses per person per Day	Water Consumption per Day (Litres)	Usage Days	Annual Water Consumption (m^3)
Total ICFAI	0.60	0.60	960	3563	2	4275	280	1197

7.2.2.2 Water conservation awareness program in facility

Need of water conservation

Water plays a crucial role in the facility, serving various purposes such as domestic use, cooking, and cleaning. The facility's daily water requirement is approximately 882 m^3/day, which is sourced from borewells and the municipal corporation.

The table below summarizes the water costs incurred by the facility

Table 60. Summary of water cost in the facility

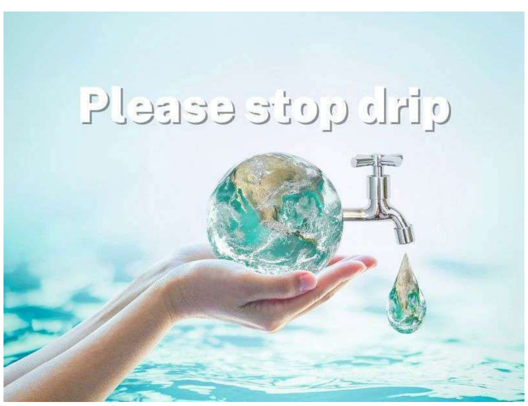
Description	Unit	Values
Water Cost	Rs/m^3	20.52

The high cost of water indicates that even a small amount of wastage can significantly increase annual operational expenses. Therefore, it is essential to minimize water consumption through effective water conservation measures to reduce overall costs and improve efficiency.

Water conservation program at institution

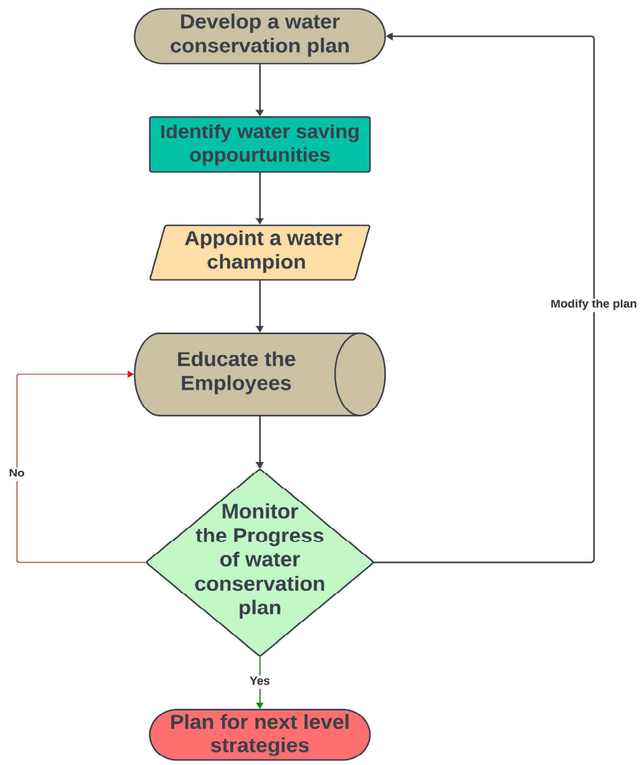
Addressing water conservation is a critical matter that necessitates the involvement of all individuals. To advocate for water conservation, it is vital to enhance people's awareness. One effective method is to showcase posters that underscore the significance of conserving water. These posters can be strategically placed at locations with high water usage, such as canteens, water dispensers, restrooms, and near block water usage points within the facility. Figure provides an illustration of a water conservation poster as an example.

Figure 25. Water conservation posters



Starting a water conservation program at your workplace can be a great way to promote water conservation and raise awareness among employees. Here are some steps you can take to get started.

Figure 26. Water conservation program plan



Initiate a water conservation plan: The first crucial step in launching a water conservation initiative involves creating a comprehensive plan. Various guidance documents on conservation planning are available to assist in this process. This plan should articulate the program's objectives, pinpoint areas where water savings can be achieved, and establish a roadmap for attaining these goals.

Uncover opportunities for water conservation: Following the development of a water conservation plan, the next step is to identify opportunities for saving water. This encompasses activities such as repairing leaks and installing low-flow fixtures

Designate a water champion: Ensuring the program's success and fostering active participation in water conservation can be facilitated by appointing a water champion. This individual can take charge of monitoring water usage, identifying potential areas for savings, and promoting water conservation practices among employees.

Educate the workforce: Critical to the program's success is educating employees about the significance of water conservation. This can be achieved through internal training programs or workshops. A survey indicates that 74% of workers feel they are not reaching their full potential at work and would appreciate access to more development opportunities. Offering educational initiatives brings various benefits to both employees and companies, providing a competitive edge in recruitment. The right educational offerings could be a decisive factor for candidates considering similar positions with comparable salary packages.

Track progress: Regularly monitoring the program's progress is vital to ensure it aligns with its goals. This involves tracking water usage and identifying areas where additional enhancements can be implemented.

7.3 Indoor environmental assessment

7.3.1 Indoor lighting

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*.

Figure 27. Lux meter

Table 61. Lighting lux level in college

Sl. No.	Building	Room	Type	Count	Lighting condition	Lux	Range of Service Illuminance (lux)	Remarks
1	Placement building	Auditorium	LED	40	OFF	528	300-750	Within limit
2	Corporate relations department	Waiting area/Lobby	Tube light	8	100% ON	254	150-300	Within limit
			LED	4	100% ON			
3	Case research centre	Entrance hall	LED	19	100% ON	318	150-300	Within limit
4	Wing C, D, E, F	Corridor	CFL	15	90% ON	856	50-150	Within limit
5	Wing C - marketing and strategy dept.	Waiting area/Lobby	CFL	12	100% ON	168	150-300	Within limit
6	Under dome	Outside lecture theatre/General area	Tube light	16	40-50% ON	785	200-500	Within limit
7	Wing E	Corridor	CFL	10	60-70% ON	134	50-150	Within limit
8	Wing E, F, G, H (2nd floor)	Outside lecture Theatre	CFL	6	75% ON	58	50-150	Within limit
9	Computer lab	IT Lab-1	LED	40	100% ON	339	300-750	Within limit
10	Lecture theatre P	Lecture hall	LED	16	OFF	670	300-750	Within limit
11	Guest house A6 ground floor	G-Floor main hall	LED	6	OFF	315	150-300	Within limit
		Dining area, outside bathroom	LED	8	OFF	380	150-300	Within limit
		Bedroom	LED	4	OFF	233	30-150	Within limit
		Master bedroom, bathroom	LED	7,1	OFF	295	30-150	Within limit
	Guest house A6 first floor	Hall	LED	9	OFF	250	150-300	Within limit
		Master bedroom, bathroom	LED	7,1	OFF	308	30-150	Within limit

Sl. No.	Building	Room	Type	Count	Lighting condition	Lux	Range of Service Illuminance (lux)	Remarks
		Bedroom	LED	6	OFF	221	30-150	Within limit
12	HVAC	Chiller	Tube light and LED	33	70% ON	73	100-200	Not Within limit
		Cabin	LED	2	100% ON	175	100-200	Within limit
13	Mess-1	Entrance area	LED	5	40% ON	751	150-300	Within limit
		Dining area, serving area	CFL+LED	22,4	80% ON	193	150-300	Within limit
14	Mess-2	Dining area, serving area	CFL+LED	24,4	85% ON	167	150-300	Within limit
		Outside Mess-2	LED	2	100% ON	61	50-150	Within limit
15	Boys hostel ABCD	D - 4th floor bathroom	LED	10	100% ON	325	50-150	Within limit
		C - 4th floor bathroom	LED	10	100% ON	320	50-150	Within limit
		A Block bathroom	LED	10	100% ON	625	50-150	Within limit
		B Block corridor	LED	6	100% ON	263	50-150	Within limit
16	Substation	HT room	LED	9	55% ON	64	100-200	Not Within limit
		Transformer 1	LED	4	100% ON	64	100-200	Not Within limit
		Transformer 2	LED	4	100% ON	35	100-200	Not Within limit
		DG	LED	10	50% ON	43	100-200	Not Within limit
17	Sports arena	Shuttlecock field	Tube light	10	100% ON	360	300-750	Within limit
			Stadium light	4x4	100% ON			
		Entrance area	CFL	9	OFF	OFF	50-100	-
18	Law school	Library	LED	40	100% ON	488	200-500	Within limit

Sl. No.	Building	Room	Type	Count	Lighting condition	Lux	Range of Service Illuminance (lux)	Remarks
		Faculty room	Tube light	11	100% ON	100	200-500	Not Within limit
		Outside area	Sodium Vapor	1	100% ON	8	50-150	Not Within limit
		Clinic	LED, Tube light	9	100% ON	142	50-150	Within limit
19	Memorial library	IT Lab-2	Tube light	40	65% ON	172	300-750	Not Within limit
			CFL	30	20% ON			
20	Maintenance staff room	Staff area	LED	28	65% ON	207	200-500	Within limit
		Meeting room	LED	2	OFF	312	200-500	Within limit
21	QRS girls hostel	Outside area	Sodium Vapor	1	100% ON	61	50-150	Within limit
			LED	1	100% ON	13	50-150	Not Within limit
		Left side of QRS	LED	1	100% ON	43	50-150	Not Within limit
		Pedestrian pathway	LED	7	100% ON	853	150-300	Within limit
22	Guest house	B1 Guest house outside area	LED	1	100% ON	50	50-150	Within limit
		B2 Entrance, Stairs	LED	4,2	100% ON	145	50-150	Within limit
		Deep entrance room hall	LED	6	100% ON	166	50-150	Within limit
23	Girls hostel	CT Block outside	LED	1	100% ON	95	50-150	Within limit
		CT Block entrance area	LED	4	100% ON	133	50-150	Within limit
		ET Block outside	LED	1	100% ON	29	50-150	Not Within limit
		ET Block entrance area, security lobby area	LED	6,3	100% ON	95	50-150	Within limit

Sl. No.	Building	Room	Type	Count	Lighting condition	Lux	Range of Service Illuminance (lux)	Remarks
		D1 Block	LED	1	100% ON	26	50-150	Not Within limit
		D2 Entrance	LED	12	100% ON	150	50-150	Within limit
		S1 Block	LED	13	100% ON	103	50-150	Within limit
24	STP-1	Outside area	LED	6	100% ON	70	50-150	Within limit
25	I and J boys hostel	I Block passageway	CFL	10	100% ON	54	50-150	Within limit
		Stairs	LED	2	100% ON	40	50-150	Not Within limit
		J block passageway	CFL	12	100% ON	55	50-150	Within limit
26	Pump house	Outside area	LED	2	100% ON	51	50-150	Within limit

Observations

- 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 daytime
- Food Lab, S&H room and Third floor corridor lightening has to be improved.

7.3.2 Indoor air quality

Indoor air quality in a university 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 conductive 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 62. 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

- Intelligent Air quality detector was used to detect the air pollutants like TVOC (Total volatile organic compounds), HCHO (Formaldehydes), PM_1, $PM_{2.5}$, PM_{10} (Particulate matters)
- Classrooms, Corridors, Laboratories, Office room, Faculty rooms and other common places of the university were checked for the IAQ standards as per ISO 16000, NBC and ASHRAE.

Figure 28. Intelligent air quality detector

Table 63. IAQ Parameters inside the university

Sl. No	Building Name	Floor	Room Number / Name	PM_1	$PM_{2.5}$	PM_{10}	HCHO	TVOC	Air quality	Air pollution level
1	IBS	Ground Floor	Auditorium outside	1587	10.4	17.5	0.01	0.01	37	Good
2			Auditorium	3231	21	37.4	0.01	0.01	69	Moderate
3			Corporate relations office (entrance)	2914	18.2	32.1	0.01	0.01	61	Moderate
4			Corporate relations office (corridor)	1730	10.2	10.1	0.02	0.02	42	Good
5			Case research centre	1248	7.6	12.8	0.02	0.02	30	Good
6			Wing D corridor	1676	10.6	18.6	0.02	0.02	40	Good
7			Marketing and Strategy Wing C	1732	10.9	12.5	0.01	0.01	45	Good
8			Lecture theatre D&C corridor	1628	10.3	12	0.02	0.02	42	Good
9			Wing E	1653	10.2	12.5	0.02	0.02	42	Good
10		2nd Floor	Outside lecture theatre EFGH	1508	9.7	16.7	0.01	0.01	38	Good
11		1st Floor	It lab	805	5.1	8.9	0.02	0.01	22	Good
12		Ground Floor (outside the building)	Lecture theatre p	1262	8.5	14.5	0.02	0.02	35	Good
13	Guest House	Ground Floor	A6 guest house	1203	7.6	13	0.02	0.02	30	Good
14		First Floor	A6 guest house	1336	8.4	14.6	0.01	0.01	35	Good
15		Outside A6	A6 guest house	2433	14.1	27.3	0.01	0.01	55	Moderate
16		Ground Floor	Entrance	1381	2.8	14.5	0.02	0.01	41	Good
17	HVAC	Ground Floor	Chiller area	1572	9.9	17.4	0.02	0.01	49	Good
18			Cabin room	1661	11.3	18.2	0.01	0.01	41	Good
19	Mess-1	Ground Floor	Entrance	1475	9.6	16.9	0.02	0.03	34	Good

Sl. No	Building Name	Floor	Room Number / Name	PM_1	$PM_{2.5}$	PM_{10}	HCHO	TVOC	Air quality	Air pollution level
20			Dining hall	1261	8.2	14.1	0.01	0.01	33	Good
21	Mess-2	Ground Floor	Dining hall	1606	10.2	17.8	0.01	0.01	43	Good
22	Hostel ABCD	4th Floor	D248	1462	9	16.2	0.01	0.01	37	Good
23			D405	1401	8.6	14.9	0.01	0.01	31	Good
24			C414	1456	9.5	16.5	0.02	0.03	37	Good
25			C404	1327	8.5	15.1	0.02	0.02	36	Good
26			A408	1503	9.8	17.7	0.02	0.01	38	Good
27			A418	1616	10.2	17.2	0.02	0.02	42	Good
28			A405	1209	7.8	14.1	0.01	0.01	30	Good
29			A412	1407	8.9	15..3	0.01	0.02	38	Good
30		Gound Floor	D002	1567	10.1	17.1	0.01	0.01	41	Good
31			New gym	1502	9.5	16.2	0.01	0.01	39	Good
32			B015	1286	8.1	12.8	0.02	0.01	30	Good
33			Entrance	1260	8	13.7	0.01	0.02	33	Good
34	Substation	Ground Floor	Panel room	1945	13.2	22.7	0.01	0.01	49	Good
35	Indoor Stadium (Sports)	Ground Floor	Shuttlecock field	1621	10.5	18.8	0.01	0.01	43	Good
36	Law School	Ground Floor	Library	522	3.3	6.6	0.01	0.01	12	Good
37			Faculty room	1507	9.8	16.6	0.01	0.06	39	Good
38	Memorial Library	Ground Floor	Main hall	1318	9.1	15.6	0.03	0.14	37	Good
39			Computer lab (IT lab -2)	779	5	8.6	0.01	0.02	21	Good
40	Maintenance Room	Ground Floor	Lobby area	1085	6.7	11.7	0.02	0.03	27	Good
41	Guest House	Ground Floor	B1 guest house (CMD quarters)	3283	21.9	37.7	0.01	0.01	74	Moderate

Observations

- The indoor air quality in the campus area is observed to be good in all locations.

7.3.3 Noise exposure assessment

6.3.3.1 Noise level regulation

- OSHA is the Occupational Safety and Health Administration (OSHA) established a noise exposure limit of 90 decibels A-weighted (dBA) for an 8-hour workday.
- The laws permitted larger noise exposures for shorter periods of time, with exposure time halved for every 5 dBA rise above 90 dBA.
- The OSHA rules, which were reinforced in 1983, stated that continuous exposure to noise levels over 115 dBA was not permitted for any length of time.
- The "action level" was established at 85 dBA, indicating the point at which employers must implement hearing conservation measures.
- Furthermore, the top limit for impulsive noise exposure was set at 140 dBA.

Table 64. Noise Level

Time	Exposure level per NIOSH	Exposure levels per OSHA
8 Hrs	85	90
4 Hrs	88	95
2 Hrs	91	100
1 Hrs	94	105
30 Minute	97	110
15 Minute	100	115

Figure 29. Noise exposure assessment instrument

Figure 30. Sample measurement images

Table 65. Noise exposure assessment in campus

Sl. No	Building Name	Floor	Room Number / Name	Maximum Decibel (dB)	Remarks
1	IBS	Ground floor	Auditorium	39	Within limit
2			Corporate relations department	48	Within limit
3			Case research centre	52	Within limit
4			Wing D - Marketing and Strategy Dept.	54	Within limit
5			Under dome	57	Within limit
6			Wing E	52	Within limit
7			Lecture theatre p	58	Within limit
8		2nd floor	IT lab-1	60	Within limit
9	Guest house A6	Ground floor	A6 guest house	42	Within limit
10	HVAC	Ground floor	Chiller area	86	Not within limit
11			Office/cabin	74	Within limit
12	Mess-1	Ground floor	Entrance area	65	Within limit
13			Dining area	78	Within limit
14	Mess-2	Ground floor	Dining area	77	Within limit
15	ABCD boys hostel	4th floor	D block	51	Within limit
16			C block	47.2	Within limit
17			B block	49	Within limit
18			A block	50	Within limit
19	Substation	Ground floor	Panel room	60.7	Within limit
20	Sports area	Ground floor	Indoor sports area	63.4	Within limit

Sl. No	Building Name	Floor	Room Number / Name	Maximum Decibel (dB)	Remarks
21	Law school	Ground floor	Library	44	Within limit
22			Faculty area	55.2	Within limit
23	Memorial library	Ground floor	IT lab-2	50	Within limit
24	Maintenance room	Ground floor	Staff area	50.3	Within limit

Figure 31. Noise measurement in HVAC plant

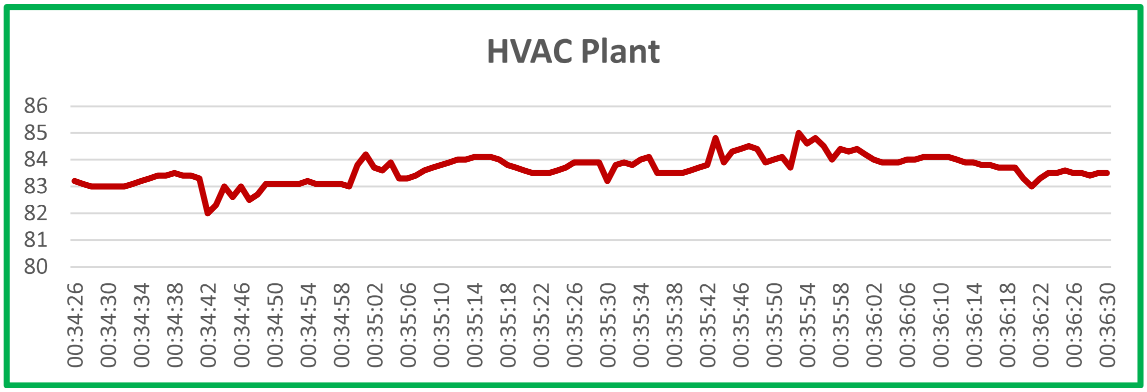
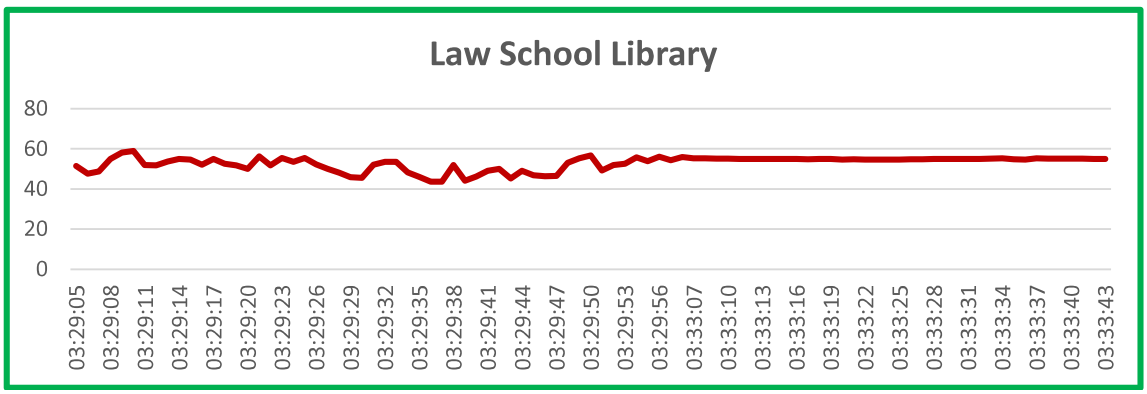


Figure 32. Noise measurement in law school library



Observation:

- The sound pressure level in the HVAC plant varies between 83 dB and 86 dB, which is near the permissible limit. It is recommended to provide earplugs for technicians working in the HVAC plant room.
- The main gathering places, corridors, library, lab, lecture halls were checked for the noise level on sample basis.
- Majority of the places are having required Nosie level as per standards.

Recommendation

- Keep placards in library and also in places like administrative blocks, laboratories, where noise level should be maintained.
- The noise level is higher in HVAC plant. Appropriate precautions, such as the use of earplugs or earmuffs, are recommended to protect hearing.

8.0 Greenhouse Gases (GHG)

8.1 Summary

This report provides the Scope 1, and 2 greenhouse gas (GHG) emissions inventory consolidated using the equity boundary for IFHE, Hyderabad for the reporting period between January 1, 2024 – December 31, 2024. This report has been written in accordance with Part 9.3.1 of the requirements of International Standards Organization (ISO) 14064-1 standard. Where applicable discretionary information has been disclosed consistent with section 9.3.2 of the Standard. The inventory has also been prepared in accordance with the Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard (the GHG Protocol).

The total of IFHE, Hyderabad GHG emissions for 2024 is 8035.67 tons of CO2-e. A breakdown by category of the reporting year emissions can be seen in the below table.

Table 66. Total GHG emission during 2024-2025

Emission	Total tCO_2e
Scope -1	3320.16
Scope -2	5610.36
Total	8830.67

8.2 Period covered by GHG emission

January 1st, 2024, to 31st December,2024

8.3 Reporting boundary

8.3.1 Scope 1 Emissions

Sources included in Scope 1 emissions comprised:

- Combustion of carbon-containing fuels in stationary equipment (e.g., diesel generator) for energy generation.
- Combustion of carbon-containing fuels in mobile equipment (e.g., Bus, tractor).
- Combustion of LPG in stationary equipment used in facility heating.
- Release of CO_2 from fire extinguishers.

Table 67.Scope -1 GHG emission

Category	Emissions
Stationary combustion	2934.22

Category	Emissions
Mobile combustion	284.12
Fire extinguisher	1.82
Total	3220.16

7.3.1.1 Stationary combustion

The stationary combustion emissions reported under Scope 1 account for the direct release of greenhouse gases resulting from the combustion of carbon-containing fuels in stationary equipment. Key sources identified include diesel generators for backup power, LPG-fired equipment used in mess for cooking purposes.

Emissions were calculated using fuel consumption data obtained from invoices, meter readings, and applying recognized emission factors from sources. The total emissions are 2934.22 CO_2e, ensuring consistency with GHG accounting standards.

Table 68. Emission from stationary combustion

Sl. No.	Year	Type of fuel	Fuel consumption	Unit	GHG emissions	Emission Factor (kg/litres)	GWP for 100-year horizon	Tonnes of CO_2 equivalent/yr
1	2024-2025	Diesel	7489	Liter	CO_2	2.9	1	2275.2
					CH_4	0.00039	29.8	
					N_2O	0.00002	273	
2	2024-2025	LPG	65020	Kilogram	CO_2	2.9	1	659.04
					CH_4	0.24	29.8	
					N_2O	0	273	

The table provides data of stationary combustion emissions: Diesel and LPG. Diesel consumption is 7489 litres, resulting in 2275.2 tonnes of CO2 equivalent emissions. LPG consumption is 65020 kilograms, leading to 659.04 tonnes of CO2 equivalent emissions.

7.3.1.2 Mobile combustion

The mobile combustion emissions reported under Scope 1 include greenhouse gas emissions resulting from the combustion of carbon-containing fuels in vehicles and mobile equipment owned or controlled by the organization. This encompasses fuel use in company-owned buses, Ambulances, and other transport or operational vehicles. The total emissions are 284.12 CO_2e, ensuring consistency with GHG accounting standards.

Table 69. Total GHG emission from mobile combustion

Sl. No.	Model	Vehicle Number	Liter of fuel	Total emission (Mt/year)
1	2021	TSO7 UL 2851 (EICHER BUS)	3169.52	40.29
2	2021	TSO7 UL 2852 (EICHER BUS)	3059	39.19
3	2021	TSO7 UL 2853 (EICHER BUS)	3118.7	42.34
4	2023	TS09UD9236 (EICHER MINIBUS)	1506.49	23.37
5	2015	TS07 EX 4393 (TEMPO TRAVELER)	582.24	10.98
6	2018	TS 09 UC 3626 (TRACTOR)	0.00	0.00
7	2019	TS 09 UC 3627 (AMBULANCE)	464	8.71
8	2019	TS 09 UC 3628 (AMBULANCE)	594	11.66
9	2018	TS 09 FD 6025 (CIAZ CAR)	1243	44.58
10	2018	TS 09 FD 6026 (INNOVA)	1217.3	32.60
11	2020	TS 09 UD 0907 (TATA INTRA)	568.93	20.11
12	2020	TS 09 UD 0908 (TATA INTRA)	431.37	10.29

The table provides mobile combustion data for various vehicles, detailing their model year, vehicle number, fuel consumption. The vehicles include Eicher buses from 2021 with emissions ranging from 39.19 to 42.34 Mt/year, a 2023 Eicher minibus with 23.37 Mt/year, and a 2015 Tempo Traveler with 10.98 Mt/year. Other vehicles include a 2018 tractor with no emissions recorded, 2019 ambulances with emissions of 8.71 and 11.66 Mt/year, and 2018 cars like the Ciaz and Innova with emissions of 44.58 and 32.60 Mt/year, respectively. Additionally, 2020 Tata Intra vehicles show emissions of 20.11 and 10.29 Mt/year.

7.3.1.3 Fire extinguisher

The emissions from fire extinguishers are classified as Scope 1 if they involve the release of greenhouse gases through discharge. These emissions typically arise from extinguishers containing Carbon dioxide This encompasses all the use of fire extinguisher in organisation. The total emissions are 1.8t CO_2e, ensuring consistency with GHG accounting standards.

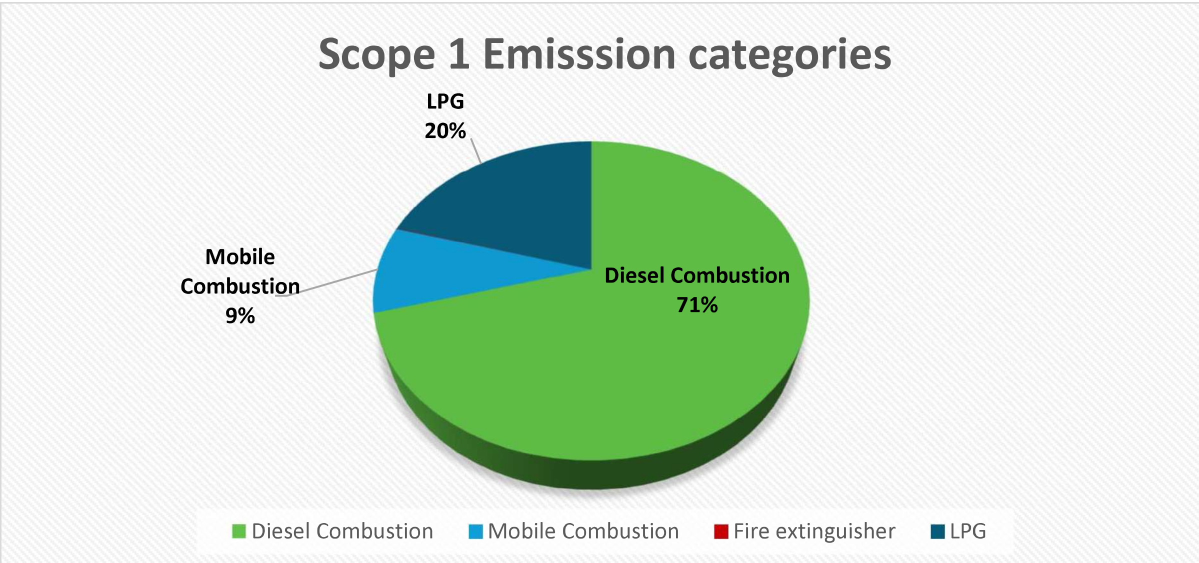
Table 70. GHG emission from fire extinguisher

Year	Gas	GWP	No's	Quantity	GHG emissions
				kg	$MTCO_2e$
2024-2025	CO_2	1	405	4.5	1.8225

The table provides data on greenhouse gas emissions from fire extinguishers for the year 2024-2025. It focuses on CO_2 with a global warming potential (GWP) of 1. There are 405 units, with a total quantity of 4.5 kg, resulting in GHG emissions of 1.8225 tonnes of CO2 equivalent per year.

7.3.1.4 Scope 1 breakdown

Figure 33. Scope 1 GHG emission



The Scope 1 emissions inventory highlights the primary sources contributing to direct greenhouse gas (GHG) emissions within the IFHE, Hyderabad operational boundary. The assessment reveals that stationary combustion is the largest contributor, accounting for 71% of total Scope 1 emissions. This is primarily driven by the combustion of fuels such as diesel in equipment and LPG.

LPG combustion represents 20% of total Scope 1 emissions, stemming from its use in heating systems and production processes. Mobile combustion contributes 9%, linked to fuel consumption in company-owned vehicles such as buses, tractors, and forklifts. While fire extinguisher emissions were minimal.

8.3.2 Scope 2 emissions

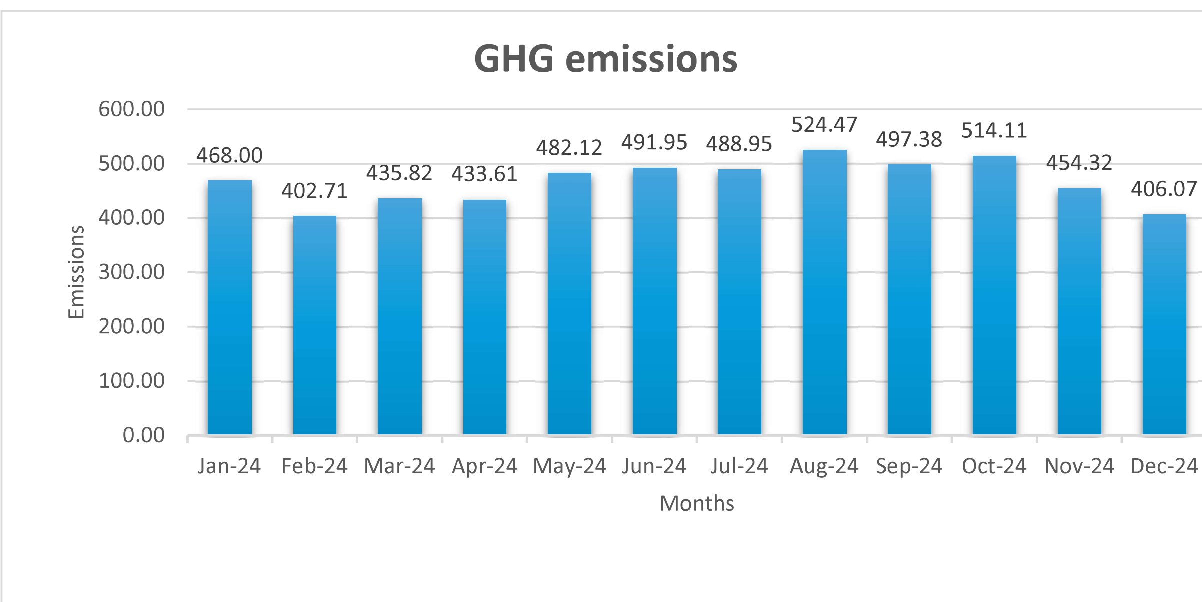
The Scope 2 emissions inventory for the IFHE, Hyderabad reflects indirect greenhouse gas emissions resulting from purchased electricity and other energy sources. The contributor to Scope 2 emissions is purchased electricity, accounting for most of the energy consumption across facilities. Emission calculations were based on verified energy consumption data from utility bills and meter readings, combined with recognized emission factors from sources from CEA 2024.

Table 71. Scope -2 GHG emission

SL No	Month	kVAh Consumption	GHG emission (Tonnes of CO_2)
		kVAh	
1	Jan-24	6,43,740	468.00
2	Feb-24	5,53,940	402.71
3	Mar-24	5,99,480	435.82
4	Apr-24	5,96,440	433.61
5	May-24	6,63,160	482.12
6	Jun-24	6,76,680	491.95
7	Jul-24	6,72,560	488.95
8	Aug-24	7,21,420	524.47
9	Sep-24	6,84,160	497.38
10	Oct-24	7,07,160	514.11
11	Nov-24	6,24,920	454.32
12	Dec-24	5,58,560	406.07
Total		**77,02,220**	**5599.51**

The IFHE, Hyderabad's Scope 2 emissions for the year 2024 were calculated based on electricity consumption data recorded in kWh across all operational facilities. The total electricity consumption for the year amounted to 77,02,220 kVAh, resulting in total Scope 2 emissions of 5599.51 tonnes of CO_2.

Figure 34. GHG emission

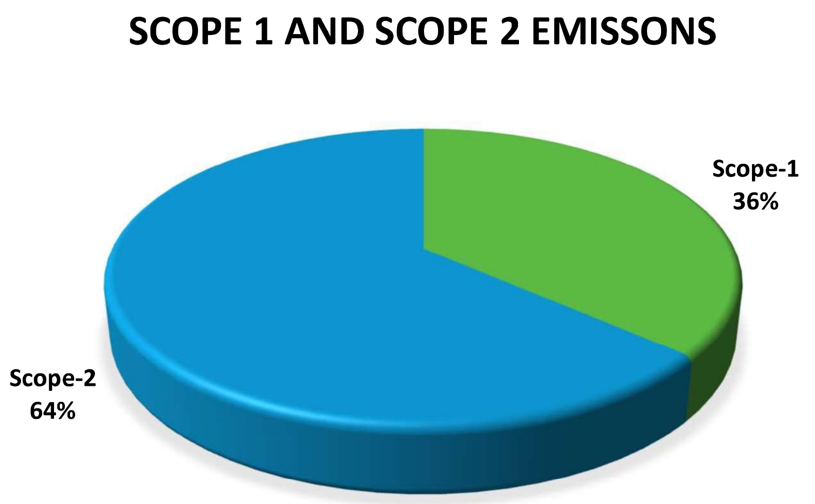


The graph illustrates the IFHE, Hyderabad monthly GHG emissions for 2024, showing fluctuations in emissions levels throughout the year. Emissions varied between 402.71 tonnes of CO_2 in February 2024 (the lowest) and 524.47 tonnes of CO_2 in August 2024 (the highest).

The data shows a general upward trend from February to August, with emissions peaking in August. This period may reflect increased operational activities or higher energy demand during the summer months. Following this peak, emissions gradually declined towards the year-end, reaching 406.07 tonnes of CO_2 in December 2024.

8.3.3 Scope1 and 2 breakdowns

Figure 35. GHG emission



The chart illustrates the proportion of Scope 1 and Scope 2 emissions within the organization's total greenhouse gas (GHG) inventory. Scope 2 emissions account for the majority at 64%, while Scope 1 emissions contribute 36%. The dominance of Scope 2 emissions indicates that indirect emissions from purchased electricity are the primary contributor to the IFHE, Hyderabad. In contrast, Scope 1 emissions, which result from direct sources such as fuel combustion in stationary and mobile equipment, form a smaller but still significant portion.

8.4 Carbon sequestration

Carbon sequestration is the process by which trees and other vegetation absorb and store carbon dioxide (CO_2) from the atmosphere through photosynthesis. Integrating carbon sequestration data into the organization's GHG inventory provides a more comprehensive view of its environmental impact and offsetting potential. Trees act as natural carbon sinks, capturing CO_2 and storing it in their biomass (trunks, branches, and roots) and soil. The rate of sequestration depends on factors such as tree species, age, size, and environmental conditions.

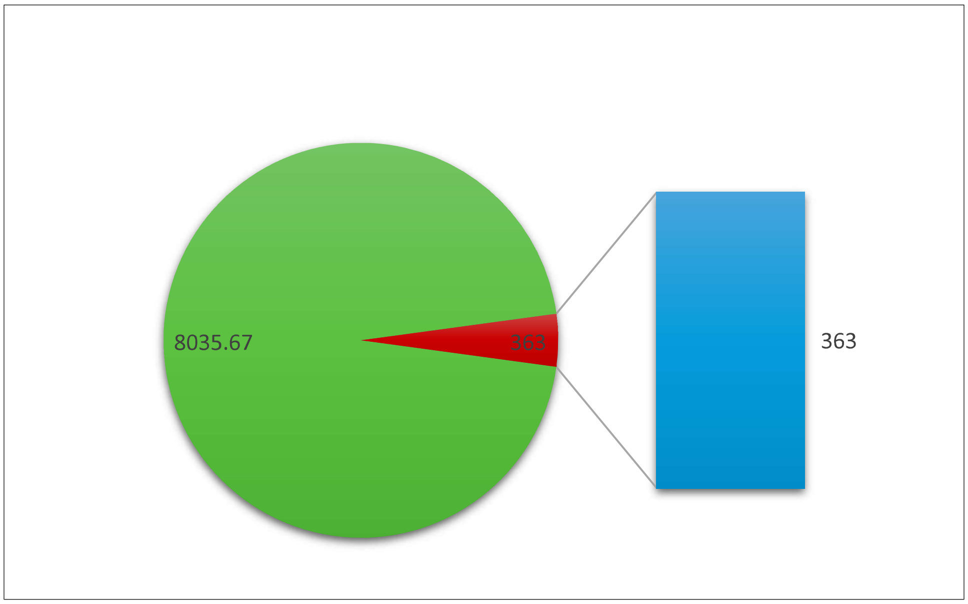
Table 72. Carbon sequestration by trees

Sl	Common name	Qty (no's)	Above ground biomass	Below ground biomass	Total biomass	Total dry weight	Total carbon	CO_2 weight
1	Mango	404	221.5	44.3	265.8	192.7	96.4	353.7
2	Sapota	101	852.2	170.4	1022.6	741.4	370.7	1360.5
3	Coconut	470	225600.0	45120.0	270720.0	196272.0	98136.0	360159.1
4	Pomegranate	85	1.6	0.3	1.9	1.4	0.7	2.5
5	Goa (Guava)	93	7.0	1.4	8.4	6.1	3.0	11.1
6	Neredu (Jamun/Black Plum)	61	74.7	14.9	89.7	65.0	32.5	119.3
7	Jackfruit	2	0.2	0.0	0.3	0.2	0.1	0.4
8	Amla (Indian Gooseberry)	11	1.2	0.2	1.5	1.1	0.5	1.9
9	Musambi (Sweet Lime)	1	0.1	0.0	0.1	0.1	0.0	0.2
10	Orange	1	0.1	0.0	0.1	0.1	0.0	0.2
11	Lemon	0	0.0	0.0	0.0	0.0	0.0	0.0
12	Drumstick	6	0.7	0.1	0.8	0.6	0.3	1.1
13	Tamarind	8	0.9	0.2	1.1	0.8	0.4	1.4
14	Neem	1864	356.3	71.3	427.6	310.0	155.0	568.8
	Gulmohar (Flame Tree)		284.1	56.8	340.9	247.1	123.6	453.5
Total matured trees		3107.0	227400.6	45480.1	272880.7	197838.5	98919.3	363.0

The IFHE, Hyderabad tree plantation initiative includes a diverse variety of 4,765 trees across multiple species, contributing significantly to carbon sequestration. The total estimated CO_2 captured by these trees amounts to approximately 363,000 kg (363 tonnes).

- A total of 1,243 trees were planted, with major contributors being Mango (353.7 kg CO_2), Sapota (1,360.5 kg CO_2), and Coconut (360,159.1 kg CO_2). Coconut trees accounted for the largest share of carbon sequestration due to their extensive biomass and growth characteristics.
- The plantation also includes 1,864 trees such as Neem (568.8 kg CO_2) and Gulmohar (453.5 kg CO_2), enhancing both carbon capture and the aesthetic value of the premises.
- An additional 1,658 plants contribute to the green cover, though their individual sequestration impact is minimal.

Figure 36. Total GHG emission



The chart illustrates that 4% of the university's total greenhouse gas (GHG) emissions reduction was achieved through tree plantation initiatives. Trees play a significant role in carbon sequestration by absorbing atmospheric CO_2 during photosynthesis and storing carbon in their biomass and soil.

9.0 Biodiversity

A biodiversity audit ensures the greenery and sustainability of the campus. The biodiversity audit is conducted to analyse 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, students from the green and environmental club were involved to identify the flora and fauna present on campus. The focus is also given to pollution control methodology, best practices for environmental conservation, etc. This audit gives recommendations to the university 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 4765 floral species are seen around the university.
- Around 300 mature trees of various species are found.
- Large variety of 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.

Table 73. Floral species in the campus

Sl. No.	Common Name	Scientific name	Qty
1	Mango	Mangifera indica	404
2	Sapota	Manilkara zapota	101
3	Coconut	Cocos nucifera	470
4	Pomegranate	Punica granatum	85
5	Goa (Guava)	Psidium guajava	93
6	Neredu (Jamun/Black Plum)	Syzygium cumini	61
7	Jackfruit	Artocarpus heterophyllus	2
8	Amla (Indian Gooseberry)	Phyllanthus emblica	11
9	Musambi (Sweet Lime)	Citrus limetta	1
10	Orange	Citrus sinensis	1
11	Lemon	Citrus limon	0
12	Drumstick	Moringa oleifera	6

Sl. No.	Common Name	Scientific name	Qty
13	Tamarind	Tamarindus indica	8
Fruit-bearing trees Total			1243
14	Other (i.e. Neem, gulmor, etc))		1864
	Neem	Azadirachta indica	
	Gulmohar (Flame Tree)	Delonix regia	
15	Plants (flower and beautification) excluding crotons- boarder plants	-	1658
Total			4765

Figure 37. Floral species in the campus

Table 74. Faunal species in the campus

Sl. 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	Parrot	Psittaciformes
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
22	Coucal	Centropus sinensis

Figure 38. Faunal species in the campus

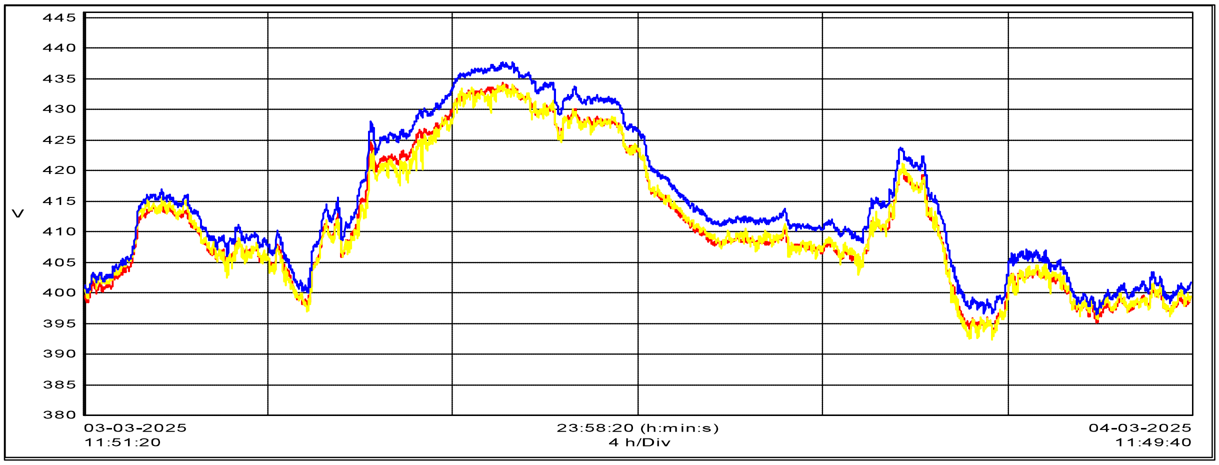
Recommendations

- To maintain the university 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.

10.0 Electrical Parameter Graphs

10.1 2000 kVA Transformer-1

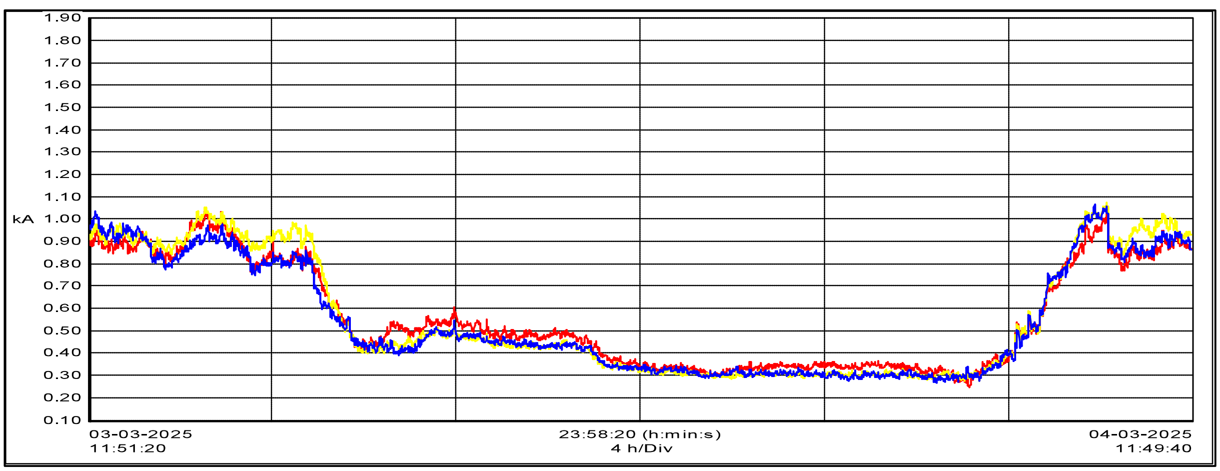
Figure 39. Voltage profile for transformer-1



Observations:

- The voltage varies from 398 V to 436 V. The average voltage is 411 V during recording time.
- The voltage profile value is within the limit specified as per the IEC 60038-2009 (±10%) standard.

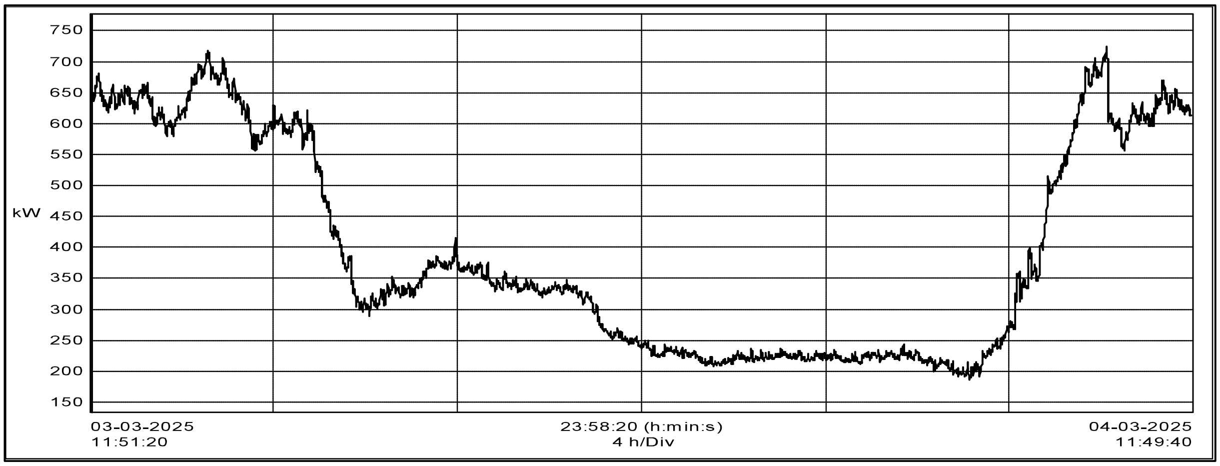
Figure 40. Current profile for transformer-1



Observations:

- The transformer-1 current varies from 250 A to 1.06 kA during recording time.

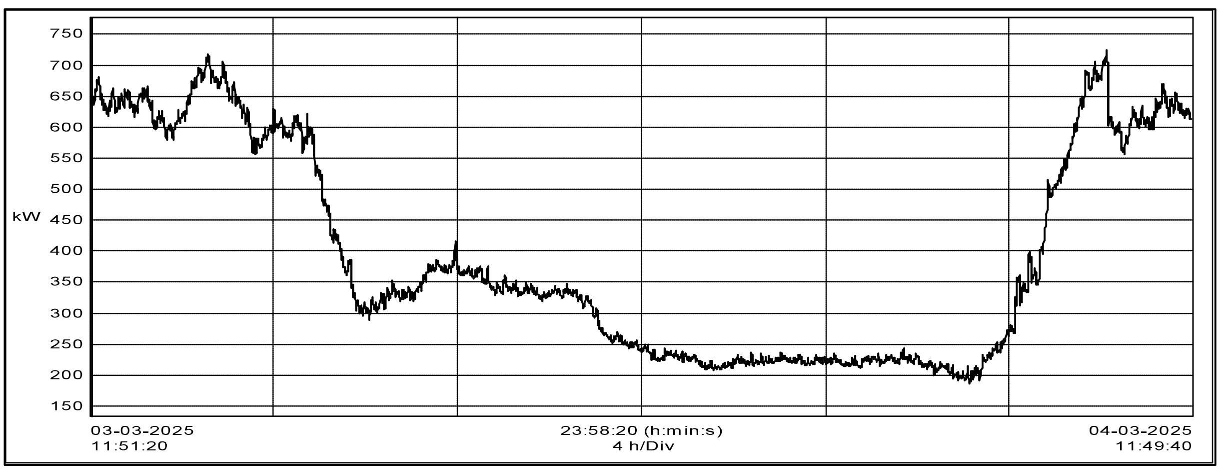
Figure 41. Power profile for transformer-1



Observations:

- The Power of the main incomer varies from 188 kW to 724 kW. Average power is 394.8 kW during recording time.

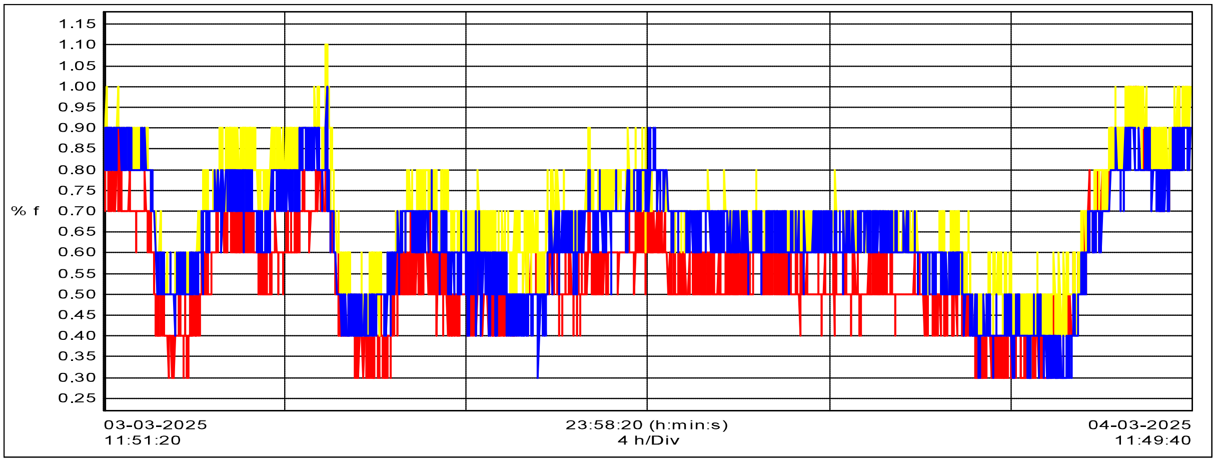
Figure 42. Power factor for transformer-1



Observations:

- The Power factor of the transformer-1 varies from 0.979 to 0.998. Average power factor is 0.995 during recording time.

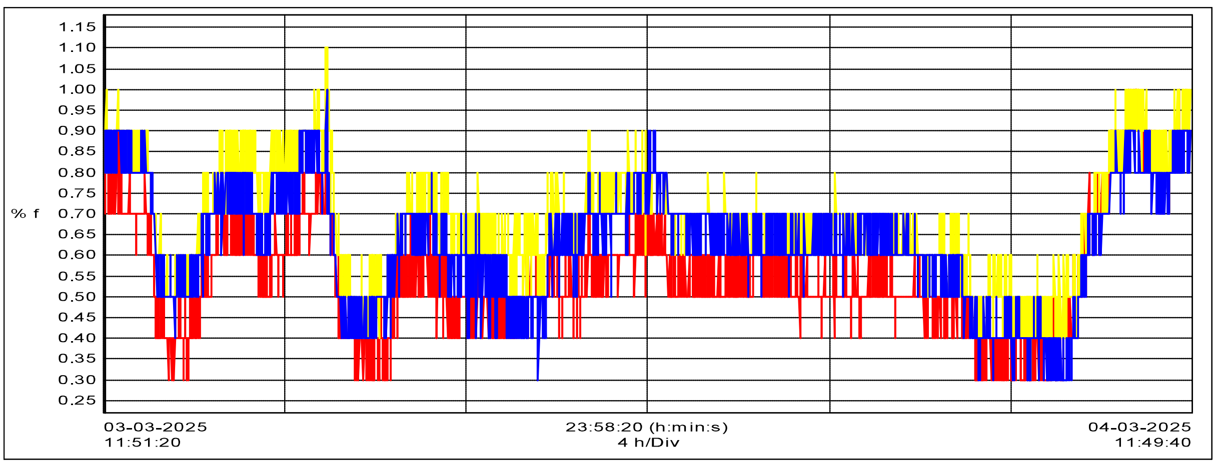
Figure 43. *Total harmonic distortion of voltage (V_{THD}%) profile for transformer-1*



Observations:

- The transformer-1 Voltage Harmonic (V $_{THD}$%) is varies from 0.3% to 1.1%.

Figure 44. *Total harmonic distortion of current (I_{THD}%) profile for transformer-1*

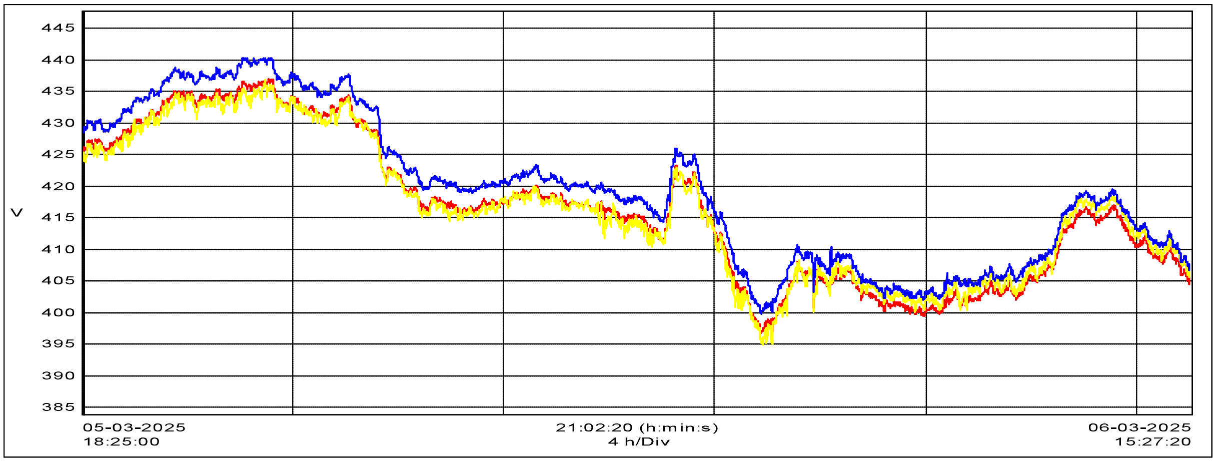


Observations:

- The transformer-1 Current Harmonic (I_{THD}%) is varies from 3.29 % to 13 %.

10.2 2000 kVA Transformer-2

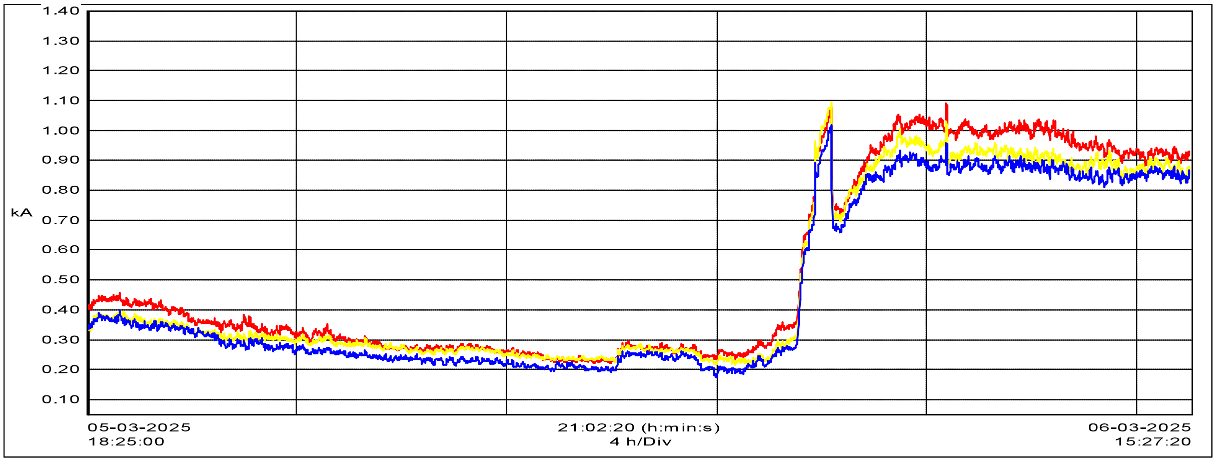
Figure 45. Voltage profile for transformer-2



Observations:

- The voltage varies from 396 V to 440 V. The average voltage is 416 V during recording time.
- The voltage profile value is within the limit specified as per the IEC 60038-2009 (±10%) standard.

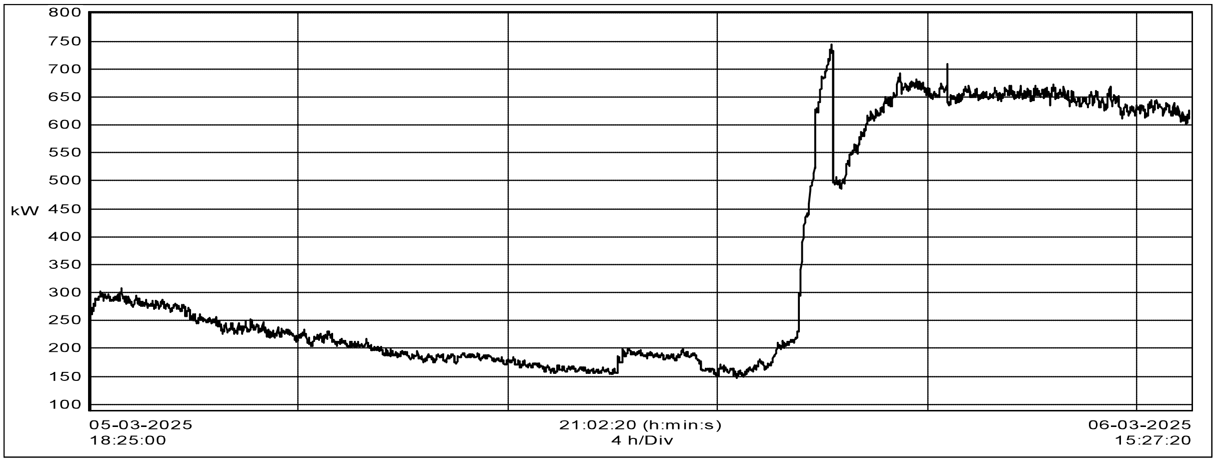
Figure 46. Current profile for transformer-2



Observations:

- The transformer-2 current varies from 172 A to 1.07 kA during recording time.

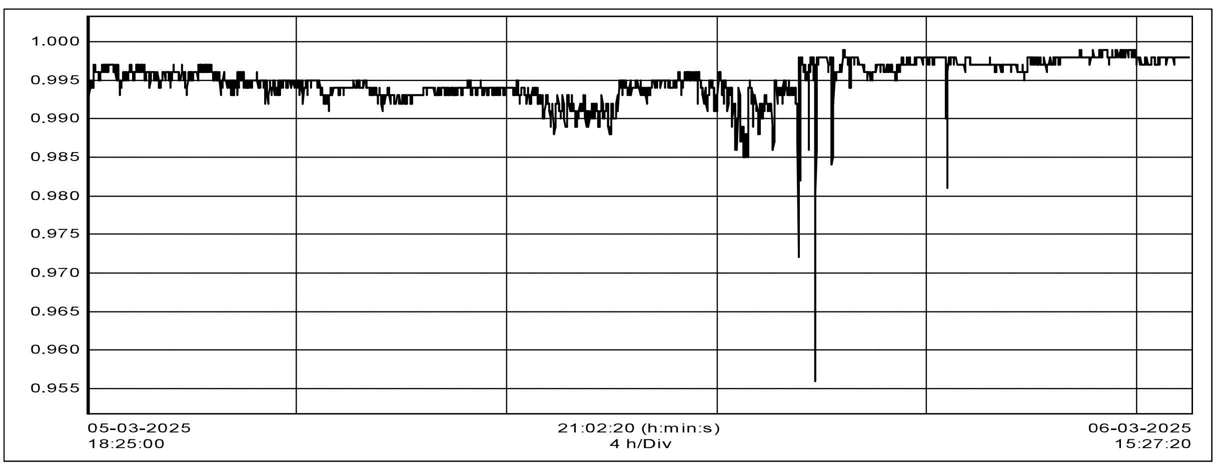
Figure 47. Power profile for transformer-2



Observations:

- The Power of the main incomer varies from 147 kW to 740 kW. Average power is 355 kW during recording time.

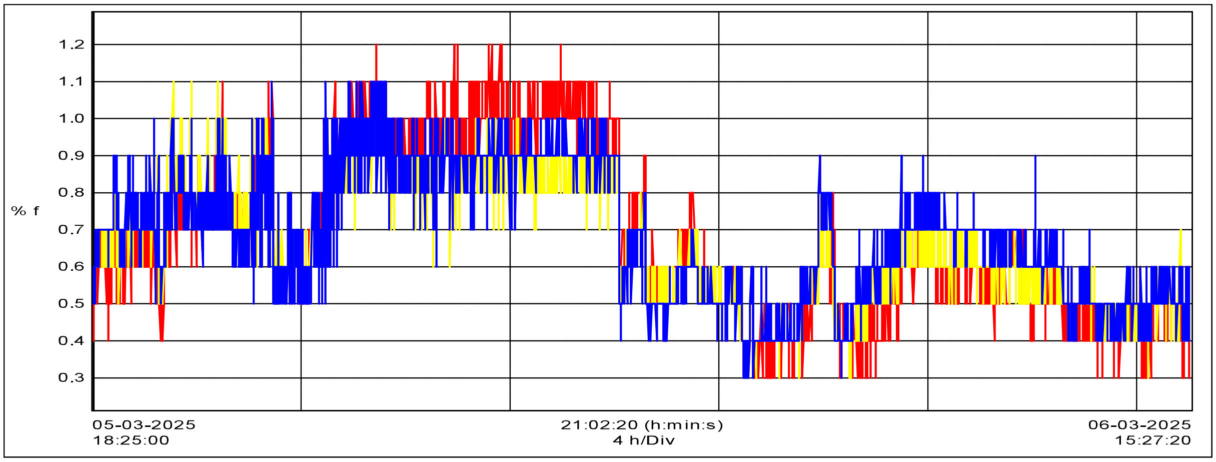
Figure 48. Power factor for transformer-2



Observations:

- The power factor of the transformer-2 varies from 0.956 to 0.999. Average power factor is 0.995 during recording time.

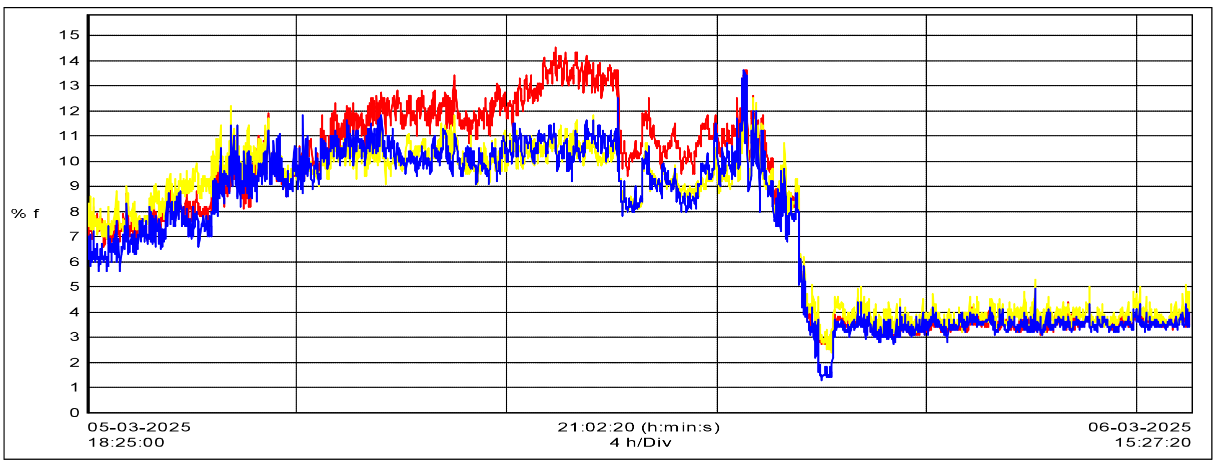
Figure 49. Total harmonic distortion of voltage (V_{THD}%) profile for transformer-1



Observations:

- The transformer-1 Voltage Harmonic (V $_{THD}$%) is varies from 0.3% to 1.2%.

Figure 50. Total harmonic distortion of Current (I_{THD}%) profile for transformer-1



Observations:

- The transformer-1 Current Harmonic (I_{THD}%) is varies from 1.3 % to 14.4%.

***Bigeta Energy Solutions LLP** is an ISO 9001:2015 certified, Energy & Sustainability Management company. We provide consultancy services in Energy Audits & Assessments, Electrical Power Assessment, Electrical Safety Assessment, ETAP Analysis, Measurement & Verification, Thermal Imaging, Energy Data Analytics, Green Building, ISO 50001 EnMS and Training. We are a team of BEE accredited energy auditor, BEE certified energy auditor, energy manager, Certified Measurement and Verification Professional (CMVP), ISO 50001 lead auditor, IGBC Accredited Professional (IGBC AP), GRIHA Certified Professional and power quality professionals committed to giving most promising solutions to customers to save energy and attain sustainability.*

Registered Office

Bigeta Energy Solutions LLP

K 206, Confident Atik, Sompura Gate, Sarjapura,
Bangalore-562 125, Karnataka
info@bigetaenergy.com, +91 99 00 591 000
www.bigetaenergy.com