Energy and Green Audit Report

August - 2023

Shri Madhwa Vadiraja Institute of Technology & Management, Udupi, Karnataka

Bigeta Energy Solutions LLP

Bengaluru

bigetaenergy.com

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SHRI MADHWA VADIRAJA
INSTITUTE OF TECHNOLOGY & MANAGEMENT
Vishwothama Nagar, Udupi Dist.
BANTAKAL

Acknowledgement

Bigeta Energy Solutions is thankful to Shri Madhwa Vadiraja Institute of Technology & Management for providing us an opportunity to conduct an energy and green audit at their institution located in Vishwothama Nagar, Bantakal, Udupi, Karnataka. We are grateful to Dr.Thirumaleshwara Bhat - Principal, Dr.Ganesh Aithal - Vice Principal, Dr. Sudarshan Rao - Dean (Quality Assurance), Mr. Vinayaka - Maintenance Engineer, 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
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1.0 Introduction

The working details of assignment are as follows:

Project	**Energy and Green Audit**
Client	**Shri Madhwa Vadiraja Institute of Technology & Management**
Industry	Engineering College
Contact	Dr. Sudarshan Rao K Dean (Quality Assurance) Mobile- +91 9448252890 Email: qa@sode-edu.in
Site	Vishwothama Nagar, Bantakal, Udupi, Karnataka - 574115
Consultant	Bigeta Energy Solutions LLP Bangalore, India
Duration	28 and 29-Aug-2023
Project Scope	To conduct energy and green audit at Shri Madhwa Vadiraja Institute of Technology & Management
Report	This document gives recommendations, details of findings and the way forward.
Consultants involved	Mr. Benet George V - BEE Accredited Energy Auditor- AEA0053 Dr. Ganapathi A (EA-34973/23) Alwar Purushotham - Sr.Engineer
Notes	The suggestions / alternatives in the audit report are based on the present operating conditions of equipment/systems and to the best of our knowledge.

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1.1 About the college

Shri Madhwa Vadiraja Institute of Technology and Management, established in Bantakal in 2010, is managed by Shri Sode Vadiraja Mutt Education Trust, Udupi. It is represented by its present head, Shree Vishwa Vallabha Theertha Swamiji. The trust was registered on October 29, 2009, as a charitable trust under the Indian Trusts Act 1882. The trust is set up with the express objective of promoting educational and research activities in the rural areas of the country.

More than 1200 students are currently pursuing engineering degrees in the fields of computer science, electronics and communication, mechanical engineering, and civil engineering. In terms of infrastructure, SMVITM is comparable to other well-established engineering colleges in the region.

The institution is getting power from Mangalore Electricity Supply Company Ltd. (MESCL). Electricity is received at 11 kV, and a 500 kVA transformer is installed in the institution to step down the incoming 11 kV supply to 433 kV. Other than the EB power supply, there are two DG's of 160 kVA and 62.5 kVA in the institution to generate power in case of EB power failure. The institute has also installed a 125-kW solar system to generate electricity.

Major Loads in the Institution:

- Fans and Lights
- Air Conditioners
- UPS
- Computers
- Pumps
- Air Blowers

Table 1. Student's details

Programme		From the state were College is located	From other states of India	NRI students	Foreign students	Total
UG	Male	669	25	1	0	695
	Female	580	5	0	0	585
	Others	0	0	0	0	0

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Table 2. Faculty details

Highest Qualification	Professor			Associate Professor			Assistant Professor			Total
	Male	Female	Others	Male	Female	Others	Male	Female	Others	
Ph.D.	5	0	0	3	5	0	4	2	0	19
PG	2	0	0	1	0	0	21	33	0	57

There are 1280 students enrolled in the college's undergraduate programs, which include CSE, ECE, MECH, CIVIL, AIML, and AIDS. In addition, the College confers Ph.D. degrees, and it has 76 faculty members.

1.2 Vision and Mission

Vision

To establish an excellent, value-based higher educational hub to meet the challenges of global competitiveness.

Mission

To impart holistic education with state-of-the-art infrastructural facilities and conducive academic ambience, at affordable costs, leading to the creation of centres of excellence with best brains collectively interacting for total personality development and intellectual growth.

1.3 Infrastructure

Figure 1. *Location of College*

The college has a total built-up area of 74460.06 square meters, and it has all of the necessary physical amenities.

1.4 Energy and Green Audit

Detailed energy and green audit fieldwork has been conducted during 28th and 29th, August 2023. In addition to external team, staff and students also involved in the audit.

1.5 Energy Audit methodology

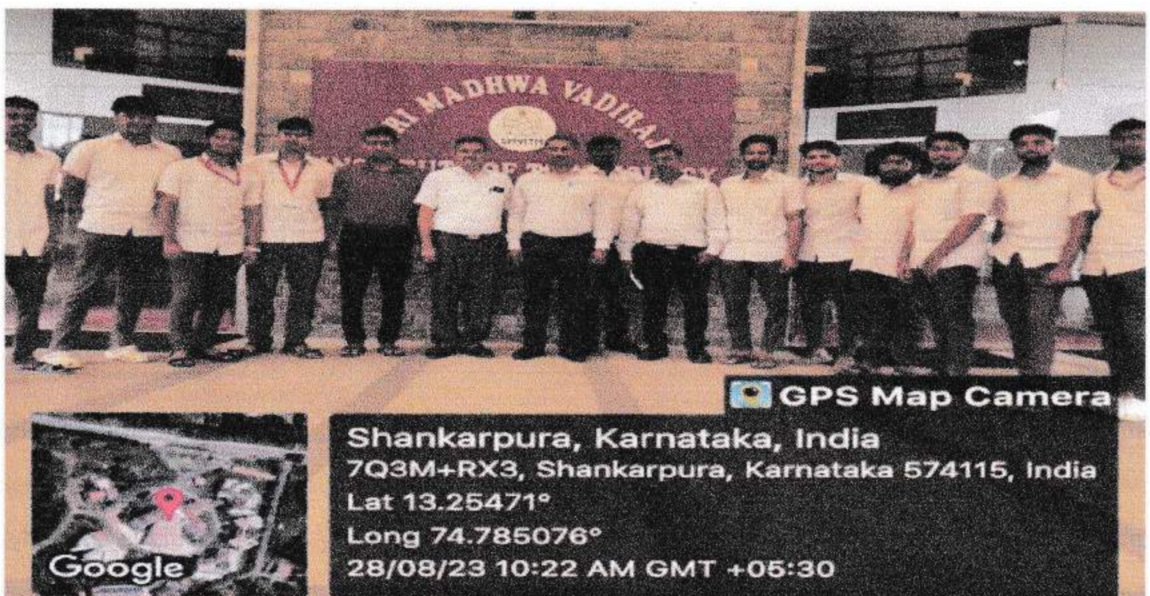
Phase 1 - Pre-Audit

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

Phase 2 - Field work and data collection

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

Figure 2. *Opening meeting*



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Phase 3 - Report

Analysis of the data and preparation of the report.

1.6 List of faculties and students who participated in the Audit

Table 3. List of faculty members involved in Audit process

S. No.	Name	Designation
1	Dr. Thirumaleshwara Bhat	Principal
2	Dr. Ganesh Aithal	Vice Principal
3	Dr. Sudarshan Rao K	Dear (Quality Assurance)
4	Mr. Vinayaka	Maintenance Engineer
5	Mr. Dinesh Kumar	Maintenance Assistant
6	Mr. Sathish Bangera	Electrician

Table 4. List of students who participated in the audit

S.No	Student Name	Year	Reg. No	Team
1	Dhanish Mohammed	II	4MW21ME004	Energy Audit
2	S.Chetam	II	4MW22ME402	
3	kitan Avari	II	4MW21ME009	
4	Guru Kiran B	II	4MW21ME400	
5	Sagar	II	4MW21CV007	
6	K.Sathvik Acharya	II	4MW21CV003	
7	Aryan Raj	II	4MW21CV001	Bio Diversity
8	Likhith Yermal	II	4MW21ME010	
9	Gagan Kumar	II	4MW21ME005	
10	Annapa	II	4MW22CV400	
11	Rohith	II	4MW22ME401	
12	Shiv preeth	II	4MW22ME403	

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

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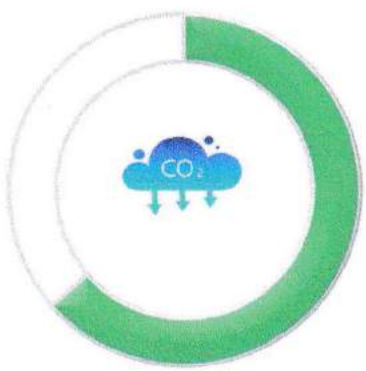
Table 5. Carbon (CO_2) offset

Sl.No	Description	Type of Energy and their CO_2 Conversion Process			
		Electricity kWh	Diesel (Vehicle + DG) Litre	Petrol (Vehicle) Litre	LPG kg
1	Annual Consumption	215693	27655	430	6400
2	CO2 Emission (Tons/Annum)	177	73	1	19
3	Total CO_2 Emission (Tons/Annum)				270 (↑)
4	No. of Matured Trees Available				700
5	CO_2 offset due to Trees (Tons/Annum)				15.26 (↓)
6	Annual Energy Exported from SPV Plant (kWh)				29982
7	CO_2 offset due to export Solar Power Plant (Tons/Annum)				25 (↓)
8	CO_2 Emission per (Tons/Annum) currently				230 (↑)
9	Expected Reduction of Annual Electricity Consumption after Implementing Proposed Energy Conservation Measures (kWh)				95438
10	CO_2 offset after implementing ECM (Tons/Annum)				78.3 (↓)
11	Expected Reduction of Annual LPG Consumption after Implementing Proposed ECM (kgs)				1232 (↓)
12	CO_2 offset after implementing biogas plant instead of LPG (Tons/Annum)				3.7 (↓)
13	Amount of CO_2 to be offset final (Tons/Annum)				82 (↔)
14	Per Capita CO_2 Consumption (Tons/Annum)				0.116

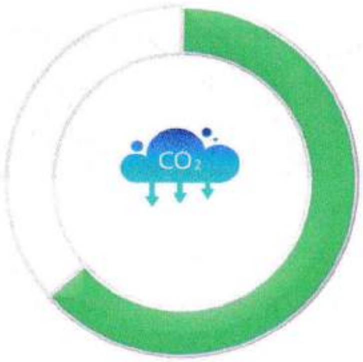
- Apart from energy conservation and environmental analysis, the audit team proposes technical recommendations focusing on energy, water, environmental, safety, and best operating practices to be followed.

CO_2 emission
270 Tons/Annum



CO_2 offset due to Trees
15.26 Tons/Annum

CO_2 offset due to solar plant
25 Tons/Annum



CO_2 offset after implementing ECM
82 Tons/Annum

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ENERGY AUDIT

2.0 Energy Audit

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

2.1 Executive summary

2.1.1 Highlights

Total annual cost savings	=	11	Rs. Lakhs
Total investments	=	38	Rs. Lakhs
Overall simple payback period	=	42	Months
Annual Electrical Energy Consumption (Sep-22-Aug-23)	=	215693	kWh
Annual Electricity cost	=	20.3	Rs. Lakhs
Solar generation (Sep-22 -Aug-23)	=	163700	kWh

2.2 Impact of proposed Energy conservation measures

Electricity Savings	=	95,438	kWh/annum
	=	27	%
Annual cost reduction	=	11	Rs. Lakhs
	=	52	%
CO_2 reduction	=	13	Tonnes/Annum

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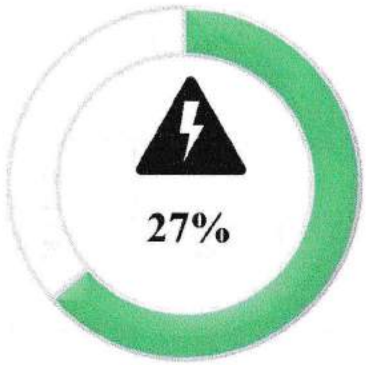
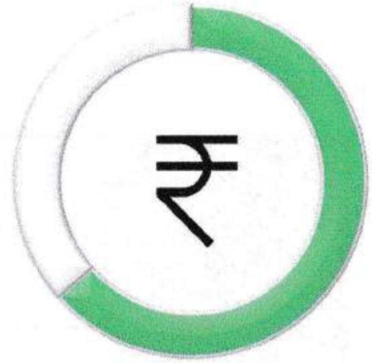
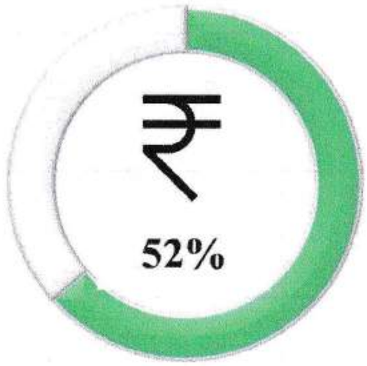


Electricity Savings
95,438 KWh



Investment
38 lakhs



Cost Reduction
11 lakhs

CO_2 Reduction
13 Tonnes/Annum

2.3 Summary of Energy Conservation Measures

Table 6. Summary of Energy Conservation Measures

S. No.	Energy Conservation Measures	Annual Savings				Investment	Simple Payback Period	CO_2 Reduction
		kWh	LPG (Kg)	Water (Lakhs Litres)	Rs. Lakhs	Rs. Lakhs	Months	(Tons/Annum)
	0-35 months payback							
1	**Optimized operation of the STP aerator blower motor by an interlock mechanism for nighttime operation** Currently, two 5.5 KW rated air blower motors are installed. It's operating 12 hours per day. Optimize the operation of the air blower for 2 hours at night.	4191	-	-	0.42	0.10	3	3.6
2	**Install an automatic water overflow controller or monitor in overhead tanks to reduce the water overflow in all buildings.** At present, there are ten tanks with a capacity of 10,000 litres and one with a capacity of 5,000 litres. It's filled twice a day, and there is no control over overflow of water.	-	-	3		0.20	13	
3	**Replacement of existing CFL lights to LED lights** At present, all blocks in the institution (Admin, Civil & Mech, EC, AIDS, and Library) have a total of 845 CFL (23 W) lights installed. Change to LED lights.	19874	-	-	1.99	2.88	17	0.11
4	**Replacement of existing conventional ceiling fans with BLDC fans in Boys and Girls hostels** Boys hostels (I and II) and girls hostels have around 223 conventional ceiling fans installed. Replace the ceiling fans with BLDC fans.	21453	-	-	2.15	5.58	31	18.23
5	**Install a solar water heater instead of using LPG to boil the water for rice cooking in the canteen.**	-	118	-	0.11	0.30	34	-

S. No.	Energy Conservation Measures	Annual Savings				Investment	Simple Payback Period	CO_2 Reduction
		kWh	LPG (Kg)	Water (Lakhs Litres)	Rs. Lakhs	Rs. Lakhs	Months	(Tons/Annum)
	The canteen uses LPG to boil water for rice. Install the solar water heater to boil the water and reduce the consumption of LPG.							
6	**Install water-efficient high-pressure nozzles in canteens and vehicles for cleaning.** In the canteen and nearer to the DG room, taps are used to clean the vessels and vehicles with high-pressure pipes. Install water-efficient, high-pressure nozzles to reduce water consumption.	-	-	11	-	0.05	-	-
7	**Install a biogas plant for food waste** Canteen food waste is around 60 kg/day. Install a biogas plant to reduce LPG gas usage.	-	1232	-	1.15	2.05	21	-
	>36 months payback							
8	**Replacement of existing 2/3-star-rated AC units with 5-star inverter AC units** Existing 2/3-star older ACs in all block should be replaced with 5-star-rated inverter AC units as they age and have higher power consumption.	18820			1.88	9.90	63	16.00
9	**Replacement of existing conventional ceiling fans to BLDC fans in all blocks** At present, all blocks have around 646 conventional ceiling fans installed. Replace the ceiling fans with EC-BLDC fans.	30117			3.02	16.15	64	25.60
10	**Install motion and occupancy sensors in corridors and rest rooms in boys and girls hostels.** It is recommended to install motion and occupancy sensors in corridors and rest rooms in boys and girls hostels to reduce their operation when unoccupied.	983			0.10	0.35	43	0.84
	Total	95438	1350	13	11	38	42	13

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2.4 Marginal cost of electrical energy

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

Table 1. Marginal cost of Energy

Description	Unit	Value
Energy consumption	kWh	20274
Energy charge	Rs./kWh	8.5
other charges	Rs./kWh	0.75
Tax (@9% of Energy charge)	%	0.77
Marginal Energy Cost	Rs./kWh	10.02

Note: unit charge taken based on latest bill

2.5 Good Practices

- A 125-KW rooftop solar plant is installed on campus as an alternate renewable source of energy.
- In Boys & Girls Hostel, exiting tube lights are changed to 9-W LED lights when they fail.
- Energy conservation practices, such as switching off the AC and fans when not required, are encouraged.
- Faculty and students are encouraged to come by EV and CNG vehicles.
- Conducting seminars every year on the topic of energy conservation.
- The Environment Club of SMVITM is conducting a workshop on paper pen making for the students of SVH Kannada High School, Innanje on the school premises.
- Every year, students celebrate World Environment Day and conduct seminars.

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3.0 Energy Conservation Measures (ECM)

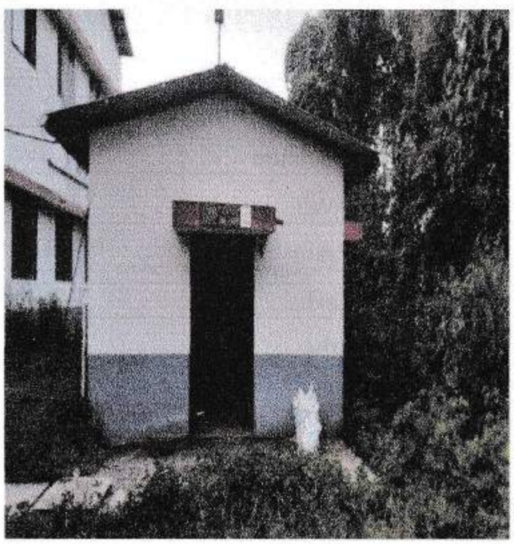
3.1 STP Treatment Plant

3.1.1 Optimized operation of the STP aerator blower motor by an interlock mechanism for nighttime operation

Background & Findings

- The institution is equipped with a 120 KLD capacity sewage treatment plant (STP) operating 24 hours a day.
- Two air blowers' same capacity (same air flow rate) are connected in the sewage treatment plant, supplying air to the aerator tank.
- The capacity of the air blowers is 5.5 KW/7.5 HP motors operating 12 hours each alternately in a day.
- The main purpose of an air blower is to supply oxygen (from ambient air) in order to maintain the BOD level.

Figure 3. *Sewage treatment plant*



Recommendation:

- Load in the STP is variable based on the people at campus. Also the actual flow to the STP is lower than the design capacity. Hence air required at STP varies with respect to time. Considering this intermittent operation during night and weekends will save energy without affecting the performance of the STP.

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- During the night, it is better to operate the motor for 45 minutes and 15 minutes off (for 1 hour of operation). It can be done from 10 p.m. to 6 p.m., resulting in 2 hours of run-time savings directly.

Benefit:

cost benefit analysis is given in the table below

Table 2. Cost benefit analysis for optimized operation of STP aerator air blower

Description	Unit	Air blower
Present system		
Total no of units operating	No's	1
Motor rated	kW	5.5
Motor Efficiency	%	86
Average power consumption	kW	6.2
Loading	%	113
Operating Hrs per day	Hrs	12
Annual operating days	Days	260
Annual Energy consumption	kWh	19.34
Proposed system-optimize the operation of Air blower		
Reduce the operating hours	Hrs	2
Energy consumption/day	kWh/day	3.22
Estimated Annual Energy savings	kWh/annum	4191.20
Energy cost	Rs./kWh	10.02
Annual cost savings	Rs. Lakhs	0.4197
Investment	Rs. Lakhs	0.1
Payback	months	3
CO_2 Reduction	Ton/Annum	3.6

3.2 Water system

3.2.1 Install an automatic water overflow controller or monitor in overhead tanks to reduce the water overflow in all buildings.

Background

- At present, there are ten tanks with a capacity of 10,000 litres and one with a capacity of 5,000 litres. It's filled twice a day, and there is no control over overflow of water.

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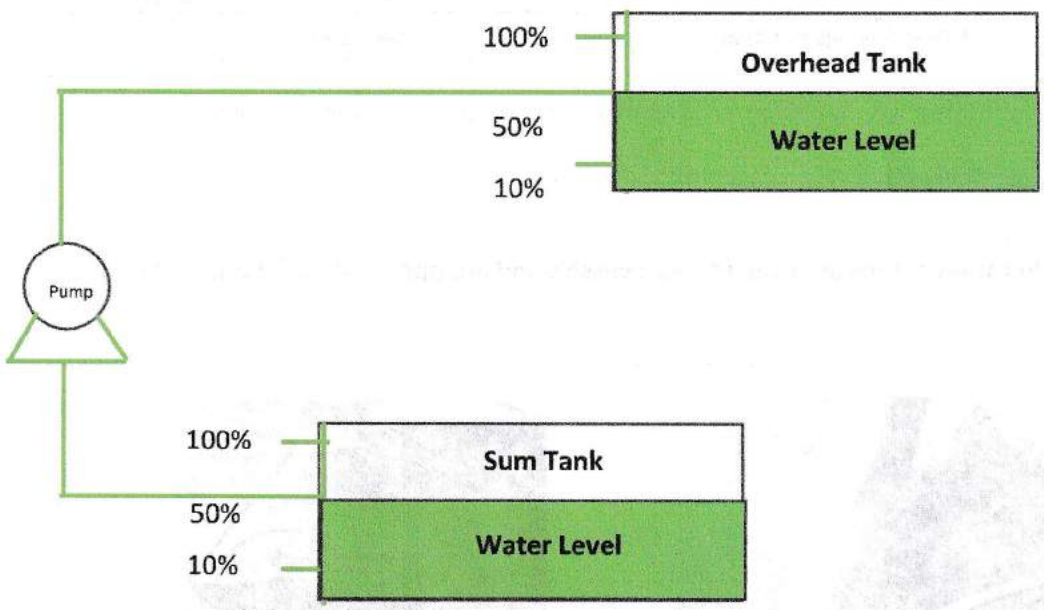
Findings:

- During the audit, it was observed that overhead tanks in boys and girls hostels overflow for at least 10 minutes.
- Overhand tanks have no water overflow control. It's wasting water and energy.

Recommendation:

- Install automatic water overflow control for overhead tanks in all buildings. It will control the water flow and reduce water waste and energy.

Figure 4. *Automatic water overflow control for overhead tanks*



Benefit:

Table 3. Cost benefit analysis for automatic water over flow control

Description	Unit	Flow controller
No. of in tanks of Hostel (Boys & Girls)	No's	4
No. of in tanks of Admin Block	No's	2
No. of in tanks of Civil/Mech Dept	No's	1
No. of in tanks of Canteen	No's	1
No. of in tanks of AIDS Block	No's	1
No. of in tanks of EC Block	No's	1
Flow rate of water	lpm	10
Average Time of overflow (2 times a day)	mins	10

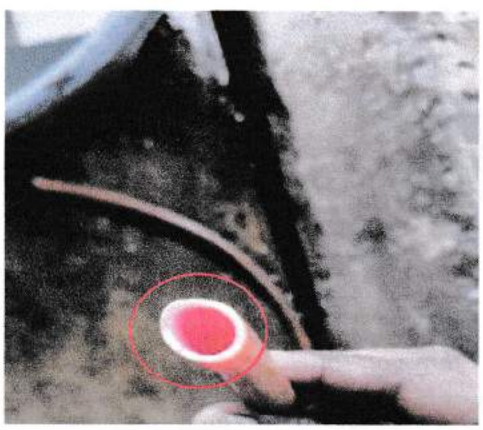
Description	Unit	Flow controller
Total over flow of water	litres	1000
Assessment of Motor power for pumping 500litres of water		
Power consumed per m3 of water	kW	0.6
Power Savings for reduction in water consumption	kW	0.6
Annual power Savings (260 days)	kW	156
Cost of one unit of electricity	Rs	10.02
Total Cost Savings per year	Rs. Lakhs	0.016
Investment	Rs. Lakhs	0.2
Payback Period	Months	12.79
Water Savings per Year	Lakh litres	2.6

3.2.2 Install water efficient high-pressure nozzles in canteen & Vehicle cleaning

Background & Findings

- In canteen, taps are used to clean vessels and are operated for 5 hours a day.

Figure 5. *Taps photos in institution*



Recommendation:

- To reduce the water consumption from this tap, install the high-pressure water nozzles in the canteen and vehicles cleaning.
- It will reduce the water consumption by 50% operate with low pressure.

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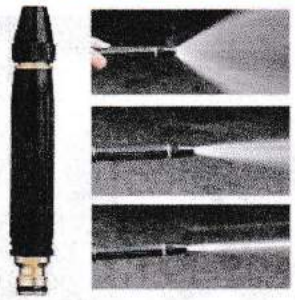
Figure 6. *High-pressure water nozzles*



Benefit:

cost benefit analysis is given in the table below

Description	Unit	values
No of open Valves in canteen	Nos	3
Flow rate of water	lpm	15
Average open time per day	mins	300
Total flow of water	litres	13500
Average water Saving due to Nozzle	%	60
Total Water Savings per day	lts	8100
Assessment of Motor power for pumping 500litres of water		
Power consumed per m3 of water	kW	0.6
Power Savings for reduction in water consumption	kW	4.86
Annual power Savings (260 days)	kW	1263.6
Power consumed by Dish washer per day	kW	1
Annual power Consumption by dish washer	kW	260
Annual Power Savings	kW	1003.6
Cost of one unit of electricity	Rs	10.02
Annual Power Savings	kW	10056
Investment	Rs. Lakhs	0.05
Payback Period	Months	0.00
Water Savings per Year	lakh Litres	10.53

Note: For calculation we consider only 3 taps

Option-2

- Install an automatic dishwashing machine in the canteen to reduce water consumption. The payback period will be high, but water will save nearly 5.85 lakh litres.

- *Automatic Dish washing machine*

3.3 Lighting System

3.3.1 Replacement of existing CFL lights to LED lights

Background & Findings

- At present, institutional existing CFL lights (23 W) are around 845 No's.
- Existing lights in Boys and Girls Hostels have already been replaced with LED lights (9W). It is good practice.

Recommendation:

- Replace the existing CFL lights with LED lights (9W). It will reduce energy consumption without changing the illumination.

Benefit:

cost benefit analysis is given in the table below

Table 4. Cost benefit analysis for replacement of CFL lights to LED lights

Description	Unit	Value
Present system		
Total no. of CFL lights in all blocks	No's	845
Average light fitting wattage	W	23
Operating Hours	hrs	8
Annual Operating Days	days	210
Annual Energy Consumption	kWh	32651

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Description	Unit	Value
Proposed system - CFL lights change to LED lights		
LED lights Average fitting wattage	W	9
Annual Energy Consumption	kWh	12776
Estimated annual Energy savings	kWh/annum	19874
Energy cost	Rs./kWh	10
Estimated annual cost savings	Rs. Lakhs	2
Total investment	Rs. Lakhs	2.88
Simple payback period	months	17
CO_2 Reduction	Ton/Annum	0.11

3.3.2 Install motion and occupancy sensors in corridors and rest rooms in boys and girls hostels

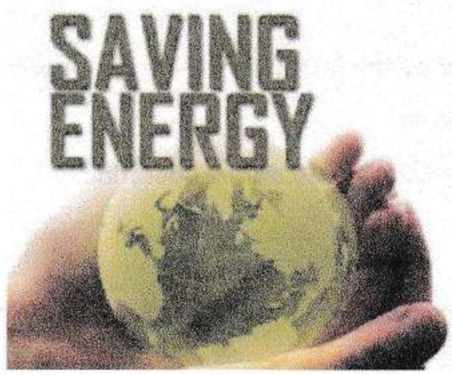
Background & Findings

- At present, hostels (boys and girls) corridors and rest rooms are using lights continuously throughout the night.

Recommendation:

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

Figure 7. *Energy saving posters in class room and corridors*



Benefit:

cost benefit analysis is given in the table below

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Table 5. Cost benefit analysis for install motion sensors for Corridors & Rest room in hostel

Description	Unit	Value
Present system		Rest room & corridors
Total no. of lights	No's	50
Average light fitting wattage	W	9
Operating Hours	hrs	12
Annual Operating Days	days	260
Annual Energy Consumption	kWh	1404
Proposed system - Install Occupancy/motion sensor		
Estimated Annual Energy Savings*	kWh	983
Energy cost	Rs./kWh	10.0
Estimated annual cost savings	Rs. Lakhs	0.10
Estimated investment for motion sensors	Rs. Lakhs	0.35
Simple payback period	months	43
CO_2 Reduction	Ton/Annum	0.84

Note: For calculation we consider Average lights remaining Emergency lights

3.4 Ceiling Fans

3.4.1 Replacement of existing conventional ceiling fans with BLDC fans in Boys and Girls hostels

Background & Findings

- According to data provided by the institution, there are approximately 223 conventional ceiling fans in the boys and girls hostels.
- Conventional fans consume 60 W–70 W during operation.

Recommendation:

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

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Benefit:

cost benefit analysis is given in the table below

Table 6. Cost Benefit analysis for replacement of existing ceiling fans to BLDC fans in hostels

Description	Units	value
Present condition		
No's of fans existing	No's	223
Power consumption	kW	0.07
Average No of hour working	Hrs	10
Annual No. of operating days	Days	260
Annual Energy consumption	kWh/annum	37687
Proposed Condition		
Replace to BLDC fan		
power consumption for BLDC fans	kW	0.028
Annual Energy consumption	kWh/annum	16234.4
Estimated annual Energy savings	kWh/annum	21452.6
Energy cost	Rs.	10.0
Total savings	Rs. Lakhs	2.1
Total investment	Rs. Lakhs	5.58
Payback period	Months	31
CO_2 Reduction	Ton/Annum	18

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

3.4.2 Replacement of existing conventional ceiling fans to BLDC fans in all blocks

Background & Findings

- According to the institution's data, all 646 units are equipped with conventional ceiling fans.

Recommendation:

- Replace the existing conventional fans with EC-BLDC fans in the institution in a phased manner and ensure good energy savings.

Benefit:

cost benefit analysis is given in the table below

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Table 7. Cost Benefit analysis for replacement of existing ceiling fans to BLDC fans in all blocks

Description	Units	value
Present condition		
No's of fans	No's	646
Power consumption	kW	0.07
Average No of hour working	Hrs	6
Annual No. of operating days	Days	210
Annual Energy consumption	kWh/annum	52907
Proposed Condition		
Change to BLDC fan		
power consumption for BLDC fans	kW	0.028
Annual Energy consumption	kWh/annum	22790.88
Estimated annual Energy savings	kWh/annum	30116.52
Energy cost	Rs	10.0
Total savings	Rs. Lakhs	3.0
Total investment	Rs. Lakhs	16.15
Payback period	Months	64
CO_2 Reduction	Ton/Annum	26

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

3.5 Canteen

3.5.1 Install a solar water heater instead of using LPG to boil the water for rice cooking in the canteen.

Background & Findings

- At present, in canteen, LPG gas is used to boil water for 40 kg of rice per day, so nearly 100 litres of hot water are required.

Recommendation:

- Install a solar water heater instead of using LPG to boil the water for rice. It will reduce the LPG consumption of boiling hot water.

Benefit:

cost benefit analysis is given in the table below

Table 8. Cost benefit analysis for install solar water heater

Description	Unit	Solar Water Heater
Quantity of rice cooked	kgs	40
Mass of Water required for cooking 1 kg of rice	Litres	2.5
Mass of Water required for cooking	kgs	100
Inlet temperature of cold water	Celsius	30
Outlet temperature of hot water	Celsius	80
Specific heat capacity of water	kcal/kg	1
Heat required to rise water	kcal	5000
Calorific value of LPG	kcal/kg	11000
LPG consumption /day	kgs	0.45
Annual LPG consumption saving	LPG/Annum	118
LPG cost	Rs/kgs	90
Savings per day	Rs	41
No of operating days per annum	Days	260
Total savings per annum	Rs. Lakhs	0.11
Investment	Rs. Lakhs	0.30
Payback period	months	33.8

Note: Rice hot water boiling it will varies based on persons

3.5.2 Install a biogas plant for food waste

Background & Findings

- In the canteen per day, approximately 60 kg of food waste is generated (50 kg of food and 10 kg of vegetables). Currently, food waste is delivered to a nearby pig farm freely.

Figure 8. *Canteen Food waste*

Recommendation:

- Instead of sending food waste to a pig farm, it is suggested that a biogas plant be installed to generate methane gas.
- This methane gas can be used to cook food in canteens.
- This reduces the LPG consumption in the canteen.

Benefit:

cost benefit analysis is given in the table below

Table 9. Cost benefit analysis for Install Biogas plant for Canteen

Description	Unit	Bio Gas Plant
Daily Kitchen Waste (Food + Vegetables)	kgs	60
Annual kitchen waste (260 Days)	kgs	15600
Methane production/kg of food waste	per kg	0.2
Methane production/day	kgs	12
Total methane production per annum	kgs	3120
Calorific value of methane	kcal/m3	4700
Total energy content of kitchen waste per day	Kcal	56400
Calorific value of LPG	kcal/kg	11900
Quantity of LPG consumed per day in canteen	kgs	25.4
LPG savings per day	kgs	4.74
LPG savings per Annum	LPG/Annum	1232
Cost of LPG	Rs/kg	93
Total savings per day	Rs	440.77
Annual savings (260 Days)	Rs Lakhs	1.15
Investment	Rs Lakhs	2.05
Payback period	Months	21.47

Note: For operating Biogas plant 1 operator is required to clean daily and fill the food waste

3.6 Air Conditioners

Background & Findings

- Administration block has 2/3-star-rated air conditioning units. A total of 22 units are installed.
- Specific energy consumption (SEC) is high for existing AC units.
- Our assessment shows an AC consumed 2.21 kW in 26°C operation; it's high in value.

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Recommendation:

- It is suggested to replace the existing 2/3 star-rated AC's with 5 star-rated inverter-based AC's.
- 5-star AC's will consume 0.97 KW of power per TR.
- It will reduce the energy consumption of the air conditioners (AC).

Benefit:

cost benefit analysis is given in the table below

Table 10. Cost benefit analysis for replacement of existing AC to 5-star rated AC's

Description	Units	Server room	AC's remaining Locations
Present condition			
No. of AC units under operating during audit	Nos.	1	20
Average power consumed by the 2-star AC units	kW	1.30	2.10
Power consumption of 5 star rated inverter AC units	kW	0.97	0.97
Difference in Power Consumption	kW	0.33	1.13
Estimated operating hours of operation	Hrs	24	6
Annual No. of operating days	Days	365	210
Compressor Loading Percentage considered	%	60%	60%
Expected Annual Energy Saving	kWh	1734	17086
Energy Cost	Rs./kWh	10	10
Estimated Annual Cost Savings	Rs.(Lakhs)	0.17	1.71
Total annual Cost savings	Rs. Lakhs	1.88	
Investment (Rs. 40,000 per AC unit)	Rs. (lakhs)	9.9	
Simple payback period	months	63	
CO_2 Reduction	Ton/Annum	16	

Note: Savings estimation is based on operating hours and savings will change based on operating hours.

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4.0 Observation and Analysis

4.1 Electricity supply and Network

Electricity is one of the energy sources used to meet the demands of the institution. The institution is getting power from Mangalore Electricity Supply Company Ltd. (MESCL). Electricity is received at 11 kV, and a 500 kVA transformer is installed in the institution to step down the incoming 11 kV supply to 433 kV. Other than the EB power supply, there are two DG sets of 160 kVA and 62.5 kVA installed in the institution to generate power in case of EB power failure.

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

4.1.1 Tariff structure of the Institution

Tariff structure of the Plant is as follows

- Tariff Code = HT2C(ii)
- Supply voltage = 11 kV
- Contracted demand = 150 kVA
- Minimum billing demand = 128 kVA (85% of CD)
- Demand charges = 128 kVA=Rs. 350 per kVA
- TOD = Opted
- Energy charges = 8.5 Rs. /kWh.

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

Table 11. EB Bill Analysis

Month	Contract demand	Billing Demand	Recorded Demand	Import	Export	Net Consumption	Fixed charges	Energy charges	Total Bill Amount	Solar Generation	Consumption
	kVA	kVA	kVA	kWh	kWh	kWh	Rs.	Rs.	Rs. Lakhs	kWh	(Solar -Export + Import)
Sep-22	150	128	71	18180	2198.25	15982	33920	131050	1.80	11034	27016
Oct-22	150	128	55	14776.5	3290.25	11486	33920	94187	1.42	12650	24136
Nov-22	150	128	67	16094.25	4383.75	11711	33920	96026	1.44	15355	27066
Dec-22	150	128	51	17391.75	1917.75	15474	33920	126887	1.79	12272	27746
Jan-23	150	128	59	20810.25	1363.5	19447	33920	159463	2.05	13513	32960
Feb-23	150	128	57	18489.75	2556.75	15933	33920	130651	1.74	14926	30859
Mar-23	150	128	60	16557.75	2115	14443	33920	118431	1.61	13033	27476
Apr-23	150	128	73	18699	3037.5	15662	33920	128424	1.74	17527	33189
May-23	150	128	67	16787.25	3781.5	13006	33920	106647	1.36	16916	29922
Jun-23	150	128	61	15773	3387	12386	44800	105281	1.46	16378	28764
Jul-23	150	128	61	21054	1146	19908	44800	169218	2.21	11880	31788
Aug-23	150	128	83	21079	805	20274	44800	172329	2.17	8216	28490
Total	-	-	-	**215693**	**29982**	**185710**	**439680**	**1538594**	**20.8**	**163700**	**349410**
Average	-	-	**64**	**17974**	**2499**	**15476**	**36640**	**128216**	**1.7**	**13642**	**29118**
Min	-	-	**51**	**14776.5**	**805**	**11486.25**	**33920**	**94187.25**	**1.4**	**8216**	**24136.25**
Max	-	-	**83**	**21079**	**4383.75**	**20274**	**44800**	**172329**	**2.2**	**17527**	**33188.5**

Observation:

- Institutional contract demand is 150 kVA, and billing demand is 128 kVA (85% of CD).
- In the month of August 2023, the maximum demand was 83 kVA with a power factor of 0.96.
- 125 kW solar system generating maximum active power in the month of April 2023 is 17527 kWh.
- The maximum net consumption of the institution is 33188 kWh (Sep-2022-Aug-23).

Figure 9. *Annual Contract demand, Record Demand*

Figure 10. *EB consumption Vs Solar generation*

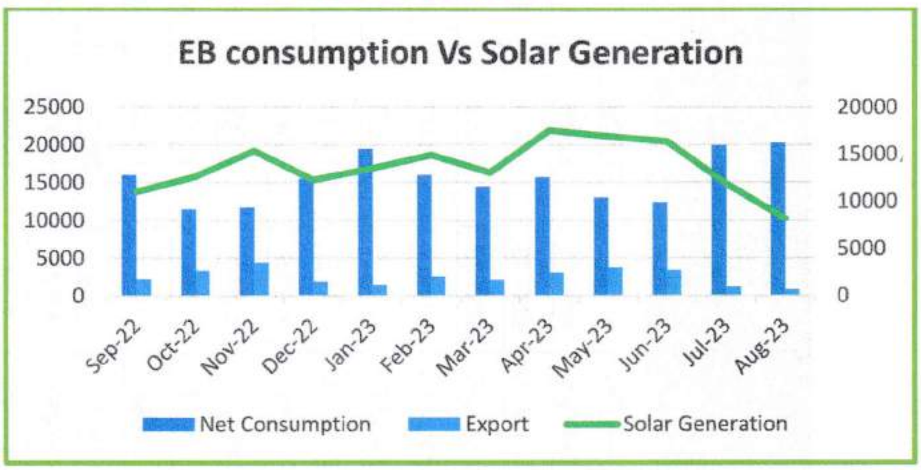

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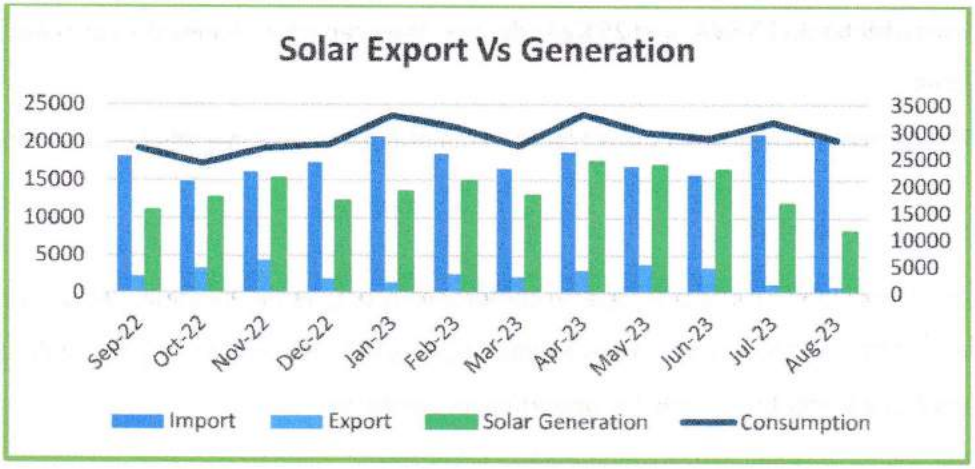
Figure 11. *Solar Export Vs generation*



4.2 Capacitor banks

The solution to improve the power factor is to add power factor correction capacitors to the institutional power distribution system. They act as reactive power generators and provide the needed reactive power to accomplish kW of work. The primary purpose of capacitors is to reduce maximum demand. This reduces the amount of reactive power, and thus total power, generated by the utilities. In the institution, one APFC panel system is installed, with a capacity of 165 kVAr.

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

Table 12. Capacitor bank individual phase current measurement

Transformer (500 kVA) Side 166 kVAR,440V						
Bank S.No	Capacitor rating (kVAr)	Rated Current	R	Y	B	Remarks
1	25	32.84	28.16	0.68	28.13	Derated
3	50	65.5	61.10	60.5	60.6	Ok
4	5	6.5	6.22	6.13	6.28	Ok
5	10	13.2	12.28	12.75	12.86	Ok
6	25	32.84	0	0	0	Derated
7	50	65.5	62	62.14	61.18	Ok
Total	165 kVAr					

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Observation:

- Capacitor banks 25 KVAr and 25 KVAr derated their capacity; change the capacitor banks with new ones.
- The present main incomer power factor is maintained at 0.96 average because of the solar system.

4.3 Air Conditioners

To provide cooling load for the work space, conference room, admin building, and server room, 22 units (1.5 TR and 2 TR) of individual split-type air conditioners are installed. During the audit, a sample-based performance assessment was done for operating air conditioners.

Table 13. Performance assessment of Air conditioners

Design Parameters	Units	Server Room AC-1	Conference Room AC-1	Conference Room AC-2	Boys Hostel
Type of Freezer	-	Split AC	Split AC	Split AC	Split AC
Make	-	Carrier	Carrier	Carrier	Carrier
Model No	-	42KGL-024C+51MSG-024RA/2010	42KGL-024C+51MSG-018RA/2010	42KGL-024C+51MSG-018RA/2010	42KGL-024C+51MSG-024RA/2010
Rated Cooling Capacity	TR	2	1.5	1.5	1.5
Rated Amps	A	-	-	-	-
AC Star rating		2	3	3	2
Operating Parameters					
Set point	^{0}C	24	26	26	-
Operating Hours	hrs.	24	3	3	8
Supply air					
Suction air DBT	^{0}C	19.4	13	20.3	17.3
Suction air RH	%	86.7	87.4	62.1	69.1
Suction air WBT	^{0}C	17.90	11.82	15.68	13.90
Suction air enthalpy	kJ/kg	50.53	33.63	43.81	38.93
Suction air density	kg/m^3	1.16	1.18	1.15	1.17
Return air					
Return air DBT	^{0}C	26.9	25.61	25.61	25.5
Return air RH	%	59.32	50.14	50.14	50.6
Return air WBT	^{0}C	21.01	18.41	18.41	18.4
Exhaust air enthalpy	kJ/kg	60.71	51.95	51.95	51.93
Δ Enthalpy	kJ/kg	10.18	18.32	8.14	13

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Design Parameters	Units	Server Room AC-1	Conference Room AC-1	Conference Room AC-2	Boys Hostel
Air velocity	m/s	1.0	0.7	0.6	1.1
Area	m^2	0.109	0.099	0.099	0.109
Actual air flow	m^3/s	0.11	0.07	0.05	0.11
	m^3/hr	384	255	196	411
	kg/hr	444	302	226	479
	CFM	226	150	115	242
Input motor power	kW	1.3	1.8	2	2.5
Effective TR	TR	0.36	0.44	0.15	0.49
SEC	kW/TR	3.64	4.11	13.74	5.07
Heat Rejected	kJ/hr	1081	1324	440	1490

Observation:

- All the AC units are older than 14 years with 2/3-star ratings.
- The specific energy consumption (SEC) is in the range of 3–14 KW/TR, which is higher than the rated value. (Refer to ECM 3.6 for replacing the older AC units with energy-efficient ones.)
- The AC units are operating at a set point temperature of 24 °C, which is a good practice.
- Admin building server room AC's operating with timer, which is good practice.

4.4 Pumps

- There are bore well pumps (5.5 KW) each and a sump pump near the sump tank (5.5 KW) is installed.
- In a sewage treatment plant (STP), a filter feed-back pump with two no's (5 HP each) is installed, operating for 2 hours per day.
- STP water pump to supply water to all blocks (3.7 KW) installed
- During the audit, sample-based pump assessments were done (flow, pump details, and power measurement).
- The performance assessment is given below.

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Table 14. Performance assessment for Bore well pumps

Design Parameter	Units	Borewell-1	Sump tank Pump	Borewell-3
Manufacturer	-	-	-	-
Model	-	HRF 19/30	HRF 19/30	HRF 19/30
Motor Power	kW	3.7	3.7	3.7
Flow	m^3/hr.	-	-	-
Head	m	-	-	-
Speed	rpm	-	-	-
Motor Efficiency	%	86%	86%	86%
Actual Measurement				
Operating Hours	hrs.	4	4	4
Actual Power	kW	5.9	4.4	3.7
Suction Pressure	kg/cm^2	0	0	0
Discharge Pressure	kg/cm^2	9	9	9
Flow	m^3/hr.	9.8	9.2	5.2
Throttling				
Suction Control Valve open	%	100%	100%	100%
Suction Control Valve close	%	0%	0%	0%
Discharge Control Valve open	%	100%	100%	100%
Discharge Control Valve close	%	0%	0%	0%
Variable Speed Drive				
VFD Installed	(Yes / No)	No	No	No
Operating Frequency	Hz	-	-	-
Calculation				
Head(H)= **Discharge Pressure-(-Suction Pressure)*10**	m	90	90	90
Hydraulic Power = **(Qinm3/hr*1000/3600)*H*9.81/ 1000**	kW	2.4	2.3	1.3
Combined efficiency = **(Hyd Power/Actual power)*100**	%	41%	51%	34%
Pump efficiency = **(Comb Eff/Motor Efficiency)*100**	%	47%	60%	40%
Motor Loading	%	137%	102%	86%

Observation:

- Borewell pump-1 near canteen is overloaded by 137%.

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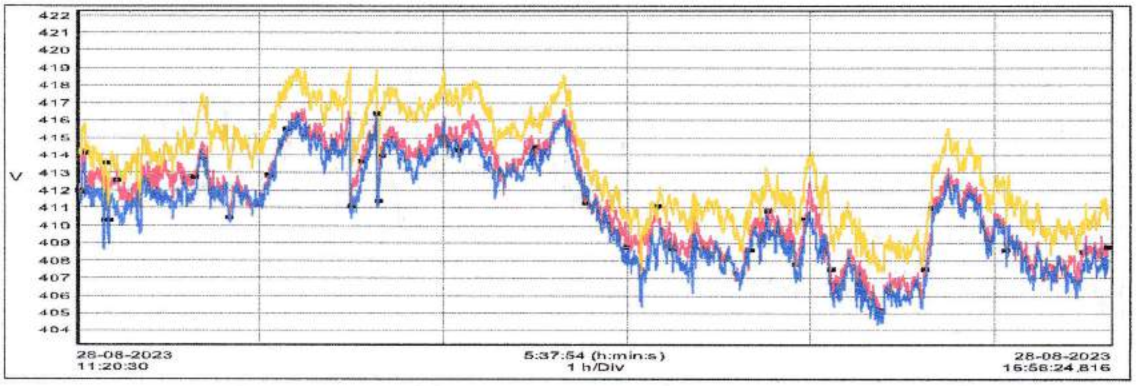
5.0 Electrical Graphs

5.1 Main incomer 500 KVA Transformer

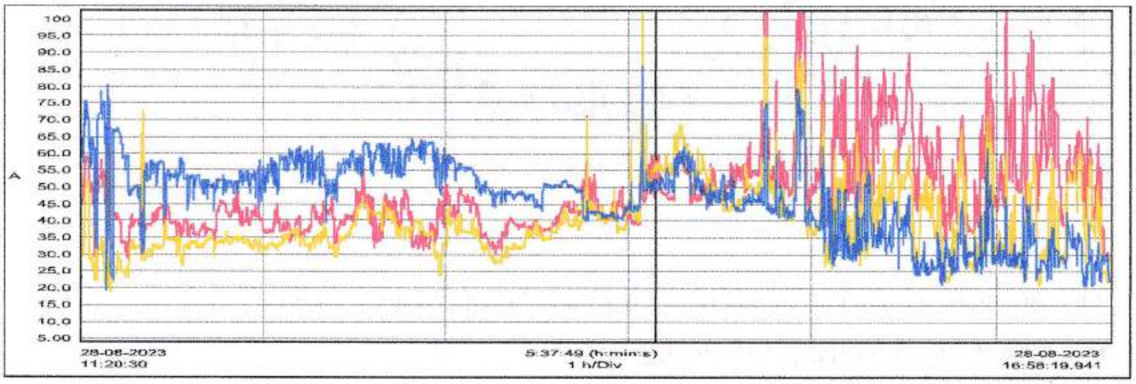
Figure 12. *Voltage profile for main incomer*



Observations:

- The main incomer panel voltage varies from 409 V to 418 V. The average voltage is 413 V during recording time.
- The main incomer voltage profile value is within the limit specified as per the IEC 60038-2009 (±10%) standard.

Figure 13. *Current profile for main incomer*



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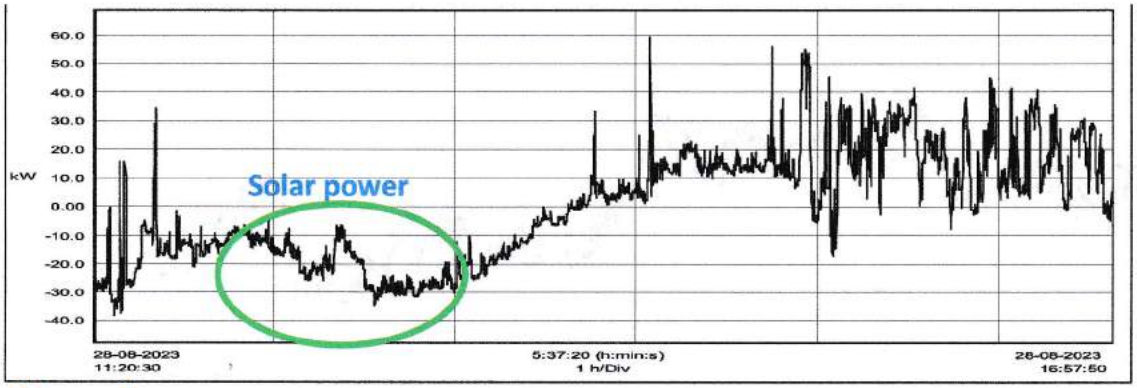
Observations:

- The main incomer the current varies from 28A to 141A during recording time.
- During recording main incomer load is less.

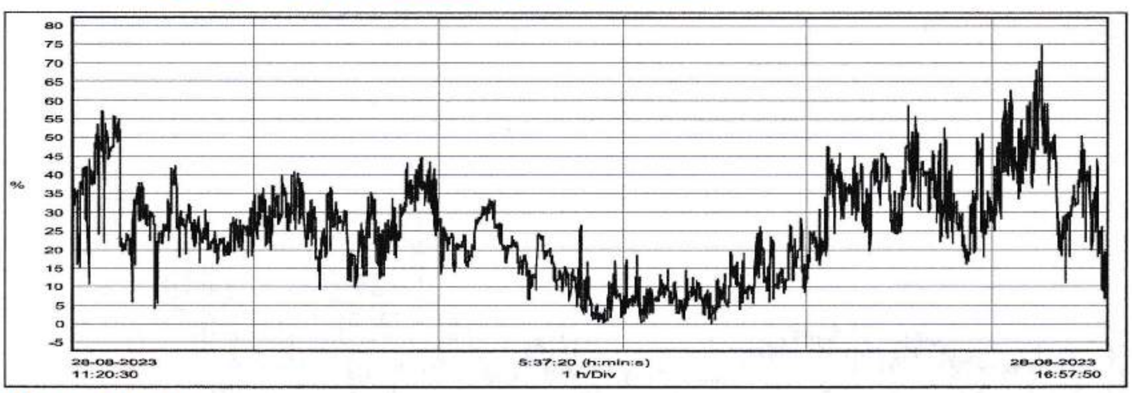
Figure 14. *Power profile for main incomer*



Observations:

- The Power of the main incomer varies from -37 kW to 59 kW. Average power is 18W during recording time.

Figure 15. *Current Unbalance in main incomer*



Observations:

- The main incomer current Unbalance is Average 25%.it is high in value.
- Distribute the loads equally in loads side.

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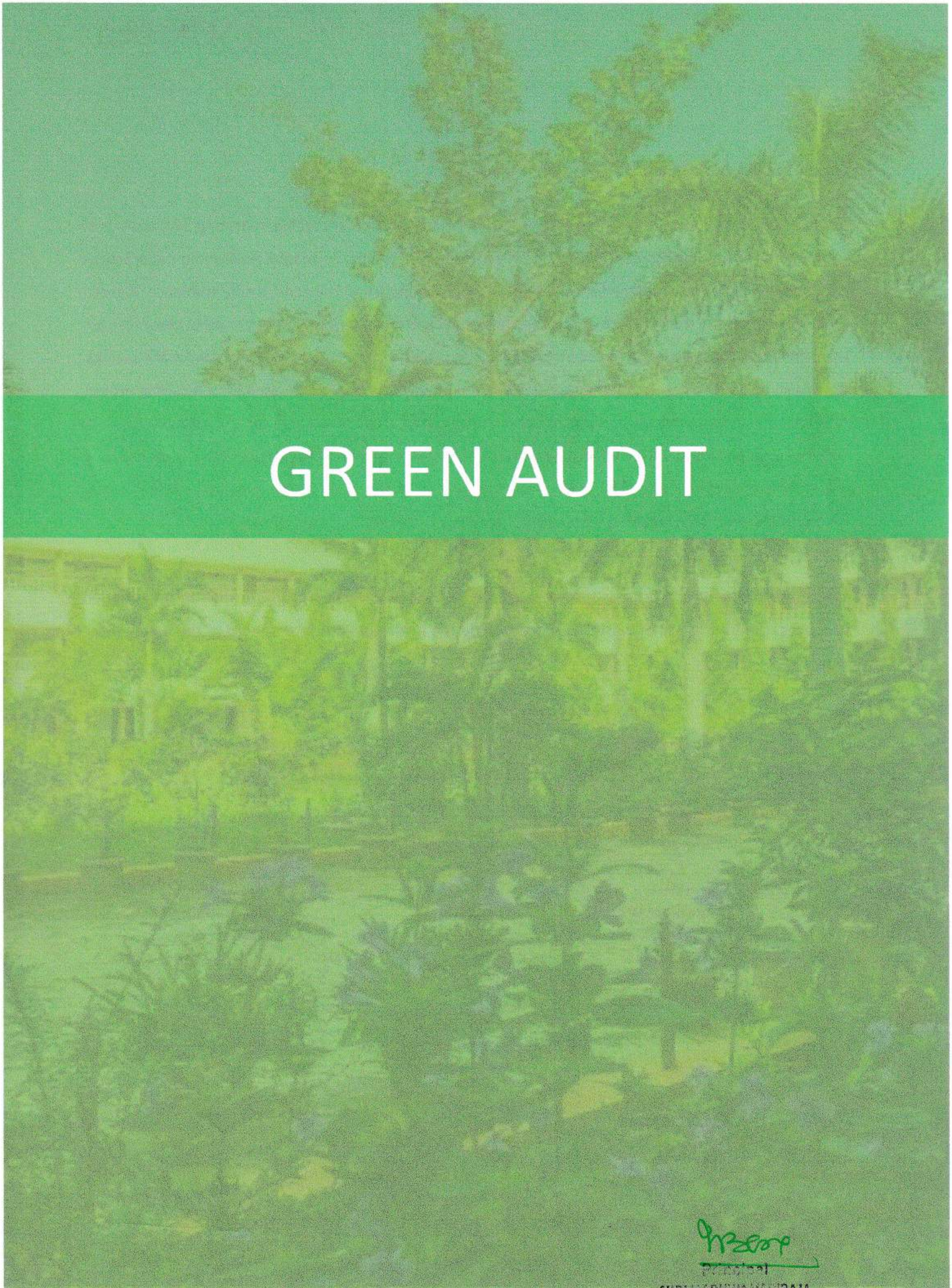

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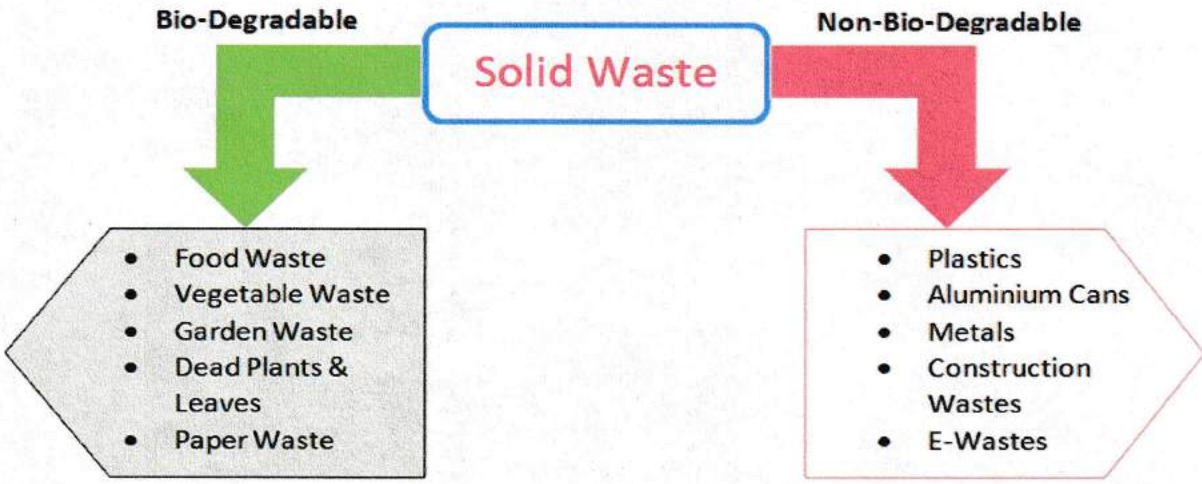
6.0 Green Audit

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

6.1 Waste Management

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

Figure 16. *Types of waste generated*



Observations

- Paper waste from office/class and labs are stored and sent for recycling
- E-Waste is collected, stored, and disposed with help of Moogambigai Metal Refineries, Mangalore.
- Incinerator is fixed for safe disposal of sanitary waste.
- Separate bins are not there for bio-degradable and non-biodegradable waste.
- No quantification of waste daily or monthly basis.
- Other solid waste is collected and disposed through the municipal corporation.
- DG changed oil is taken back by DG service person.
- Garden waste is collected and dumped in backyard.
- Waste from chemistry lab is going to same drain.
- Steel glasses are provided for drinking water.
- Cleaning and collecting wastes at frequent intervals.
- Food waste is being disposed to local pig rearing units.
- Making pens with waste paper.

Table 15. Waste generation

S.NO	TYPE OF WASTE	QUANTITY IN KG/DAY	QUANTITY IN KG/YEAR
1	Paper	5	1800
2	Plastic	1	360
3	Bio Waste - food waste (300 Days – hostel days)	60	18000
4	Bio Waste - crop waste	10	3600
5	E-Waste	0.44	158.4
6	Construction Debris	3	1080
Total		79.44	21998.4

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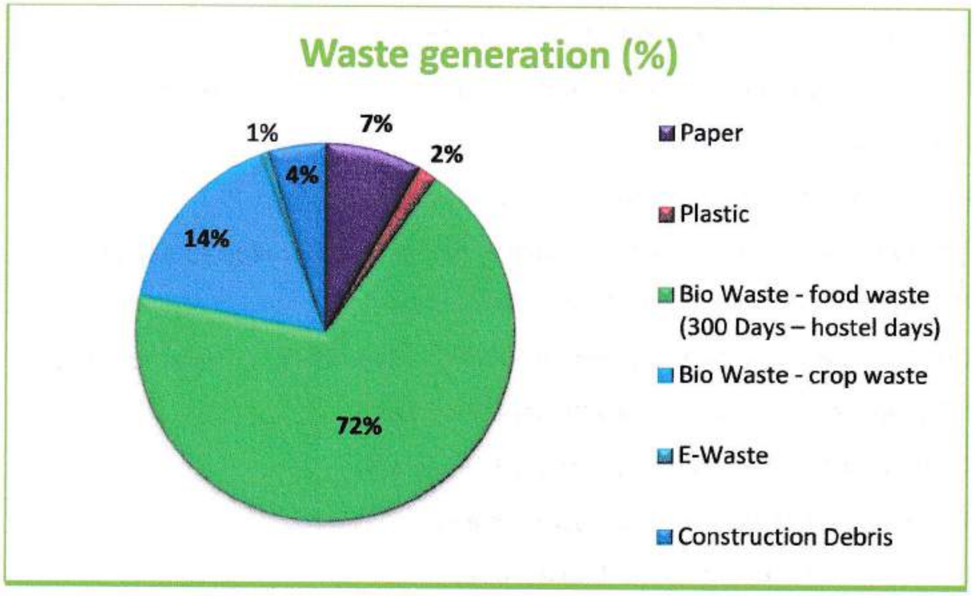
Figure 17. *Total waste generation*



- The campus generates nearly 79.44 kg of waste every day, including paper, construction debris, plastic, e-waste, and bio-waste (food waste, leaves, grass, etc.). According to per-month data, 72% of waste comes from food, 14% organic (both dry and wet leaves), 7% from paper, 4% from construction debris, 2% from plastic, and 1% from e-waste.
- As per our observations, the college should take the initiative to reduce their overall waste. Most of the waste comes from used food from the hostel or canteen and papers in classrooms.
- Waste from construction debris is found around the campus. So, this waste can be effectively reused for landscaping. Only a minimum amount of e-waste is generated inside the campus, and it is disposed of through Moogambigai Metal Refineries, Mangalore.
- The incinerator is fixed for the safe disposal of sanitary waste. Separate bins should be placed for biodegradable and non-biodegradable waste disposal.
- Educate the students on how to use the bins and their purpose. Maintain proper records on the type of waste, quantity of waste, and vendor details on a daily basis.
- Establish vermicompost pits for dumping garden and wet waste from campus. Paper waste can be reduced by using both sides before disposal.
- The college should set a yearly goal to lower waste generation. Nearly 1.8 tons of paper is sent to recycling every year. You can minimize paper by going for digital practices (electronic signatures

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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.

Recommendations

- Reduce the amount of waste that is produced in classrooms.
- Keep biodegradable and non-biodegradable waste bins for segregation of waste.
- Establish vermicompost for composting dry leaves, green waste, and wet waste.
- Install a mini biogas production unit to convert food waste into biogas.
- Use construction debris waste for landscaping.
- Maintain records for the type of waste and the amount of waste disposed of.
- Use concrete blocks from the civil lab for landscaping applications.
- 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).
- LPG Savings by Installing biogas plant for the food waste produced from canteen is given in **(section 3.5.2)**.

Figure 18. *Strategies need to be implemented*

Dust Bins

Vermicompost

mini biogas plant

6.2 Water Management

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

Observations

- Two borewells are available on campus to meet the water requirement.
- Overhead tanks of 2X10,000 litres in the admin block, 1X10,000 in the EC block, 1X10,000 in the civil and mechanical blocks, 1X10,000 in the AIDS block, 1X5,000 in the workshop block, 1X10,000 in the library block, 2X10,000 in the canteen, 2X10,000 in the girls hostel, and 2X10,000 in the boys hostel are installed. The total capacity of the installed water tanks is 1,25,000 litres.
- Waste water is collected and treated in an STP plant with a capacity of 74,000 litres.
- Overhead tanks of 7 x 10000 litres for storing and utilizing STP water are installed in all blocks.
- Exact consumption details are not available as water meters are not installed.
- v. A demo A rainwater harvesting system is installed in the civil and mechanical blocks.
- Rainwater flowing off of places near the admin block is used to recharge a bore well.
- In all blocks, the overhead tanks are overflowing.
- A RO water system is provided for drinking water.
- Many taps in both boys and girls rest rooms in both academic and hostel blocks are not properly closed.
- The approximate water consumption is 100,000 litres per day.
- Periodic testing of raw water and drinking water is done.
- Open-pipe irrigation is used on campus.
- Around 300 taps are installed on the campus.

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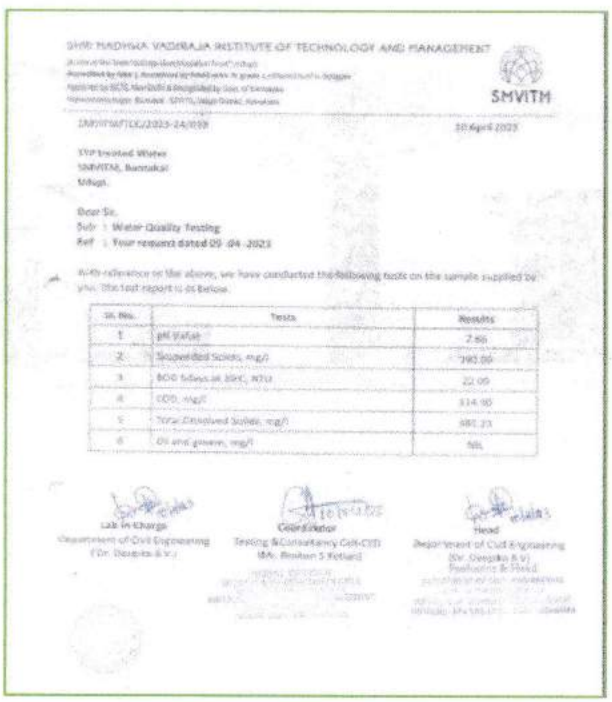
- Water flow varies from 5 lpm to 12 lpm.
- Potable water is used for cleaning buses.

Water from a fully open valve pipe of diameter 10mm is used for more than 4 hours per day at a rate of 10 lpm to clean utensils in the kitchen of the canteen.

Table 16. Water test results

Sl.NO	Parameters	Unit	Boys Hostel	Girls Hostel	Canteen	BIS: 10500-2012 Desirable Limit
1	Ph	-	6.98	7.35	6.75	6.5-8.5
2	Total Hardness as $CaCO_3$	mg/l	88	88	84	200 Max
3	Turbidity	NTU	1.4	0.9	.98	1 Max
4	TDS	mg/l	176	196	176	500 Max
5	Conductivity	mg/l	265.6	285.6	285.6	-
6	Chlorides	mg/l	21.99	27.99	19.99	250 Max
7	Nitrate Nitrogen	mg/l	Nil	Nil	Nil	Nil
8	Ammonical Nitrogen	mg/l	Nil	Nil	Nil	Nil
9	H2S (Bacteriological Contamination)	-	Nil	Nil	Nil	Nil

Figure 19. *STP Water Quality test report*



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SMVITM

STP treated Water

Dear Sir,

Sub : Water Quality Testing

With reference to the above, we have conducted the following tests on the sample supplied by you. The test report is as below.

Sl. No.	Tests	Results
1	pH Value	[illegible]
2	Suspended Solids, mg/l	[illegible]
3	BOD [illegible]	[illegible]
4	COD, mg/l	[illegible]
5	Total Dissolved Solids, mg/l	[illegible]
6	Oil and grease, mg/l	Nil

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Coordinator — Testing & Consultancy Cell

Head — Department of Civil Engineering

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Figure 20. *Water Quality test report canteen*

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SMVITM

SMVITM/TCC/2023-24/0119

10 July 2023

Canteen
SMVITM, Bantakal
Udupi

Dear Sir,
Sub : Water Quality Testing
Ref : Your request dated 09-07-2023

With reference to the above, we have conducted the following tests on the sample supplied by you. The test report is as below.

Sl. No.	Tests	Results	BIS-10500-2012 Desirable limit
1	pH Value	6.95	6.5 to 8.5
2	Total Hardness as $CaCO_3$, mg/l	76	200 max
3	Turbidity, NTU	2.98	1 max
4	Total dissolved solids, mg/lt	156.00	500 max
5	Conductivity, mg/lt	275.6	
6	Chlorides, mg/lt	29.99	250 max
7	Nitrate nitrogen, mg/lt	Nil	Nil
8	Ammonical Nitrogen	Nil	Nil
9	H_2S (Bacteriological Contamination)	Nil	Nil

Lab In-Charge
Department of Civil Engineering
(Dr. Deepika B V)

Coordinator
Testing &Consultancy Cell-CED
(Mr. Roshan S Kotian)

Head
Department of Civil Engineering
(Dr. Deepika B V)

Figure 21. *Best Practices*

Best Practices

Sewage Treatment Plant

RO Drinking System in all blocks

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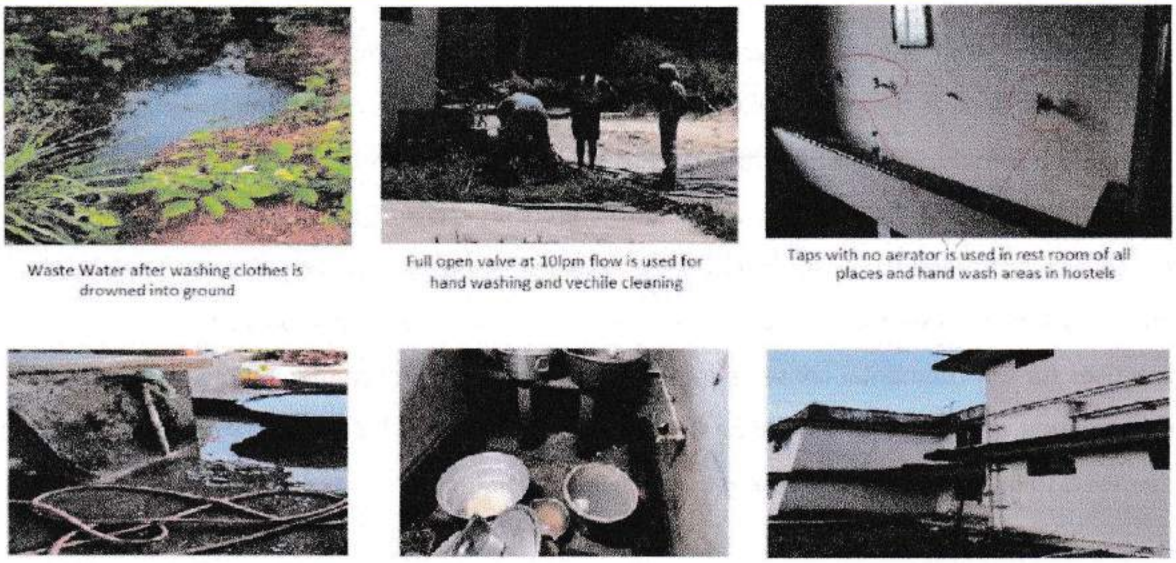
Figure 22. *Processes in need of improvement*



Waste Water after washing clothes is drowned into ground

Full open valve at 10lpm flow is used for hand washing and vechile cleaning

Taps with no aerator is used in rest room of all places and hand wash areas in hostels

Fully open valve at 15lpm is operated for 5 hours daily to clean cooking utensils

Over Flow water in overhead Tanks

Recommendations

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

7.0 Biodiversity

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

Observations

- Nearly 53 floral species are seen around the campus.
- Around 700 mature trees of various species are found.
- 25 faunal species are found on the campus.
- The faunal diversity is lower compared to the floral diversity.
- Many exotic trees are found on campus.
- Flowering, medicinal, and herbal plants are less common compared to common native plants.
- Rank holders are planting trees on campus.

Table 17. Floral species in the campus

S.No	Common Name	Scientific Name
1	Mauritius Hemp	Furcraea Foetida
2	Oleander Spurge	Euphorbiaceae
3	Kudzu	Pueraria Montana
4	Asian Spyder Flower	Clomeviscosa
5	Prostrate Shrub	Euphorbiaceae
6	Dogbanes	Apocynaceae
8	Garden Croton	Codiaeum Variegatum
9	Travers Palm	Ravenala Madagascariensis
10	Bermuda Grass	Cynodon Dactylon
11	African Arrowroot	Canna Indica
12	Tulsi	Ocimum Tenuiflorum

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S.No	Common Name	Scientific Name
13	Dumb Cane	Dieffenbachia Seguine
14	Santa Maria	Parthenium Hysterophorus
15	Cape Periwinkle	Catharanthus Roseus
16	Dunchi	Legume Sesbania Bispinosa
17	Indian Almond	Terminalia Catappa
18	Pongam	Millettia Pinnata
19	Coconut	Cocos Nucifera
20	Polyalthia	Monoon Longifolium
21	Broom Rain	Albizia Lebbeck
22	Mango	Mangifera Indica
23	Orchid	Orchidaceae
24	Indian Banyan	Ficus Benjamina
25	Date Palm	Phoenix Dactylifera
26	Hibiscus	Hibiscus Rosa-Sinensis
27	Night-Blooming Jasmine	Cestrum Nocturnum
28	Chicoo	Manilkara Zapota
29	Crape Jasmine	Tabernaemontana Divaricata
30	Golden Trumpet	Allamanda Cathartica
31	Golden Dewdrop	Duranta Erecta
32	Pitanga	Eugenia Uniflora
33	Golden Tree	Cassia Fistula
34	Queen's Crepe	Lagerstroemia Speciosa
35	Guava	Psidium Guajava
36	Jackfruit	Artocarpus Heterophyllus
37	Banana	Musa Acuminata
38	Sugar Cane	Saccharum Officinarum
39	Breadfruit	Artocarpus Altilis
40	Papaya	Carica Papaya
41	Indian Sandalwood	Santalum Album
42	Calabura	Muntingia Calabura
43	Chinese Apple	Malus Prunifolia
44	Java Plum	Syzygium Cumini
45	Cashew	Anacardium Occidentale
46	Acacia	Vachellia Nilotica

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S.No	Common Name	Scientific Name
47	Neem	Azadirachta Indica
48	Jujube	Ziziphus Jujuba
49	Chinese Ixora	Ixora Chinensis
50	Gooseberry	Ribes Uva-Crispa
51	Rose	Rosa Indica
52	Yellow Elder	Tecoma Stans
53	Bamboo	Bambusa Vulgaris

Table 18. Faunal species in the campus

Si.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	Peacock	Pavo Cristatus
13	Indian Myna	Acridotheres Tristis
14	Hummingbirds	Trochilidae
15	Starling	Sturnus Vulgaris
16	Cat	Felis Catus
17	Dog	Canis Lupus Familiaris
18	Frog	Anura
19	Millipede	Diplopoda
20	Common Earthworm	Lumbricina
21	Bug	Hemiptera
22	Crow	Corvus Spp

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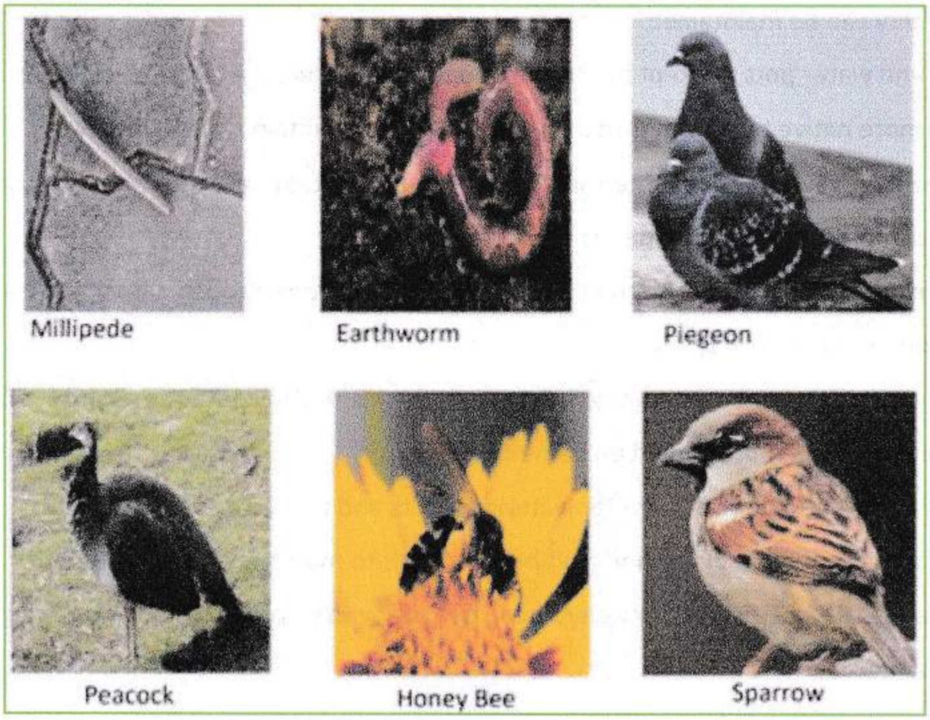
Figure 23. *Flora and Fauna in the campus*



Recommendations

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

8.0 Carbon Foot Print Analysis

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

Table 19. Carbon Foot Print Analysis

Sl.No	Description	Type of Fuel and their CO_2 Conversion Process			
		Fuel Consumption			
		Electricity kWh	Diesel (Vehicle + DG) Litre	Petrol (Vehicle) Litre	LPG kg
1	Total Annual Consumption	215693	27655	430	6400
2	CO2 Emission (Tons/Annum)	177	73	1	19
3	Total CO2 Emission (Tons/Annum)				270 (↑)
4	No. of Matured Trees Available				700
5	CO_2 offset due to Trees (Tons/Annum)				15.26 (↓)
6	Annual Energy Exported from SPV Plant (kWh)				29982
7	CO_2 offset due to export Solar Power Plant (Tons/Annum)				25 (↓)
8	CO_2 Emission per (Tons/Annum) currently				230 (↑)

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Sl.No	Description	Type of Fuel and their CO_2 Conversion Process			
		Fuel Consumption			
		Electricity kWh	Diesel (Vehicle + DG) Litre	Petrol (Vehicle) Litre	LPG kg
9	Expected Reduction of Annual Electricity Consumption after Implementing Proposed Energy Conservation Measures (kWh)				95438
10	CO_2 offset after implementing ECM (Tons/Annum)				78.3 (↓)
11	Expected Reduction of Annual LPG Consumption after Implementing Proposed ECM (kgs)				1232 (↓)
12	CO_2 Offset after implementing biogas plant instead of LPG (Tons/Annum)				3.7 (↓)
13	Amount of CO_2 to be Offset (Tons/Annum)				82 (↔)
14	Per Capita CO_2 Consumption (Tons/Annum)				0.116

Observations

- Major carbon emission is for the electricity usage.
- Encourage carpooling and usage of cycles planting more trees will help to reduce net carbon emission.

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