ENERGY, ENVIRONMENT & GREEN AUDIT REPORT

AUDIT CONDUCTED FOR

PAAVAI ENGINEERING COLLEGE

(Autonomous Institution)

Paavai Nagar, NH-44, Pachal - 637 018, Namakkal (Dt), Tamilnadu.

DATE OF AUDIT

03 JUNE 2024

(Audited and accounted from June 2023 to May 2024)

AUDIT CONDUCTED BY

RAM-KALAM CENTRE FOR ENERGY CONSULTANCY AND TRAINING

(An ISO 9001: 2025 Certified Company & Registered Under MSME, GoI)

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TABLE OF CONTENT

ENERGY, ENVIRONMENT & GREEN AUDIT REPORT

1. ACKNOWLEDGEMENT

ACKNOWLEDGEMENT

RAM-KALAM CENTRE FOR ENERGY CONSULTANCY AND TRAINING, Coimbatore – 641 062 is thankful to the Management, Principal, Faculty and Technical team members of **M/s. PAAVAI ENGINEERING COLLEGE (Autonomous),** Paavai Nagar, NH-44, Pachal -637 018, Namakkal (Dt), Tamilnadu for providing an opportunity to conduct a detailed Energy, Environment and Green Audit process in the college premises.

It is our great pleasure which must be recorded here that the Management of **M/s. PAAVAI ENGINEERING COLLEGE (Autonomous)** extended all possible support and assistance resulting in thorough completion of the audit process. The audit team appreciates the cooperation and guidance extended during the course of site visit and measurements. We are also thankful to all those who gave us the necessary inputs and information to carry out this very vital exercise.

Finally, we offer our sincere thanks to all the members in the engineering division/ technical / non-technical divisions and office members who were directly and indirectly involved with us during collection of data and while conducting field measurements.

Management Team Members	
Shri. N.V. NATARAJAN, B.Com., FCA	Chairman
Dr. M. PREMKUMAR	Principal

Audit Team Members	
Dr. S.R. SIVARASU, Ph.D.,	**BEE Certified Energy Auditor (EA-27299)** Lead Auditor-ISO-14001:2015 (EMS), IGBC AP, GRIHA CP, CII CP in SWM Carbon Footprint Auditor & Implementer **Mobile: +91- 80567 19372, 99420 29372**
Er. P. MALLIGARJUN, M.E.,	**Director (Technical)**

ENERGY, ENVIRONMENT & GREEN AUDIT REPORT

2. INTRODUCTION

TO

ENERGY-ENVIRONMENT-GREEN

AUDIT PROCESS

2.1: Preface about the Institution:

- The vision of our Chairman, Shri CA N.V. Natarajan, started with the founding of the **'Paavai Varam Educational Trust'** in 1997. The trust aims to offer quality education to underprivileged youth, especially from rural and remote areas around Rasipuram, a small town in Tamil Nadu known for its historical significance and products like pure ghee, sago and silk.
- **Paavai Engineering College** started in the year 2001, offering **UG** programmes and **PG** programmes has been approved by **AICTE, NAAC** and accredited by **NBA**. The college is securing top ranks consistently among the leading engineering colleges in Coimbatore region.
- The departments of Engineering and Management Studies are recognized as approved research Centre's by Anna University Chennai to offer Ph.D. programmes. It has obtained research grants from AICTE, TNSCST and other funding agencies. The college has been organizing Seminars, Workshops, FDP and Conferences periodically in the state-of-the-art technologies. The institution has signed **MoUs** with leading MNCs like **Infosys, Microsoft, Wipro and also Spoken Tutorial of IIT Bombay** resource Centre.
- The College is located in Namakkal, just 7 km from the nearest railway station and right on NH-44 and is easily accessible by road and rail. It is situated on a 10.29 acres campus that is clean, green and serene.

2.2: Vision:

- To strive to be a globally model Institution all set for taking 'lead-role' in grooming the younger generation socially responsible and professionally competent to face the challenges ahead.

2.3: Mission:

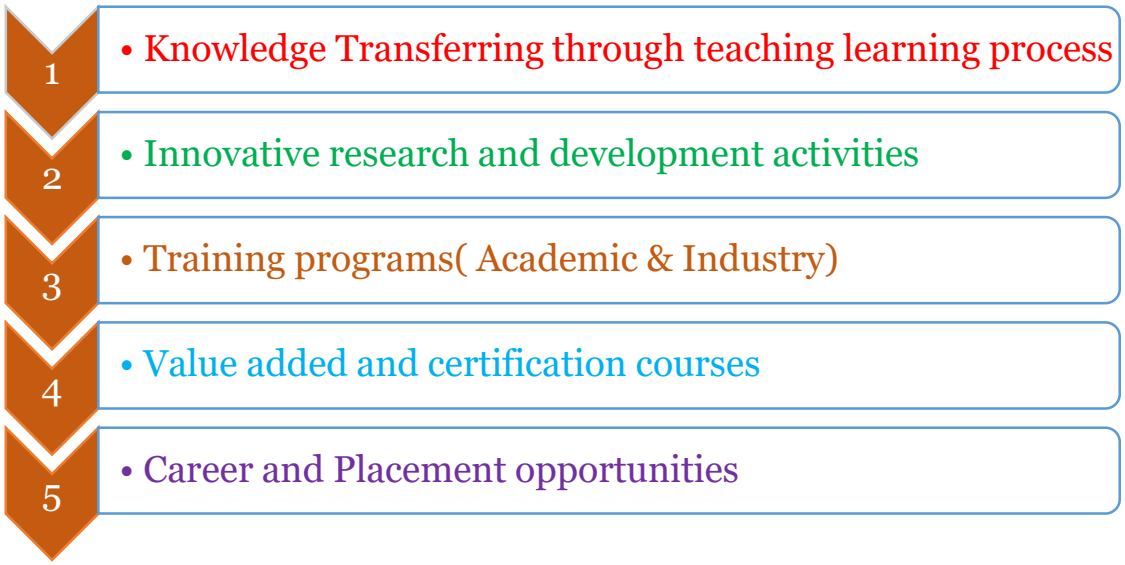
- To provide goal- oriented, quality – based and value – added education through state – of – the – art technology on a par with international standards.
- To promote nation – building activities in science, technology, humanities and management through research
- To create and sustain a community of learning that sticks on to social, ethical, ecological, cultural and economic upliftment.

2.4: Quality Policy:

Paavai Institutions strives to be recognised as a centre of excellence for learning in Engineering, Technology and Management. To achieve this we are committed to:

- Continuously improving the quality of education and maintaining the institution as an effective human resource development organization under all changing environment.
- Pursuing Global standards of excellence in all our endeavours namely teaching, research and consultancy.
- Contributing to the nation and beyond, through the state-of-the-art technology, by producing vibrant technocrats, outstanding engineers and excellent managers who are ever willing to work to the spirit of challenge and innovation with high ethical and professional standards.

2.4: Major Activities in the Institution:



2.5: Scope of the Audit Process:

- **Energy Audit:** To conduct a detailed energy audit in the college campus with a main focus to identify judicious usage of electrical and thermal energy (where, when, why and how energy is being utilized).
- **Environmental Audit:** Identification of history of activities, present environmental practices followed, monitoring records and known sources of environmental issues inside the college.
- **Green Audit:** Assessment on Campus greenery in terms of mature trees, flowering shrubs, bushes, medicinal plants, adoption of green energy generation and utilization, reduction of CO_2 due to green energy system and identification of possible implementation and enhancement of current greenery practices.

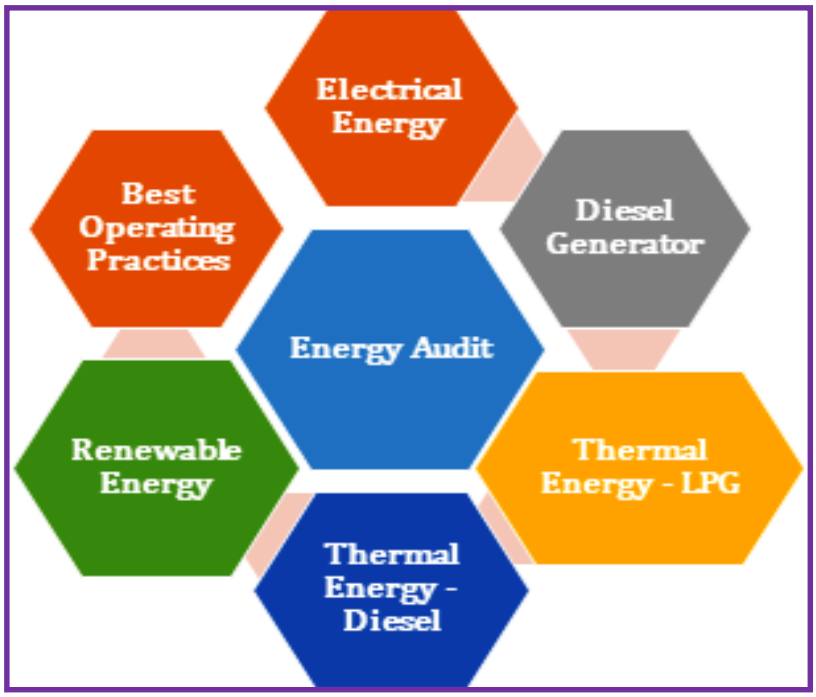
2.6: Outcomes of the Audit Process:

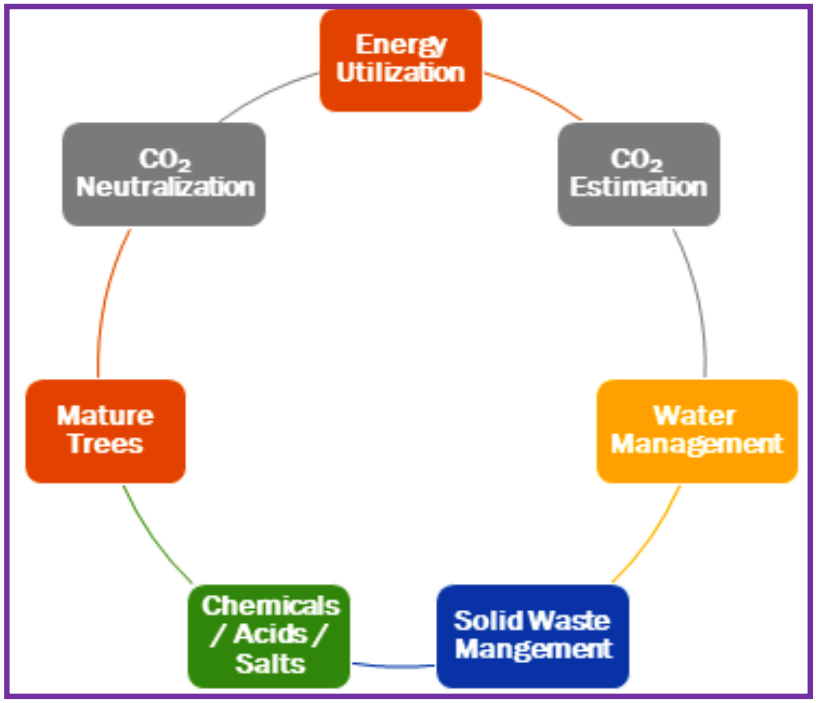
- Recommendations based on field measurement with achievable **En**ergy **Con**servation (ENCON) proposals under **No cost/Low cost and Cost investment categories**
- **Minimization of present energy cost** by adjusting and optimizing energy usage and reduction of energy wastage without affecting the regular activities
- **Identification of possible cost and energy saving from energy conservation, waste reduction, reuse and recycling**
- Formation of methodology for long term road map for maintaining green environment within the campus and encourage the stakeholders for continuous improvements

2.7: Audit Approach:

The audit team completed the assessment of energy consumption in the factory premises and operating hours of each machine (system) using two approaches namely **i) Objective Approach** in which a detailed measurement was taken and **ii) Subjective Approach** in which field data is collected from the maintenance department.

2.8: Coverage in Energy- Environment & Green Audit Process:





ENERGY, ENVIRONMENT & GREEN AUDIT REPORT

3. EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

Energy Analysis:

→ A detailed audit was conducted **M/s. PAAVAI ENGINEERING COLLEGE (Autonomous),** Paavai Nagar, NH-44, Pachal - 637 018, Namakkal (Dt), Tamilnadu.

→ The audit team has come out with ***10 Energy Conservation Proposals (ENCONs)*** and the summary of all the ENCONs are given below:

S. No.	Description	Parameters		
		Present	After	Savings
1.	Annual Energy Consumption	3,88,211 kWh + 95,589 kg LPG + 570 Ton Wood	3,54,708 kWh + 89,490 kg LPG + 532.7 Ton Wood	**33,503 kWh + 6,099 kg LPG + 37.3 Tons Wood**
2.	Annual Financial Cost	Rs.194.8 Lakhs	Rs. 181.2 Lakhs	Rs. 13.6 Lakhs
3.	Initial Investment	Rs. 11.0 Lakhs		
4.	Payback Period	**Nearly 0.81 Years (9.7 Months)**		
5.	Overall Energy Reduction	**8.6 % Electricity + 6.4 % LPG + 6.5 % Wood**		
6.	Annual Financial Savings	**Nearly 7.0 % of annual financial cost**		

Note:

- Apart from the Energy Conservation, the audit team proposes ***many technical recommendations*** focusing on energy, equipment's life improvement, safety and best operating practices.
- All types of energy carriers (like **Electricity, Wood & LPG**) used for regular applications are considered for this audit process.

Audit Conducted & Verified by

(Dr. S.R. SIVARASU)

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Table-1: Energy Conservation Proposal (ENCON) along with Annual Energy and Financial Savings

S. No.	Proposed Energy Conservation Measures	% Saving & Source	Estimated Savings		Initial Investment (Rs.)	Payback Period	Page No.
			Annual Energy Savings	Monetary Savings (Rs.)			
ENCONs Savings through Electrical Energy							
1.	Increasing the Energy Production from the Roof Top Solar Photovoltaic System using regular Panel Cleaning Schedule	2 % on Solar PV System	119 kWh	1,428	Zero Cost	Immediate	17
2.	Reduction of Cable Losses and Active Power Consumption using Capacitor Compensation	2 % on Electrical	7,764 kWh	93,168	20,000	0.21 Years	19
3.	Reduction of Mechanical Transmission Losses in the STP Aerator Blower Motor	8 % on STP Blower Motor	6,720 kWh	80,640	30,000	0.37 Years	21
4.	Reduction of Energy Consumption through retrofitting a Common Variable Frequency Drive (VFD) in the STP Aerator Blower Motor	20 % on STP Blower Motor	8,400 kWh	1,00,800	1,00,000	1.00 Years	23
5.	Replacement of Existing Convention Ceiling Fans into EC BLDC Fans	50 % on Fans Load	10,500 kWh	1,26,000	1,80,000	1.43 Years	25
ENCONs Savings through LPG Thermal Energy							
6.	Reduction of LPG Consumption using Burner Cleaning and Swapping of Active Burners.	2 % of LPG for Stoves	765 kg	80,325	20,000	0.25 Years	27
7.	Reduction of LPG Consumption by converting the conventional Vapour Off-Take (VOT) system in to Liquid Off-Take System	Technology Substitution	1,510 kg	1,58,550	1,50,000	0.95 Years	29
8.	Reduction of LPG Consumption in Dosa making Stove by replacing the Conventional Burner with Radiant Burners	10 % of LPG	3,824 kg	4,01,520	2,00,000	0.50 Years	31

S. No.	Proposed Energy Conservation Measures	% Saving & Source	Estimated Savings		Initial Investment (Rs.)	Payback Period	Page No.
			Annual Energy Savings	Monetary Savings (Rs.)			
ENCONs Savings through Wood Thermal Energy							
9.	Reduction of LPG Consumption in Boiler Feed Water Pre-heating using Solar Thermal Energy System	Technology Substitution	8.8 Tons	73,920	2,00,000	2.71 Years	33
10.	Reduction of Heat Energy in the Boiler Outer Side + Steam Pipes Lines using TCC	5 % Wood on Boiler	24.8 Tons	2,08,320	60,000	0.30 Years	35
Total	**33,503 kWh + 6,099 kg LPG + 37.3 Tons Wood**			**13,55,751**	**11,00,000**	--	--
Renewable Energy Proposal on "Solar Based Energy Generation: Installation of Roof Top Solar Photovoltaic Power Plant (SPP) and Reduction in the Energy Billing"							

Recommendations and Best Operating Practices:

- All SSB must be fitted with digital energy meters.
- Prepare block wise maintenance checklist of electrical and thermal system
- Calculate the Unit Per Litre (UPL) for every run of DG and average it for monthly
- Convert the existing conventional lightings and fans into energy efficient lights and fans
- Earth pits must be visible for easy access, should be done regular maintenance and measure their values annually
- Similar to Fan, now BLDC based ACs are made available in the market; which consumes less amount of energy (Power) during its starting and running condition.
- It is essential and the right time to form an **Energy Management Team**

ENERGY, ENVIRONMENT & GREEN AUDIT REPORT

PART-A: ENERGY AUDIT REPORT

4. STUDY
ON
ENERGY CONSUMPTION PATTERN

4.1: Assessment of Existing Electrical and Thermal Energy Systems:

<table>
<tr><th>S. No.</th><th>Description</th><th>Details</th></tr>
<tr><td colspan="3">Electrical Energy Usage</td></tr>
<tr><td>1.</td><td>Name of the customer</td><td>PAAVAI ENGINEERING COLLEGE (Autonomous)</td></tr>
<tr><td>2.</td><td>Communication Address</td><td>Paavai Nagar, NH-44, Pachal - 637 018,
Namakkal (Dt), Tamilnadu.</td></tr>
<tr><td>3.</td><td>Service Number Type of Supply & Tariff</td><td>SC No: 04-215-011-813; Low Tension; Tariff – LM II B 2; 112 kW
Private Educational Institutions and Hostels</td></tr>
<tr><td>4.</td><td>Energy Suppliers</td><td>Kerala State Electricity Board Limited</td></tr>
<tr><td>5.</td><td>Generator Details</td><td>250 kVA – Cummins - (Inbuilt fuel tank – 300 L)
125 kVA Cummins (Inbuilt fuel tank – 200 L)</td></tr>
<tr><td>6.</td><td>DG Operation</td><td>Manual Operation</td></tr>
<tr><td colspan="3">Annual Electrical Energy Consumption, Electricity Consumption from DG & Diesel Consumption</td></tr>
<tr><td colspan="3">Electricity 3,88,211 kWh | Diesel for DG 8,588 Litres | Units Generated 27,482 kWh</td></tr>
<tr><td colspan="3">Unit per Litre for the DG: Nearly 3.2 kWh/Litre</td></tr>
<tr><td colspan="3">Thermal Energy Used</td></tr>
<tr><td rowspan="3">7.</td><td>Liquified Petroleum Gas (LPG)</td><td rowspan="2">Cooking</td></tr>
<tr><td>Seasonal Wood</td></tr>
<tr><td>Diesel (Ordinary)</td><td>Transport+ DG</td></tr>
<tr><td colspan="3">Annual Energy Consumption of Thermal System</td></tr>
<tr><td colspan="3">LPG 95,589 kg | Wood 570 Tons | Diesel (Transport) 1,52,236 Litres</td></tr>
<tr><td colspan="3">General Loads (Both Electrical and Thermal)</td></tr>
<tr><td rowspan="2">8.</td><td rowspan="2">Lighting System</td><td>❖ Indoor lighting: The management is now committed to convert the existing FTL into LED in a phased manner</td></tr>
<tr><td>❖ Outdoor lighting: All the street lightings are LED based energy efficient lamps
❖ Requested to retrofit timer based ON-OFF control in the existing street lighting system</td></tr>
<tr><td>9.</td><td>Fan Loads (Ceiling)</td><td>❖ All the ceiling fans are conventional type only which consumes nearly 60-70 W/fan at maximum position.
❖ The audit team requested to change the conventional fans into BLDC based Electronically Commutated fans in a phased manner.
❖ The average power consumption will be 35 W/fan at maximum position (More than 50 % reduction)</td></tr>
</table>

10.	Air Conditioning System	• Mostly **BEE star rated** ACs and the outdoor units are mostly placed in shaded area of the respective building
11.	Motors and Pump loads	• Mainly used for water distribution, purification and waste water treatment • Small motors are used in hotel kitchen equipment's & in the canteen
12.	Uninterrupted Power System (UPS)	• All the computers, server, surveillance, projectors, telephonic units are connected with UPS with nominal back up time of nearly **1 hours duration.** • Total capacity of the UPS is nearly **552 kVA.**

Table-2: Annual Energy Consumption and Energy Generation (2023-2024)

S. No.	Month	Electricity Consumption (kWh)	Wood Consumption (Tons)	LPG Consumed (kg)	Diesel Consumed (L)			Solar Energy Generation (kWh)
					DG	Transport	Total	
1.	Jun-23	33,705	40	7,600	711	11,087	11,798	490
2.	Jul-23	34,395	41	7,866	721	11,432	12,153	474
3.	Aug-23	35,213	45	8,246	725	11,102	11,827	482
4.	Sep-23	35,906	50	7,980	713	14,686	15,399	494
5.	Oct-23	36,658	49	8,170	704	14,701	15,405	500
6.	Nov-23	37,301	32	7,942	710	14,432	15,142	482
7.	Dec-23	28,758	41	8,018	712	12,405	13,117	475
8.	Jan-24	29,506	50	7,980	725	11,995	12,720	480
9.	Feb-24	30,428	58	7,714	712	8,596	9,308	635
10.	Mar-24	31,273	56	7,980	721	14,477	15,198	648
11.	Apr-24	32,173	52	7,923	724	13,088	13,812	648
12.	May-24	22,895	56	8,170	710	14,235	14,945	650
Total		3,88,211	570	95,589	8,588	1,52,236	1,60,824	5968

- The cost of the electricity is Rs. 12.00/kWh (One LT service dedicated for the college)
- The cost of the LPG is Rs. 105.0/kg (70 % of the overall institution consumption is accounted)
- The Wood cost Rs. 8,500/Tons (70 % of the overall institution consumption is accounted)
- Green Energy Contribution from Solar PV: 6.5 %

ENERGY, ENVIRONMENT & GREEN AUDIT REPORT

PART-B: ENERGY AUDIT REPORT

5. ENERGY CONSERVATION PROPOSALS (ENCONs)

ENCON-I	**Increasing the Energy Production from the Roof Top Solar Photovoltaic System using regular Panel Cleaning Schedule**
Assessment Area	Energy generation from Roof Top Solar Photovoltaic System
Observations	• **5.7 kW** roof top solar PV plant was installed on the roof top of the institution, generating electricity to feeding to MV panel. • The solar panels must be cleaned at regular intervals as the dust accumulation will reduce the expected power output and hence it is a loss of generation. • In general; a minimum of 1 % power generation may be improved by regularly cleaning the panels. Most of the bulk power generating solar PV plant has separate panel cleaning schedule (pipes, cleaning detergents and man power) to operate the same.
Assessments	**Dirty solar panels** • Lose efficiency and lifespan, Reduce overall system performance • May cause permanent module staining, Loss of return on investment • Affect your limited warranty **Whereas Regular cleaning** • Ensures a maximum output and Maintains your warranty • Saves money and Extends the life of the investment • Prevents permanent module staining
Recommendation (Target)	• It is highly recommended to clean the solar panel (Use RO water for cleaning with good mop stick is enough) **monthly twice (15 days once**) which ensures a minimum of 1-2 % higher productivity for the same installed capacity. • Prepare a separate cleaning schedule; assign a team of members with higher degree of supervision. • Ensure the power output before and after cleaning. Visually inspect the panels for any damage, cracks, stains and other abnormalities. • Conduct an IR thermography study on the solar panels, solar DC and AC connectors, AJB and Inverter once in a year. • Identify any thermal hotspot generated to the atmospheric condition or due to the functioning of electrical network and rectify it immediately.

Energy & Financial Saving Calculation:

Parameters	**Description**	
Installed capacity of SPV Plant	**5.7 kW (Grid Tied connected in MV Panel)**	
Location	Roof Top of the Main Building	
Energy Calculation	**Before**	**After**

Expected % of Energy Saving	--	**2 % Improvement**
Annual Energy Generation (Expected)	5,968 kWh	6,087 kWh
Annual Energy Saving	--	**119 kWh**
Annual Financial Saving	--	**Rs. 9,110/-**
(119 kWh x Rs. 12.00/kWh = **Rs. 1,428/-)**		
Initial Investment	-	**Zero Cost**
Simple Payback	**--**	**Immediate**

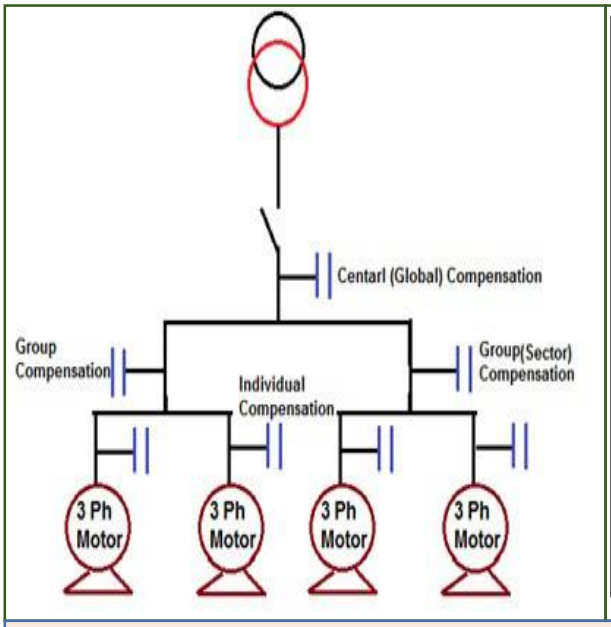
Tips for Solar Panel Cleaning:

- Never use an abrasive sponge or soap for your solar
- Not to use harsh materials when cleaning solar panels as they could cause damage, and solar panels are costly to repair.
- Run a hose along the panels to remove any dirt.
- Use a long-handled wiper to clean the panels while you are standing on the ground.
- Use safety ropes or a harness for support.
- Always watch out for dirt on the solar panels to make sure it doesn't build up.

ENCON-II	Reduction of Cable Losses and Active Power Consumption using Load End Capacitor Compensation (At DB Level)
Assessment Area	Electrical Distribution System
Observations	• HT electrical system from power house is being distributed through various electrical distribution panel board conveniently located in each building all over the college campus. • Supply side power factor is maintained by fixed capacitors; whereas the load end PF is to be corrected by connecting suitable values of FC, mostly at the distribution panels.
Assessments	• In any electrical distribution network, the distribution losses may account for 2-6 % and this can be reduced by i) Selecting proper cable size (class 1 or 2) with reduced resistance and ii) Compensate the distribution losses by connecting load end capacitors at each higher capacity load and/or at DB level. • This method has many advantages like i) reduction of kVA demand (applicable for HT consumer), ii) reduction of distribution losses and iii) maintaining the terminal voltage from source to load end.
Recommendation (Target)	• Connect suitable rating of capacitors (Nearly 10 kVAr, 3-Phase, 440/400 V, Heavy Duty) at the PCC and try to reduce the distribution line loss.

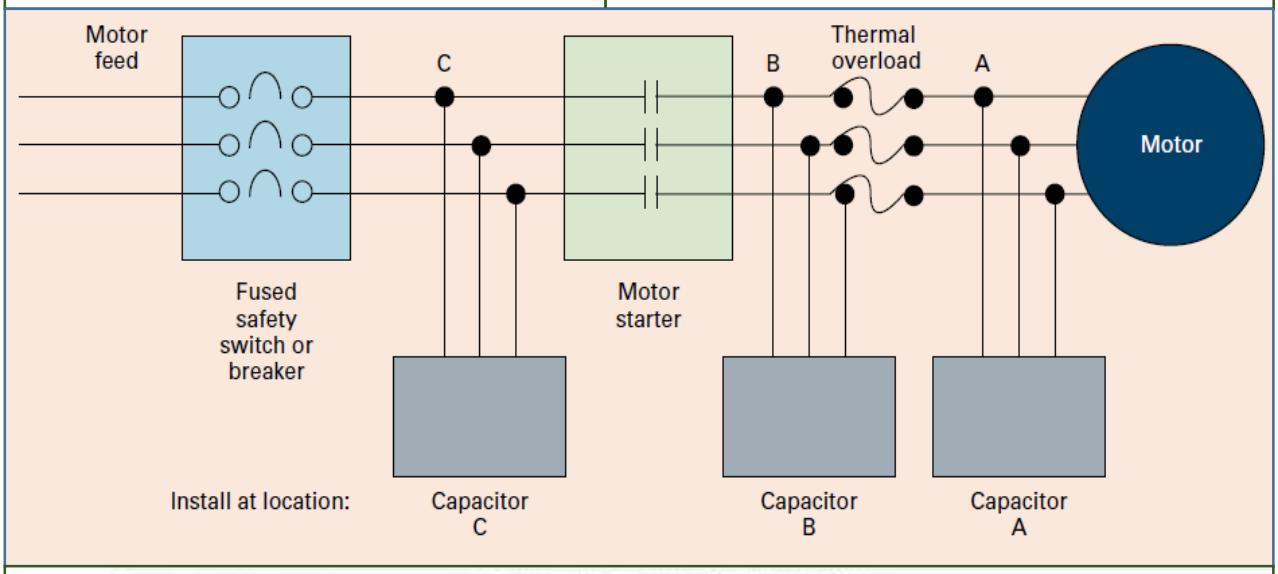
Energy & Financial Saving Calculation:

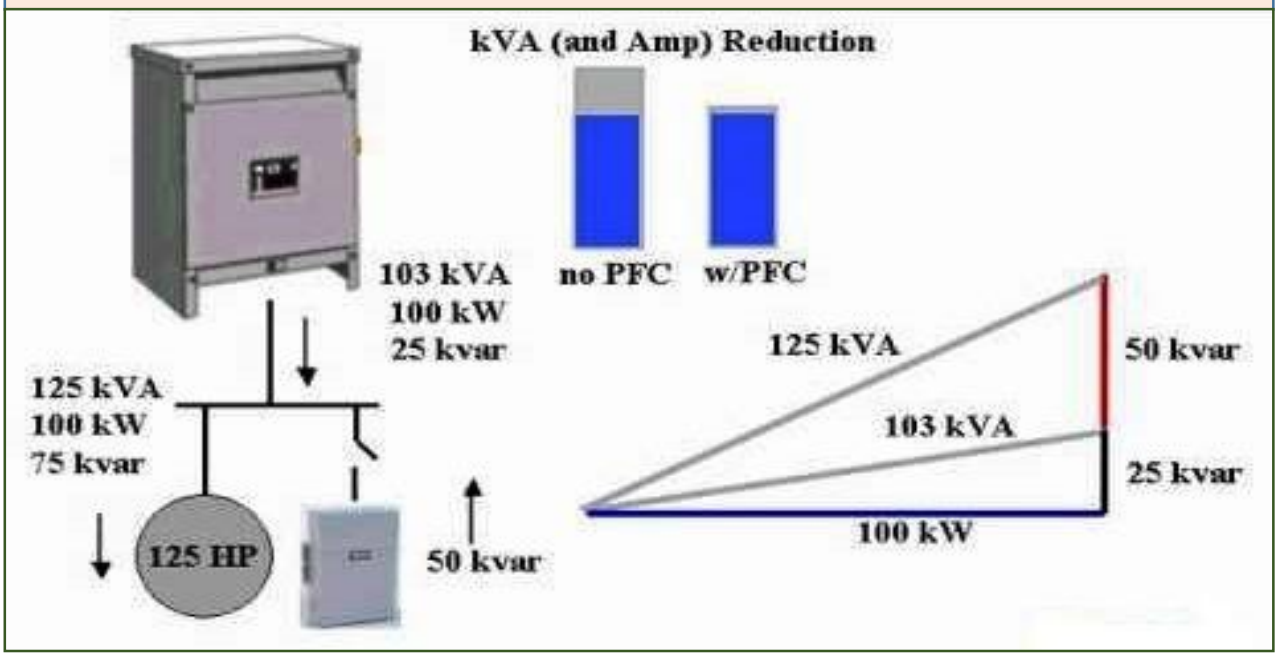
Parameters	Description	
No. of DBs (Approx. Value)	**4 No's. (Fix as a trail at the entry of each block)**	
kVAr required to connected	10 kVAr each in all DB	
Energy Calculation	**Before**	**After**
Expected % of Energy Saving	**--**	**2.0 %**
Annual Energy Consumed	3,88,211 kWh	3,80,447 kWh
Annual Energy Saving	--	**7,764 kWh**
Annual Financial Saving	--	**Rs. 93,168/-**
(7,764 kWh x Rs.12.00/kWh = Rs. 93,168/-)		
Initial Investment	-	**Rs. 20,000 /-**
Per kVAr charge of Heavy-Duty Standard Make Capacitor is around **Rs. 500/-.** Hence for 10 kVAr x 4 locations = **40 kVAr**; the initial investment is **Rs. 20,000/-**		
Simple Payback	**--**	**0.21 Years**
CO_2 Reduction	**--**	**6.4 Tons/Annum**



CASE STUDY -CAPACITOR BANK AT LOAD END
CONNECTED LOAD 970 KW AT 200 METERS
FROM POWER HOUSE CAPS OFF – 0.8 PF & CAP ON – 0.97 PF

Description	Capacitor at powerhouse	Capacitor at load end
Rating	1211 KVA	1000 KVA
Line current	1715 amps	1443 amps
Cables in I I	5 runs	5 runs
Current /cable	343 mps	289 amps
Cable losses	35 kw	25 kw
cable loss pm	22000 units	15000 units (for 700 hrs)
Net savings	nil	7000 units per month

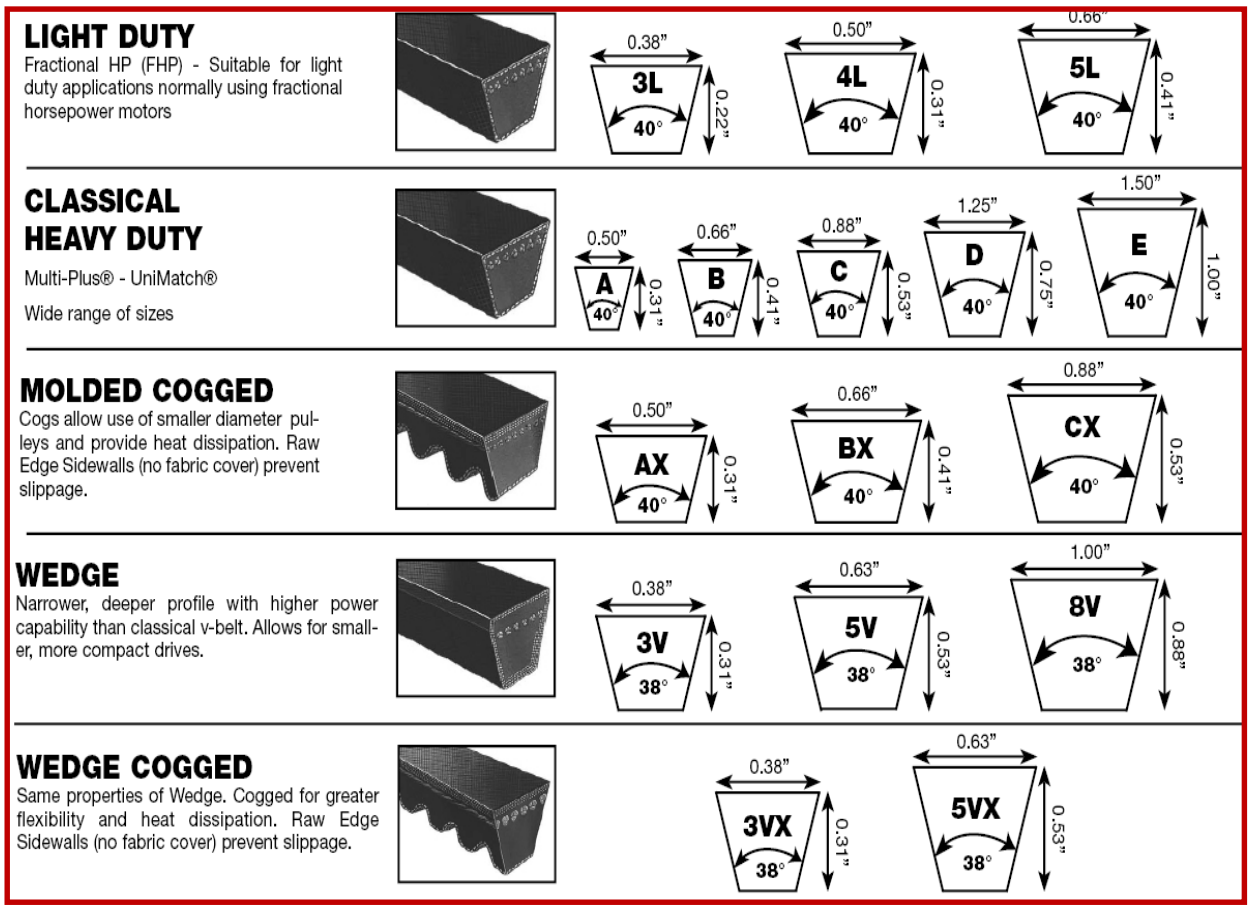




ENCON-III	Reduction of Mechanical Transmission Losses in the STP Aerator Blower Motor & Condition Monitoring of the Belt Slippage Loss
Assessment Area	Energy Consecration in the Belt-Pulley Transmission System
Observations	• **In STP; 02 no's** of air blower motors with **11.0 kW/15.0 HP**; CG Make; 1,460 RPM; η = 89.6 % belt-driven 3G/3B –B 63 are running with tapper lock belt-pulley drive system.
Assessments	• V-belt drives rely entirely on friction between the belts and sheave grooves to transmit power. Adequate friction is obtained through proper tensioning of the belt. • Standard V-belt drives, can stretch up to 3% of the original length throughout the life of the belt. If proper tension is not maintained, the required friction can be lost and the belt can slip. • When slip occurs, additional heat is generated between the belts and grooves. Slippage can also occur during torque spikes especially during start up time.
Recommendation (Target)	• Noticed that the present V belts are wobbling (most of the places) with high percentage of slippage losses. • Due to the wobbling, aging of the belts may lead to frequent replacement of belts. However, the energy loss (approximately 8 to 10%) due to the belt transmission is also high and is a loss for the industry. • The cogged belts by design, is having 30 % more power carrying capacity for the same classical V belt weight. • The cogged belts run cooler, nearly 50 % more longer hours, and occupy less space in the pulley. • The narrow and cogged belts operate higher speed ratios using smaller diameter pulleys. • Replace the existing motor into energy efficient motor along with the replacement of conventional belt into cogged belt with resized pulley. • It increases the lifespan of the belt and pulley and provides superior grip in the mechanical power transmission. • Also, the temperature on the belt and pulley; especially at the driving and non-driving ends are less than conventional arrangement. • Deemed savings for cogged belts would allow prescriptive or up-stream energy efficiency, easing the burden on the end user to invest for better energy conservation.

Energy and Financial Saving Calculation:

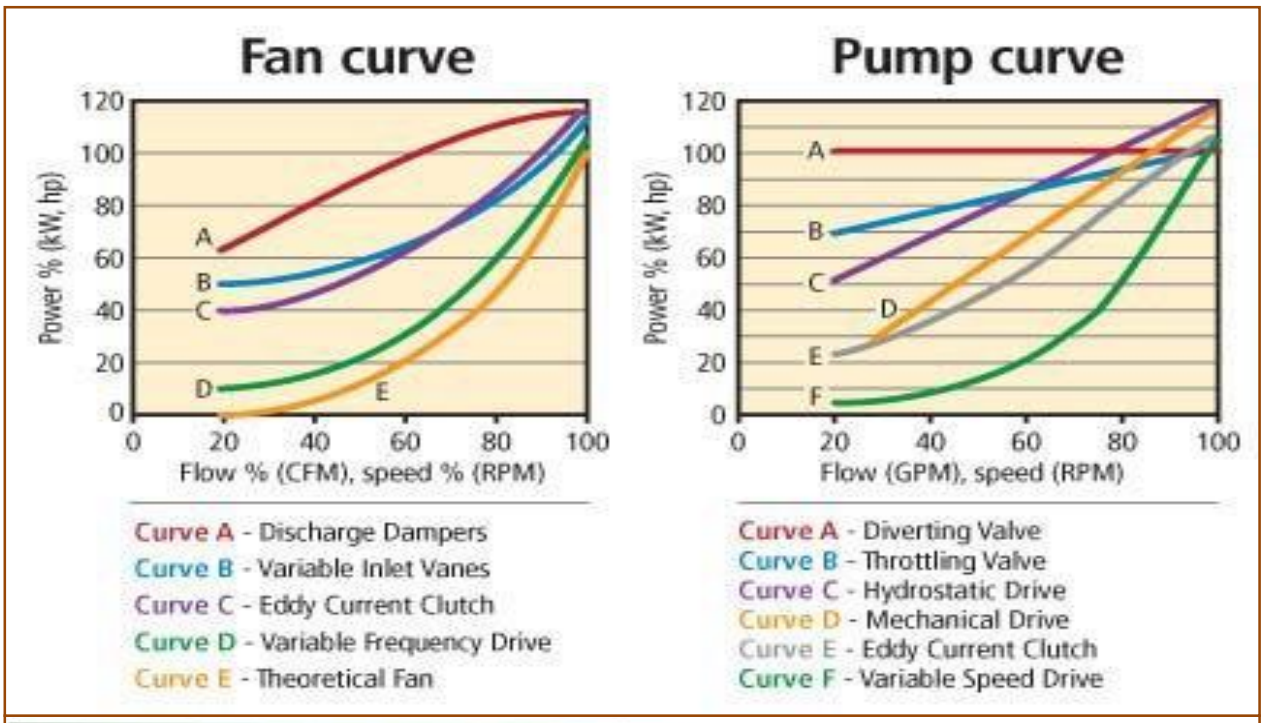
Parameters	Description	
Proposed cogged belt conversion	STP Aerator Blower (11.0 kW) – **2 No's**	
(Each motor operates for 12 hours/day and the other motor is standby)		
Present Configuration	3 pulley/3 belt (1:1 Speed configuration) – B 63 Belt	
Energy Calculation	**Before**	**After**
Expected Power Savings (%)	--	**8 %**
Power Consumption	9.8 kW *	9.0 kW
(* Assuming if the motor operates at 80 % load condition)		
Cumulative Power Savings	--	**0.8 kW**
(Considering 12 hours of operation/day x 350 days/annum = 4,200 hours/annum)		
Annual Energy Saving (for one motor)	--	**3,360 kWh**
Annual Energy Savings (Two motors)	--	**6,720 kWh**
(6,720 kWh x Rs. 12.00/kWh = **Rs. 80,640/-)**		
Annual Financial Saving	--	**Rs. 80,640/-**
Initial Investment (for two motors)	-	**Rs. 30,000 /-**
(For the two motors with new resized tapper lock pulley on both sides)		
Simple Payback	--	**Nearly 0.37 Years**
CO_2 Reduction	--	**5.5 Tons/Annum**

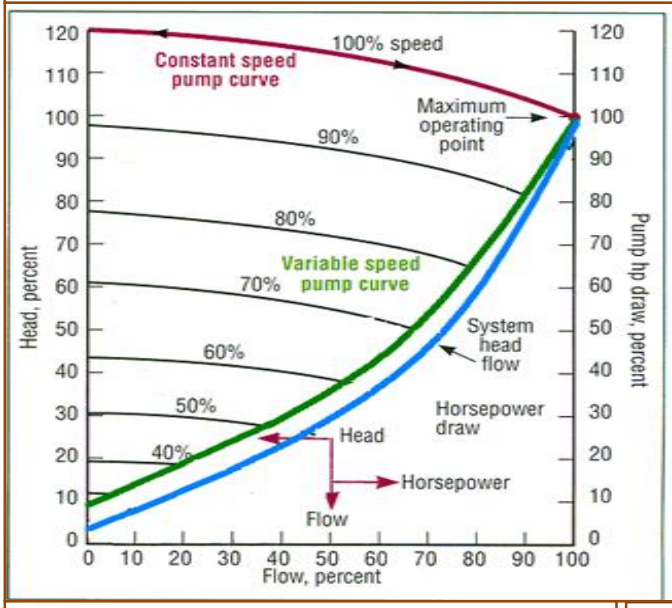


ENCON-IV	Reduction of Energy Consumption through retrofitting a Common Variable Frequency Drive (VFD) in the STP Aerator Blower Motor
Assessment Area	Energy Conservation in the STP blower using closed loop automation
Observations	• **In STP; 02 no's** of air blower motors with **11.0 kW/15.0 HP**; CG Make; 1,460 RPM; η = 89.6 % belt-driven 3G/3B –B 63 are running with tapper lock belt-pulley drive system.
Assessments	• During the night time and in the early morning hours, these blowers run at the same speed to pump the oxygen in the aerator tank. • Providing correct oxygen level at any moment requires automatic flow adjustments. Blower systems must therefore be most efficient, stable and adaptable to changing conditions.
Recommendation (Target)	• It is recommended to retrofit a VFD as a common to both the motors and operate this motor at reduced speed (by adjusting the frequency) during night and early morning hours as the ambient air has good amount of O_2. • Or Retrofit the existing blower motor with Dissolved O_2 sensor based closed loop VFD system. This must be prominent to adjust the speed of the motor based on the availability of the oxygen. • Some of the IT parks and other STP plants may turn off the aerator tank blowers especially during early morning by interlocking mechanism since the air itself has enough O_2 and no need to operate the blower and thus saves considerable amount of energy.

Energy and Financial Saving Calculation:

Parameters	**Description**	
Proposed cogged belt conversion	STP Aerator Blower (11.0 kW) – **2 Nos**	
(Each motor operates for 12 hours/day and the other motor is standby)		
Energy Calculation	**Before**	**After**
Expected Power Savings (%)	**--**	**20 %**
Power Consumption	9.8 kW *	7.8 kW
(* Assuming if the motor operates at 80 % load condition)		
Cumulative Power Savings	**--**	**2.0 kW**
(Considering 12 hours of operation/day x 350 days/annum = 4,200 hours/annum)		
Annual Energy Saving (for one motor)	**--**	**8,400 kWh**
Annual Financial Saving	--	**Rs. 1,00,800/-**
Initial Investment (for two motors)	-	**Rs. 1,00,000 /-**
Simple Payback	**--**	**Nearly 1.00 Year**
CO_2 Reduction	**--**	**6.9 Tons/Annum**

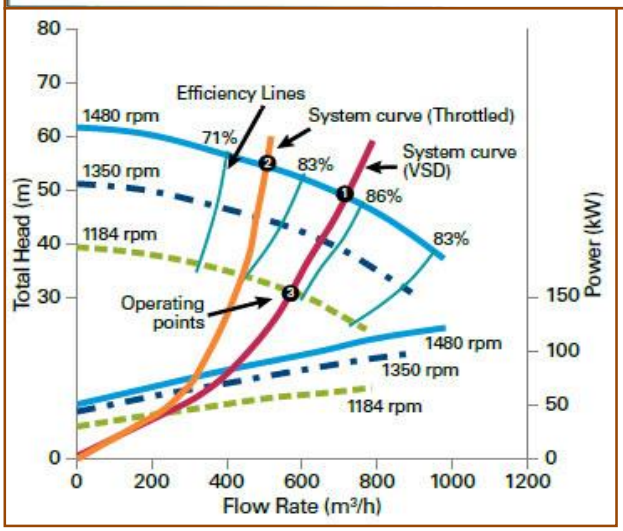


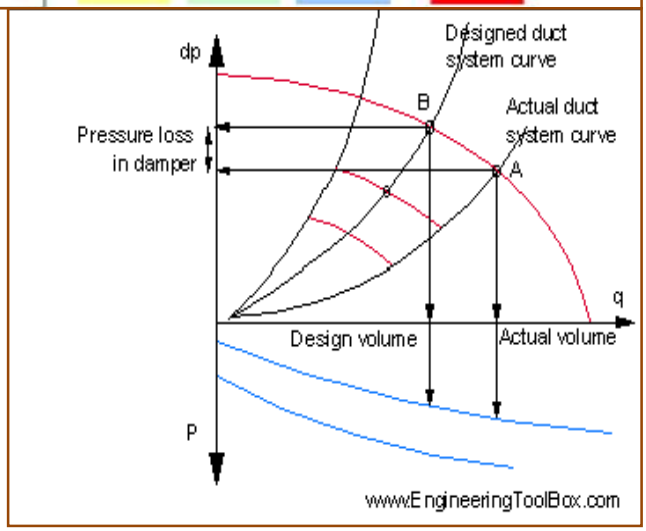


- FLOW ∝ RPM
- HEAD ∝ RPM²
- **POWER ∝ RPM³**

10% speed reduction = 27% energy savings

RPM	FLOW	HEAD	POWER
100%	100%	100%	100%
90%	90%	81%	73%
80%	80%	64%	51%
70%	70%	49%	34%
60%	60%	36%	22%
50%	50%	25%	13%
40%	40%	16%	6%





ENCON-V	Replacement of Existing Convention Ceiling Fans into Electronically Commutated BLDC Fans
Assessment Area	Energy conservation in ceiling fans located in the college campus
Observations	College area including all Buildings, Class, Lab, Faculty cabins, Auditorium, Hostel rooms & Other areas
Assessments	• BLDC fans operate in less energy with same air delivery. Similarly, these fans generate lesser noise, runs with inverter supply, remote control-based speed control, aesthetic look and better lifespan. • Conventional fans consume 1 unit of electricity for approximately 12-13 hours of running period, whereas the BLDC fans consume the same 1 unit of electricity for nearly 28-29 hours.
Recommendation (Target)	• Recommended to replace the existing conventional fans into EC BLDC fans in a phased manner and ensure good energy saving.

Energy and Financial Saving Calculation:

Parameters	Description	
Total No. of Fans available	Consider nearly **100 No's** of conventional fans to be changed from conventional to BLDC fans in the hostels; accounts for **7.0 kW**	
Approx. Operating Hours (Average assumed value)	**10 hours/day & 300 days/Annum = 300 hours/annum** (Actual operating hours may change)	
Energy Calculation	**Before**	**After**
Power Consumed (Approx.)	7.0 kW	3.5 kW
Expected Reduction of Power	--	**3.5 kW (50 % ↓)**
Annual Energy Saving	--	**10,500 kWh**
Annual Financial Saving	--	**Rs. 1,26,000/-**
Initial Investment	**-**	**Rs. 1,80,000/-**
(Considering Rs. 2,000/fan - Salvage value of Rs. 200/fan for old fan = Rs. 1,800/fan)		
Simple Payback	**--**	**Nearly 1.43 Years**
CO_2 Reduction	**--**	**8.6 Tons/Annum**

(Note: BLDC fans consume **less power when it operates at low speeds** which further saves energy. Further a conventional fan draws nearly about **100 VA**, whereas the EE fan draws only **30 VA.** This will be more beneficial for HT consumer as direct reduction of kVA rating).

One No-star regular fan's consumption in a year	1 x 2520 x 42 = 105840Wh or 105.84Units/year
For 30 million No-star fans sold in 2022, The energy consumed in a year	105.84 x 30 x 106 = 3.175 BillionUnits.
One 5-star SEE fan's consumption in a year	1 x 2520 x 14 = 35280Wh or 35.28Units/year
If 30 million 5-star SEE fans were sold in 2022,The energy consumed in a year	35.28 x 30 x 106 = 1.058 BillionUnits.
One 1-star fan's consumption in a year	1 x 2520 x 39 = 98,280Wh or 98.28Units/year
If 30 million 1-star fans are sold in 2022,The energy consumed in a year	98.28 x 30 x 106 = 2.948 BillionUnits. Note: (1 Unit = 1kWh)

SERVICE VALUE	STAR RATING	MAX POWER	MONEY SAVING	
x < 4.0	0	>75 W	0	
4.0 ≤ x < 4.5	1	<57 W	>300 Rs/Yr	→ Regular fan
4.5 ≤ x < 5.0	2	<51 W	>600 Rs/Yr	→ Fewer Choices & Low ROI
5.0 ≤ x < 5.5	3	<46 W	>800 Rs/Yr	
5.0 ≤ x < 6	4	<42 W	>900 Rs/Yr	
x > 6.0		<38 W	>1000 Rs/Yr	→ BLDC Motor

(x - Measured Sevice value)

All values are nominal for **48" inch** fan delivering **230 CMM** airflow for **12 hours/day at Rs 6.50 / Unit.**

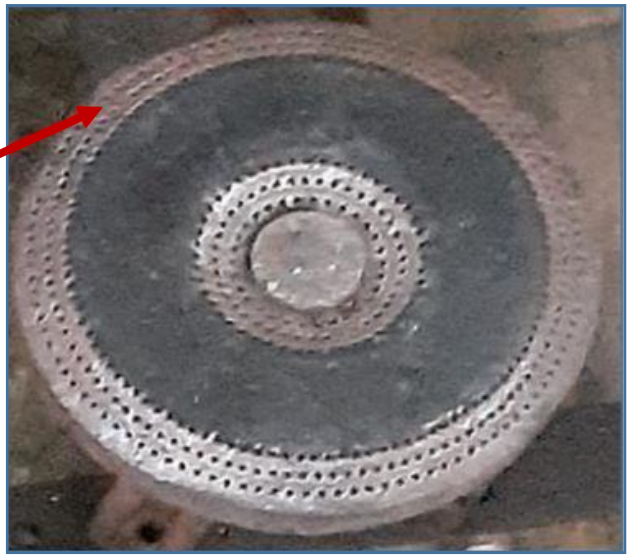
ENCON-VI	Reduction of LPG Consumption using Regular Burner Cleaning and Swapping of Active Burners.
Assessment Area	LPG Consumption (Cooking system in kitchen area)
Assessment	• Cooking system in the college mess mainly uses LPG as an energy carrier and utilize Gas stoves as a medium to cook the food. • Gas stoves are easy to maintain. However, when the flow of gas gets blocked, the burner heads cannot burn efficiently. • The best indicator for the efficiency of LPG system is the irregular flame pattern and yellow flames. • Formation of soot in both side of the burners, cleaning methods and interval improves the efficiency and reduce the LPG consumption.
Recommendation (Target)	• LPG commercial burners are made up of cast iron in which smoke formation is high and frequently able to crack due to aging. • It is recommended to clean the burner every week with solvent, rinse and gently clean the holes with ordinary fine cloth. Also, it is highly encouraged to swap with active spare burners. The investment on spare burners are less expensive. Make it a practice to swap the burner every week. • Identify an alternative with Stainless Steel (SS) burners (slightly costlier compared with existing one). But the lifespan is longer and replacement cost is much reduced. • Recommend to clean the burner at least twice in the week and saves nearly 5 % assured LPG saving.

Energy and Financial Saving Calculation:

Parameters	Description	
Swapping of new burners every week and cleaning of existing burner with natural ingredients (Ex: Dishwashing detergent, Non-abrasive scrub pad, Microfiber towels)		
Energy Calculation	**Before**	**After**
Expected Savings on LPG	**--**	**2 %**
LPG Consumption/Annum	**38,236 kg ***	**37,471 kg**
LPG Savings/Annum	--	**765 kg**
The expected financial savings is 765 kg x Rs. 105.0/kg = **Rs. 80,325/Annum**		
Initial Investment	-	**Rs. 20,000 /-**
Purchasing of cleaning ingredients for Rs. 20,000 with a payback of 0.25 Years		
CO_2 Reduction – 2.3 Tons/Annum		

(* From the total **LPG of 95,589 kg**; assuming **40 % of the LPG** is being utilized for burner based stoves; hence it is **38,236 kg**).

Examples of Soot Formation in LPG burners:

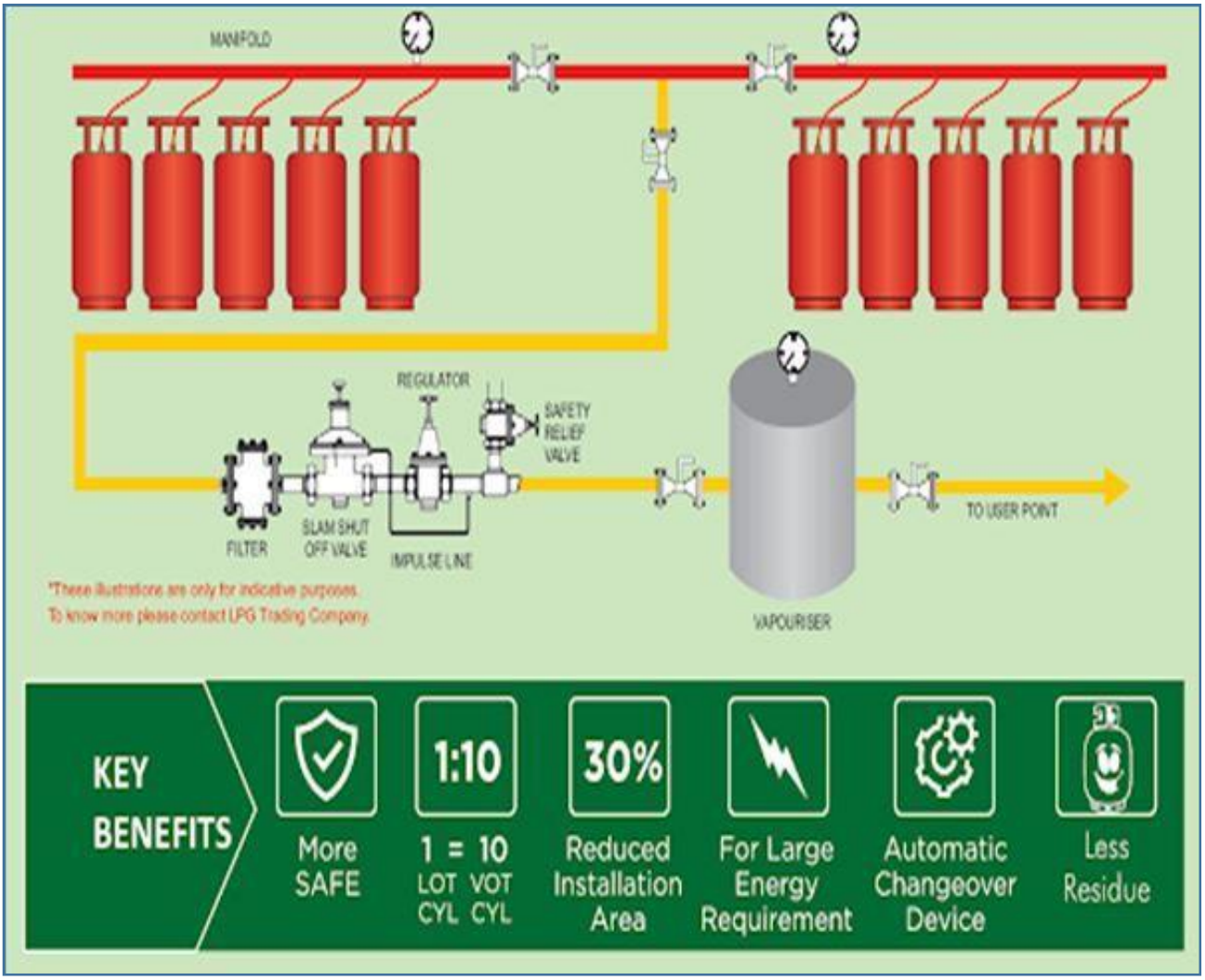


ENCON-VII	Reduction of LPG Consumption by converting the conventional Vapour Off-Take (VOT) system in to Liquid Off-Take System
Assessment Area	LPG Consumption (Cooking System in Hostel Mess)
Assessment	• At present the cooking has been done using Conventional single LPG VOT system by connecting 19.0 cylinders. • Set pressure on the gas pipe line is nearly 3.0 bar. The left over in the cylinders are brought back to the kitchen and are fitted with single burner stove for preparing milk and tea. In conventional Vapour Off-Take (VOT) system, the gas left over is normally 0.5 kg/cylinder (19.0 kg cylinders). • In LOT system; the gas left over being reduced to 0.1 kg/cylinder (in which 47.5 kg cylinder may be replaced) and thus LPG savings ensured. • This system has high pressure vaporizer; which takes the liquid at nearly 6 bar pressure and vaporize it and sent the gas to the heating application at 3.0 bar pressure. Because of high pressure intake; the leftover in the cylinder is much lower. • However the vaporizer has a heater coil; which is electrically controlled based on the closed loop temperature setting which consumes nearly 2 to 3 units/day (May vary depends on the heater coil capacity).
Recommendation (Target)	• It is recommended to convert the existing VOT system into advanced LOT system which is an advance concept in Multi-cylinder Installation; offers Strength of Bulk LPG Installation and easy functionality. LPG LOT System withdraws Liquid LPG up to 10 kg/h. LPG LOT has many advantages and to name a few; • Compact design and safe usage. • Requires less area than bulk installations • Optimum utilization of gas (Minimum left-over) • Uniform pressure (which saves nearly 20 % of LPG consumption) • Cheaper than bulk installation & Almost zero maintenance cost • Easy availability and convenient to handle

Energy and Financial Savings:

Parameters	Description	
Energy Calculation	**Before**	**After**
Leftover/Cylinder (Annual)	**0.3 kg**	**0.0 kg**
Expected LPG Savings/Cylinder	**--**	**0.3 kg**
Annual LPG Savings	**--**	**1,510 kg**
Annual LPG Savings = 0.3 kg x 5,031 No's of cylinder/annum = 1,510 kg		
Equivalent to **79 No's of 19.0 kg cylinders** with a financial savings of 1,510 kg x Rs. 105.00/kg = **Rs. 1,58,550/Annum**		

Initial Investment	**Rs. 1,50,000/-**
(Changing the conventional VOT into LOT system and replacement of old manifolds)	
Simple Payback	**Nearly 0.95 Years**
CO_2 Reduction	**4.5 Tons/Annum**

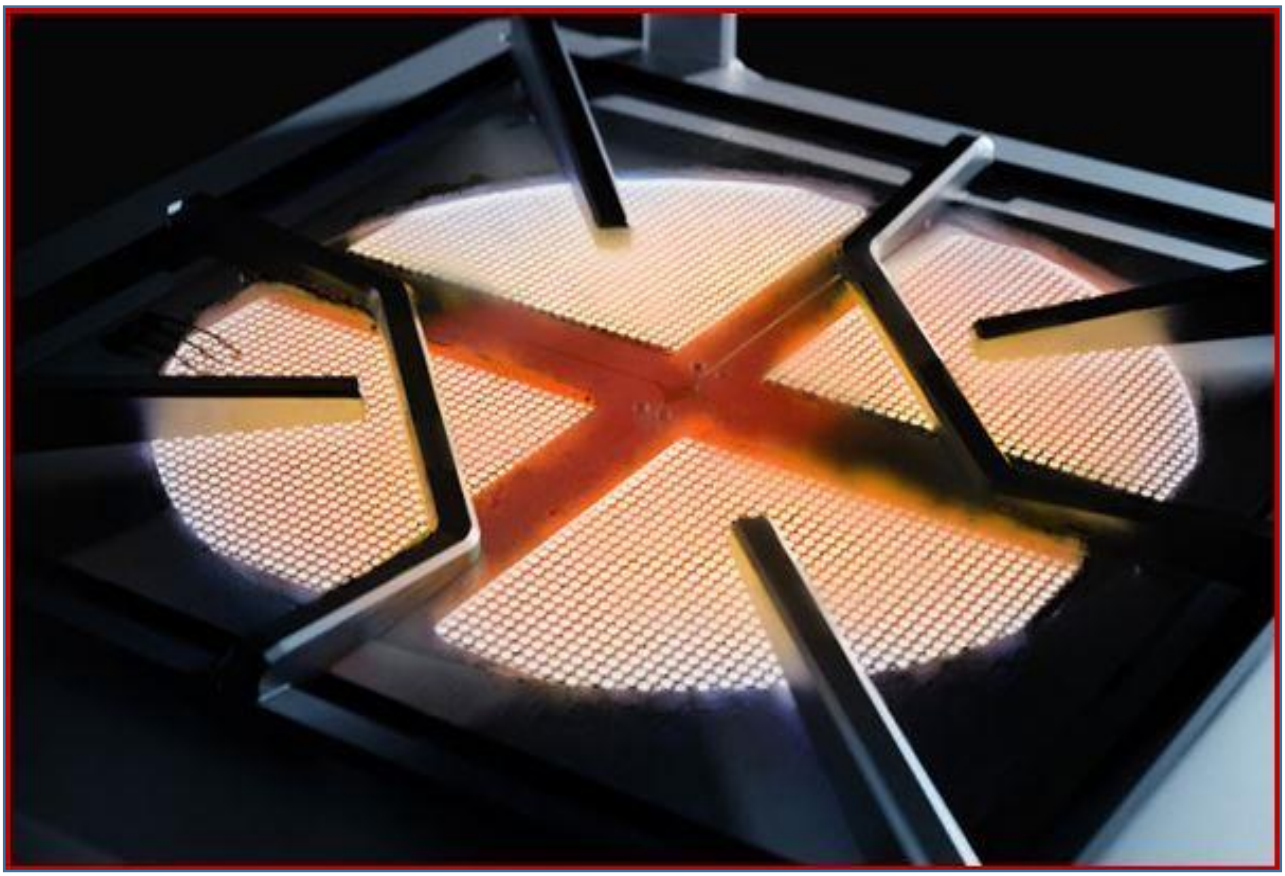


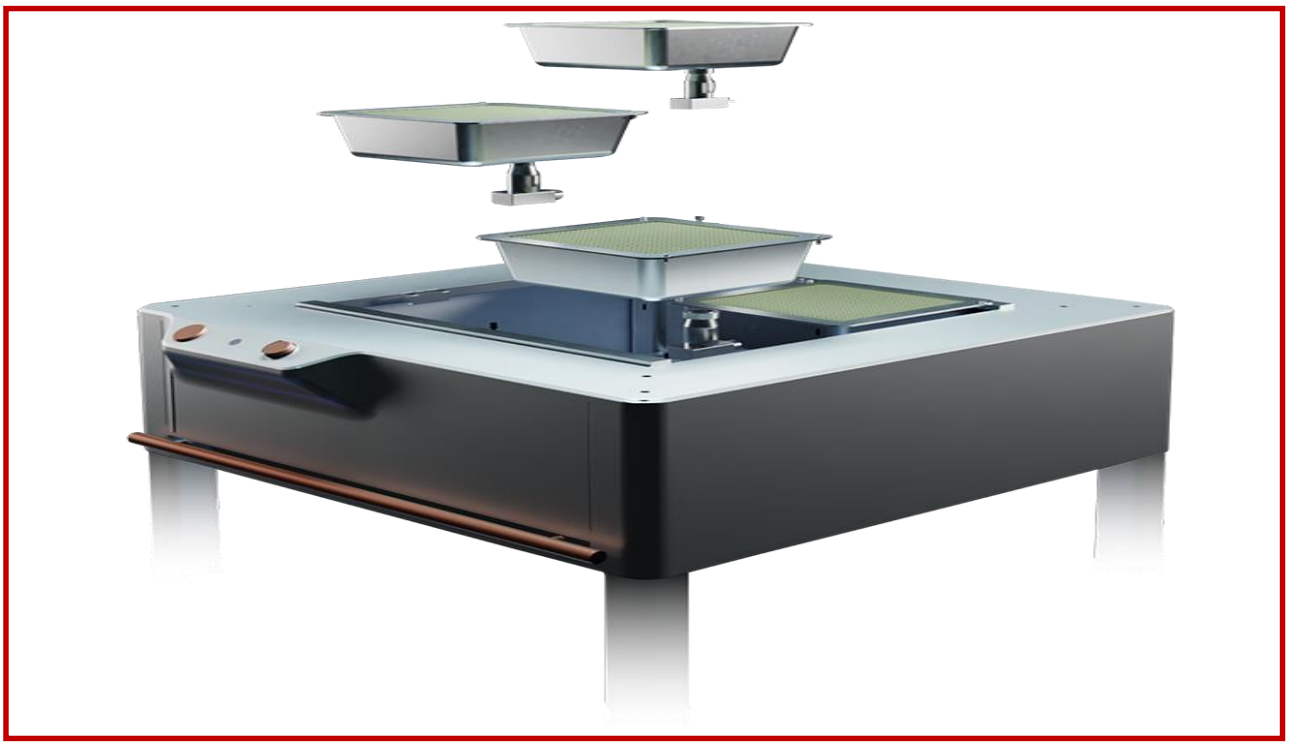
(Note: It is much simpler to maintain the LPG cylinders with higher safety in LOT arrangement. The management has to think in this direction and find a best way to implement the same in future).

ENCON-VIII	Reduction of LPG Consumption in Dosa making Stove by replacing the Conventional Burner with Radiant Burners
Assessment Area	LPG Consumption (Cooking system in kitchen area)
Assessment	• Nearly 30-40 % of the LPG is being delivered to Dosa making machine for making Dosa, Utappam, Chapathi etc., • These stoves are not fitted with LPG flow meters and hence exact LPG utilization is not known. • Conventional burners are used for cooking food. The stove emits heats in the surrounding area and hence increases the het in the ambient air which reduces the productivity of the person(s) working on and near the stove.
Recommendation (Target)	• Good side of 'FIRE' is radiant heat that generates Far Infra-red Rays (FIR). FIR is the most potent energy format to transmit heat into the smallest water molecule from 300 GHz to 430 THz. • These waves cook food uniformly without burning and retain maximum moisture in food even after cooking. FIR belongs to the good spectrum of light that was discovered by NASA as the safest and most beneficial light wave to have healing properties. • In general, flame and heat tend to accumulate at the centre where as in Radian Technology, regulate the flame evenly and uniformly across the burner. These burners are flameless, smokeless, and noiseless and produce uniform radiant heat. • The device has been tested and certified by LERC ((LPG Equipment Research Centre – a premier research arm under Petroleum Ministry) at a thermal efficiency, under IS 14612, between 65-68.9% as against conventional commercial gas burners with an efficiency rating between 36-45%.

Energy and Financial Saving Calculation:

Parameters	Description	
Energy Calculation	**Before**	**After**
Expected Savings on LPG	**--**	**10 %**
LPG Consumption/Annum	**38,236 kg * kg**	**34,412 kg**
(* From the total **LPG of 95,589 kg**; assuming **40 % of the LPG** is being utilized for dosa making stoves; hence it is **38,236 kg.** From that 20 % of saving could be possible).		
LPG Savings/Annum	--	**3,824 kg**
The expected financial savings is 3,824 kg x Rs. 105.00/kg = **Rs. 4,01,520/Annum**		
Initial Investment	-	**Rs. 2,00,000**
(Changing the existing burner with radiant burner and their subsystem for Dosa Stoves)		
Simple Payback	--	**0.50 Years**
CO_2 Reduction	--	**11.5 Tons/Annum**





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ENCON-IX	Reduction of LPG Consumption in Boiler Feed Water Pre-heating using Solar Thermal Energy System
Assessment Area	LPG consumption reduction in boiler steam generation by boiler feed water pre-heating in the mess area
Assessment	• The capacity on the boiler (Water tube type) is 0.5 Ton/hour installed in centralized kitchen. The fuel input for the boiler is Wood. • Only RO water is being fed to the boiler through a feed pump and a separate RO water tank is located near to the boiler house. • It is a good practice to supply RO water to the boiler; as it prevents i) Removal of over 98% of dissolved solids in the makeup – including scale forming salts that lower heat transfer, ii) Increase boiler efficiency through minimized boiler deposits and iii) Reduction of feed water alkalinity – with the direct result of lower neutralizing amine use. • However at present the feed water is being supplied to the heating chamber at atmospheric temperature and there is no pre-heating treatment. • Also the condensate water recovery is not practised in the boiler operation due to operational difficulties.
Recommendation (Target)	• Increased feed water temperature, must reduce the work done by the boiler to reduce fuel consumption. • For the kitchen application, condensate generation is less. Recovery of condensate water and return of it into feed water tank is slightly complicated and economically not viable. • However, the audit team suggest to install a 1,000 LPD solar thermal system (for one boiler operation) at the rooftop of the respective building and preheat the feed water from ambient to nearly 55 to 60^{0}C and supply to the boiler. This energy conservation proposal must substantially reduce the LPG consumption during the cold-start operation of the boiler. • Increasing the feed water temperature by **8^{0}C may save 3 %** fuel consumption and thus change in temperature may be taken as defined time of operation of the control mechanism.

Calculation of Energy Mapping between LPG and Solar Thermal Energy System:

- Assuming nearly 2,000 litre of water heater is being used for a boiler to produce steam per day; the energy calculation is presented below;

S. No.	Description	Parameters
1.	Quantity of hot water produced per day	2,000 kg (litres)
2.	Energy required to heat the water from ambient (25^{0}C) to 60 ^{0}C (Sensible heat)	= **m x C_P x Δt** = 2,000 x 1 x (60 - 25) **= 70,000 kcal/day**

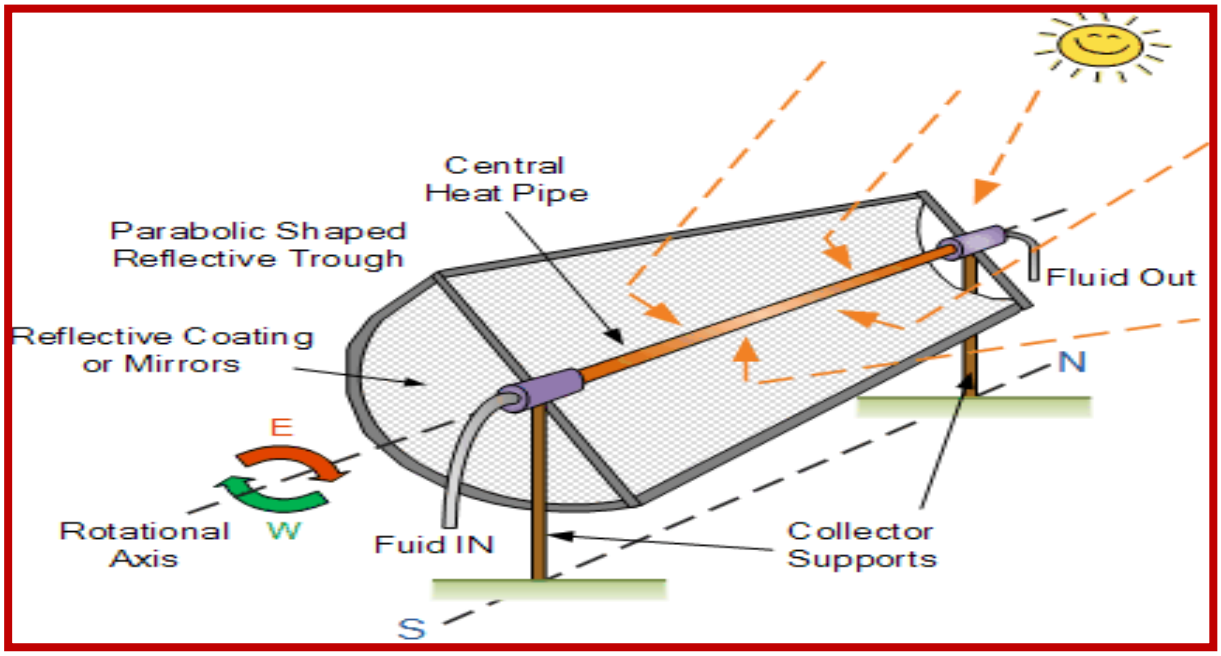
3.	Energy input to the boiler (considering 40 % as boiler efficiency)[1]	$= \frac{70,000}{0.4}$ = 1,75,000 kcal/day
4.	LPG required to heat up to supply same quantity of heat energy is given by one to one comparison) [2]	$= \frac{1,75,000}{4,000}$ **= 43.8 kg/Day**
5.	Total LPG required/annum (By assuming 200 operating days/annum) – **This energy is saved.**	**8,760 kg/Annum**

([1] typical cooking boilers are in the range of 35-40 % efficiency only)

[2] Gross Calorific Value (GCV) of the Wood is 4,000 kcal/kg)

Energy and Financial Saving Calculation:

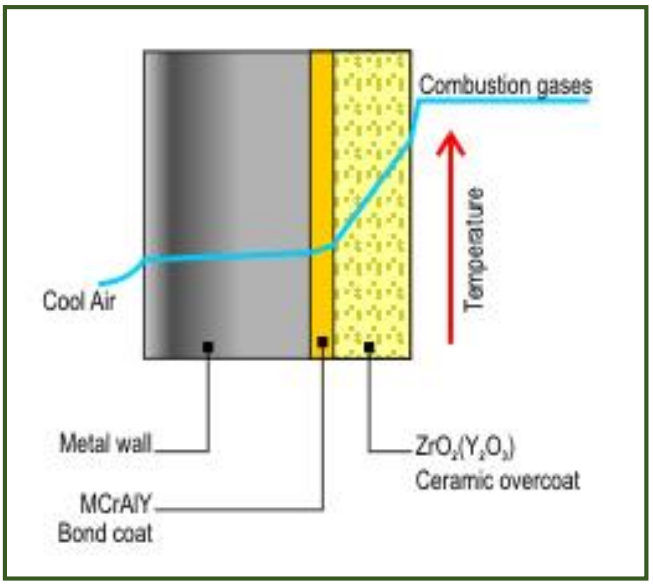
Parameters	**Description**	
Energy Calculation	**Before**	**After**
Expected Fuel Savings/Annum	--	**8,760 kg (8.8 Tons)**
Annual Financial Savings	--	**Rs. 73,920/-**
(8.8 Tons x Rs. 8,400/Ton = Rs. 73,920/-)		
Initial Investment	-	**Rs. 2.00,000 /-**
Simple Payback Period	--	**Nearly 3.38 Years**
• Installation of 2,000 + 2,000 LPD industrial solar water heating system either with FPC or ETC (copper with chrome coated, Insulated SS tanks & pipes (May be added with backup electric heating system). • The initial investment amount includes a 30 % capital subsidy from MNRE.		
CO_2 Reduction – 16.7 Tons/Annum		

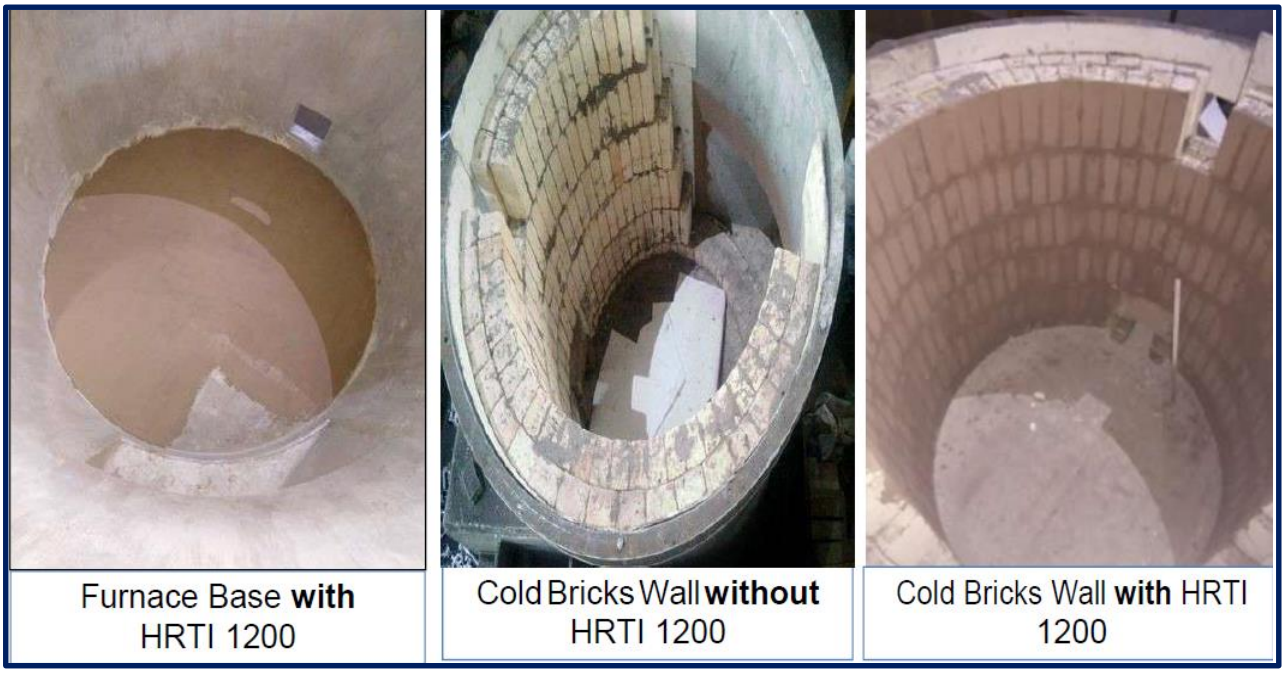


ENCON-X	Reduction of Heat Energy Exposed in the Steam Pipes Lines (Especially in Pipes Joints) using Thermo Ceramic Coating (TCC)
Assessment Area	Steam Boiler use for Cooking System in Hostel Mess
Assessment	• The major consumption of wood in the cooking system is in the boiler which is used to generate steam for cooking application. • Optimization in any form in the boiler will lead to a huge savings and reduced the specific energy consumption significantly. • Steam is distributed to the cooking application through proper piping system operated at required pressure and flow. • All the pipes are surrounded two-layer insulation namely i) Ceramic wool insulation acts as a first layer and ii) then covered by metal cladding. • These insulations prevent the heat exposed in the atmosphere due to which the energy content in the steam is being maintained. Also, it avoids the condensation while exposing to atmosphere air. • However, the pipe joints; bends (T and L bends) and left-over pipes are usually uncovered and are directly exposed to the atmosphere. These areas where energy loss happens and usually the surface temperature is high (nearly 70-80 ^{0}C). • It is a good practice to maintain the skin temperature at a maximum of 20 ^{0}C above the ambient temperature. This will lead to consume less fire wood and thus saves energy.
Recommendation (Target)	• The heat exposed to the atmosphere also leads to the energy loss. The audit team recommends arresting the heat and hence saving the energy. • Thermo Ceramic Coating (TCC) - an energy saving coating is a combination of specialized high temperature resins and heat reflecting ceramics. • Applied on the outside metallic pipes and it reflects radiation heat back in the process area, thereby preventing radiation heat losses and save the fuel energy. • The benefits of using TCC coating are i) saving on running time, ii) reduction in heat in internal walls and ceilings, iii) no damage (change) in the existing insulation, iv) zero maintenance and v) saves energy between 5-10 %. • Two types coating material is available namely i) TCC -1200 ^{0} C or applying on Internal Ceramic Wool/ Blanket and ii) TCC-200 ^{0}C for applying on External Shell of Furnace.

Energy and Financial Saving Calculation:

Parameters	Description	
Energy Calculation	**Before**	**After**
Expected Savings on wood	**--**	**5 %**
Wood Consumption/Annum	**570 Tons**	**541.5 Tons**
Wood Savings/Annum	--	**28.5 Tons**
The expected financial savings is 28.5 Tons x Rs. 8,400/Ton = **Rs. 2,39,400/Annum**		
Initial Investment	-	**Rs. 2,00,000**
Simple Payback	--	**Nearly 0.84 Years**
CO_2 Reduction	--	**54.2 Tons/Annum**





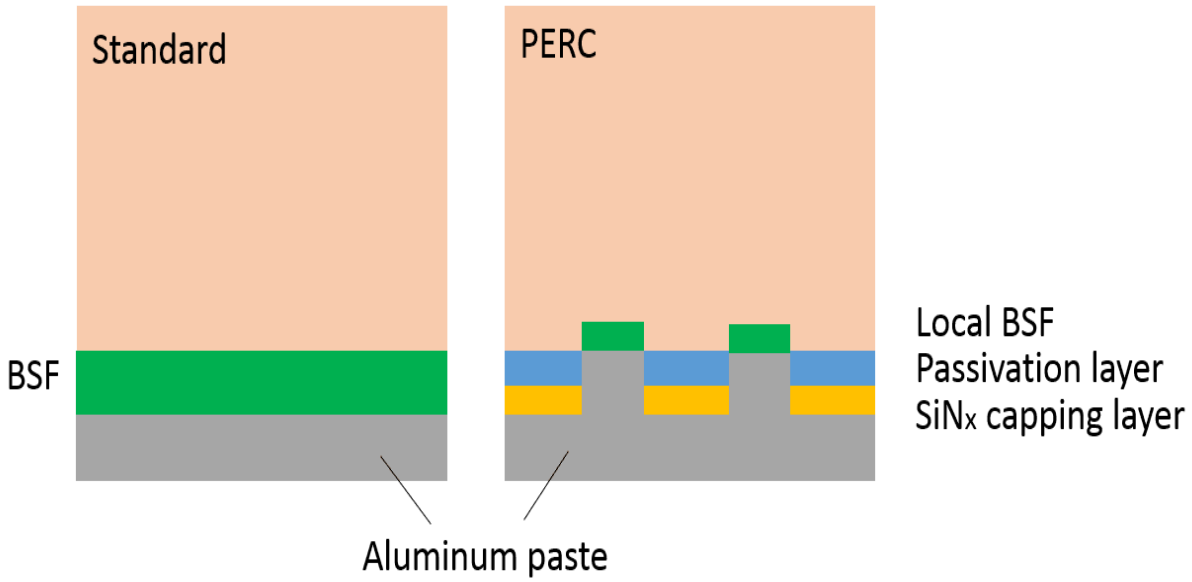
Renewable Energy Proposal on "Solar Based Energy Generation: Installation of Roof Top Solar Photovoltaic Power Plant (SPP) and Reduction in the Energy Billing"	
Assessment Area	Electrical Distribution System (Energy Utilization Pattern)
Observations	• All the electricity consumers (irrespective of their tariff structure) are eligible to install SPP in their roofing; start generating power and being fully utilized by the consumer (connecting the inverter output to any of the SSB or in the MV panel).
Assessments	• Installation of renewable energy-based power generation might be mandatory in future (as per policies of either state or central or both). Some bankers are now insisting that the consumer has to install a quantum of renewable energy system to reduce their carbon footprint when they avail top-up loads for expansion activities. • Further; during the environment assessment; power generation from the solar plant is being utilized to neutralize the CO_2 emission. Hence it will be value added utility for the company.
Recommendation (Target)	• The open terrace on the factory is completely vacant (also not affected by building, tree and any other artificial shading) which may be used to install appreciable capacity of Solar Photovoltaic Power Plant. • After measuring the terrace; appropriate power capacity of SPV plant must be installed. However, the audit team recommends to install **100 kW roof top solar PV plant** initially and later on expand if required.
Technology Driven Solar System	• **Mono PERC Solar PV System:** With a technology that combines rear wafer surface passivation and local rear contacts to maximize light capture, mono PERC solar modules are paving the way for dramatically increased PV system efficiency. • The standard monocrystalline cell presents a uniform Back Surface Field (BSF), whereas the mono PERC solar cell presents local BSF atop passivation and SINx capping layers, which significantly improves the capture of light and electrons. • The advantages of Mono PERC PV system are; ◆ High-performance mono PERC cell structure. ◆ Exceptional performance under low-light and high temperature conditions. ◆ Higher energy density/square foot. ◆ Increased light absorption, as unabsorbed light is reflected back to the solar cell. ◆ Extended cable lengths for easier installation; ◆ Superior anti-reflective coating captures more light to deliver increased efficiency.

	◆ Enhanced junction box sealing protects against moisture and extends product life. • **Back Sheets in PV Panels:** The primary function of the PV back sheet material is to offer protection to the solar module's various components throughout its lifetime. • This in turn ensures loss-free energy generation for the solar panel. The solar back sheet should be able to resist active environmental elements such as moisture, temperature changes, chemical substances and physical damages for years on end. • The active electrical elements found within the modules must also be insulated to ensure the safety of surroundings.

Energy & Financial Saving Calculation:

Parameters	Units	Description
Power capacity of the proposed SPP	kW	100
Maximum sun shine hour (Solar hour)	Hours	3.5
Annual Operating Days	Days	250
Maximum energy generated from SPP	kWh	87,500
Annual Financial Saving	Rs.	8.1 Lakhs
Initial Investment (Assessment, erection& commissioning)	Rs.	**42.0 Lakhs**
Simple Payback Period		**5.2 Years**

(Note: Installation of RES especially solar plants; the total cost of the system is being claimed in depreciation which is more beneficial for the consumer. The first-year depreciation is 60% of the total investment which makes solar attractive and quicker Return on Investment).



ENERGY, ENVIRONMENT & GREEN AUDIT REPORT

PART-B: ENVIRONMENT AUDIT REPORT

6. ESTIMATION

OF

CO_2 EMISSION & NEUTRALIZATION

(ELECTRICITY, WOOD, LPG, DIESEL, MATURE TREES & SOLAR PV SYSTEM)

6.1: Assessment of Annual Energy Usage:

Table-3 shows the types of energy carriers used for their regular operation in the college campus along with application area and their source.

Table-3: Energy Carriers, Application area and their sources used for College Operation

S. No.	Type of Energy Carrier	Application Area	Source of Procurement
1.	Electricity (LT Service - 01 No)	Powering to all electrical / electronic / HVAC equipment's	From TANGEDCO
2.	Solar PV System **(5.7 kW)**		Captive Power Generation
3.	Diesel	Transport vehicles and Diesel Generator (Captive Generation)	From authorised distributor
4.	Liquified Petroleum Gas (LPG)	Used only for cooking	
5.	Seasonal Wood		From Local Vendor
6.	Mature Trees, Bushes & shrubs	The college has nearly **570 mature trees** of different varieties which are more than **10 years old.**	

6.2: Environmental System: CO_2 Balance Sheet:

→ CO_2 Balance sheet is the indicator on the carbon emission and their neutralization in a year

→ As per the Environmental Management System (EMS); only Scope-1 & Scope-2 based energy consumption is accounted.

→ The following tables provide the balance sheet indicating various energy carriers associated with the regular activities and their CO_2 mapping.

Table-4: Environmental System: CO_2 Balance Sheet (2023-24)

S. No.	Annual Energy Consumption & CO_2 Emission			Annual CO_2 Neutralization		
	Description	Parameters	Emission (Tons)	Description	Parameters	Neutralized (Tons)
1.	Wood	570 Tons	1,083.0	Electricity (DG)	27,482 kWh	24.5
2.	Diesel	1,60,824 Litres	424.6	Mature Tree	570 No's	12.4
3.	Electricity	3,88,211 kWh	318.3	Solar Energy	5,968 kWh	4.9
4.	LPG	95,589 kg	286.8			
Total Emission			2,112.7	Total-Neutralized		41.8
Balance CO_2 to be Neutralized = 2,070.8 Tons/Annum; Per capita Consumption = 403 Grams/Person*						

(* No. of Students, Faculty & Staff for the year 2023-24 is 5,143)

6.3: Calculation Table:

For Electricity = $\left[\text{kWh x } \frac{0.82 \text{ kg of CO2 emission}}{\text{kWh}}\right]$
For Diesel = $\left[\text{Diesel Consumption (Litre) x } \frac{2.64 \text{ kg of CO2 emission}}{\text{Litre of Fuel Consumption}}\right]$
For LPG = $\left[\text{LPG Consumption (kg) x } \frac{3.0 \text{ kg of CO2 emission}}{\text{kg of LPG Consumption}}\right]$
For Wood = [Wood Consumption (kg) x 1.9 kg of CO2 Consumption]
A mature tree is able to absorb nearly CO_2 at a rate of 21.8 kg/annum; $\frac{(21.8\ x\ 570)}{1{,}000} = 12.4\ \frac{\textbf{Tons}}{\textbf{Annum}}$

6.4: Recommendations:

From the above discussion points; it is evident that activities taken forward to neutralize the CO_2 is predominant and to become a Net-Zero Carbon Emission buildings. The management has to plan several activities achieve the target.

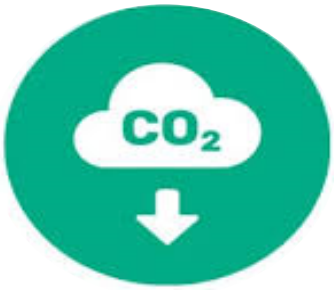
- Increase the foot print of trees planted inside the college campus.
- Encourage the students to plant more trees and account them all.
- It is a right time to install considerable amount of roof top solar PV plant and generate the electricity. This must reduce the utility supply and hence reduce the direct CO_2 reduction.
- **As per the Solar Policy-2019** from Government of Tamilnadu; for any educational institutions have to implement substantiate a minimum of **6 % of its energy generation from renewable energy source**.
- Convert existing convention street lightings into solar based battery-operated lightings.
- Identify higher fuel consuming vehicle and either rework or replace it.
- Conduct training programmes for the transport staffs at regular interval and encourage them to maintain the vehicles at good condition throughout the year.

6.5: References:

[1] https://ecoscore.be/en/info/ecoscore/co2

[3]http://www.tenmilliontrees.org/trees/#:~:text=A%20mature%20tree%20absorbs%20carbon,the%20average%20car's%20annual%20mileage

CO_2 Emission:
2,112.7 Tons/Annum



Planned CO_2 Reduction
41.8 Tons/Annum

CO_2 to be neutralized
2,070.8 Tons/Annum

ENERGY, ENVIRONMENT & GREEN AUDIT REPORT

PART-B: ENVIRONMENT AUDIT REPORT

7. TRANSPORT, FIRE EXTINGUISHERS & REFRIGERANT GASES IN AIR CONDITIONING SYSTEM

7.1: List of Transport Vehicles:

- ✓ Pollution level of all vehicles are regularly monitored and are maintained within the prescribed limit since the college is committed to provide green environment for better atmosphere.
- ✓ The list of transporting vehicles along with their type of engine are represented in Table-5.

Table-5: List of Transporting Vehicles available in the College

S. No.	Type of Vehicle	Fuel used	No. of vehicles	Pollution certified (Y/N)
1.	Bus	Diesel	16	Yes
Total No. of Vehicles			**16**	Yes

7.2: Details of Pollution Free Transport Vehicles & Copy of Pollution Certificate:

- The college is committed to green environment not only in the campus; but also, to the entire atmosphere. In order to commute the students and staff; the management is operating vehicle services from various places to the college.
- These vehicles are well maintained by a set of dedicated bus operators and are continuously monitored by the management officials.
- No history of accidents (either major and/or minor) for the past five years. Maintaining best performance on the engine, tyre and other accessories.
- Maintaining proper records on each trip, fuel consumption, distance travelled, no. of passengers and mileage (kmpl)
- All the drives and helpers are well experienced with good track records on i) fuel economy, ii) maintenance free operation, iii) accident free and iv) student friendly.
- All the vehicles are checked periodically and are having valid pollution certificate and certificate of insurance. These vehicles are fitted with Bharat Standard (BS)-IV type engines. However, the management has a commitment to convert the vehicles to BS-VI; once the life time of the vehicles are ended.
- The college administration is also providing skill development training to the bus operator through renowned experts and improve their productivity. Further the management is also conducting regular medical camps for all the bus operator through which i) complete body check-up, ii) blood pressure, iii) blood sugar level, iv) vision check-up and v) other general medical examination are carried out.
- **High Speed Diesel (HSD**) is used as fuel for all the vehicles; which emits less CO_2 in the atmosphere than compared to conventional fuel. Further; the fuel is procured from a single consumer and hence it maintains the quality and provides good engine life.

Form 59

[See rules 115 (2)]

Pollution Under Control Certificate

Authorised By :
State Transport Department

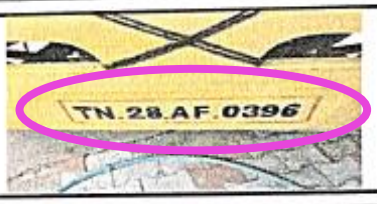
Date	:	**04/11/2024**
Time	:	**13:17:45 PM**
Validity upto	:	**03/05/2025**

Test Validity

Certificate SL. No.	:	TN02800250023302
Registration No.	:	TN28AF0396
Date of Registration	:	10/Dec/2009
Month & Year of Manufacturing	:	July-2009
Valid Mobile Number	:	******0000
Emission Norms	:	BHARAT STAGE II
Fuel	:	DIESEL
PUC Code	:	TN0280025
GSTIN	:	
Fees	:	Rs.110.00
MIL observation	:	No

Vehicle Photo with Registration plate
60 mm x 30 mm

Vehicle Number



Sr. No.	Pollutant (as applicable)	Units (as applicable)	Emission limits	Measured Value (upto 2 decimal places)
1	2	3	4	5
Idling Emissions	Carbon Monoxide (CO)	percentage (%)		
	Hydrocarbon, (THC/HC)	ppm		
High idling emissions	CO	percentage (%)		
	RPM	RPM	2500 ± 200	
	Lambda	-	1 ± 0.03	
Smoke Density	Light absorption coefficient	1/metre	2.45	1.08

This PUC certificate is system generated through the national register of motor vehicles and does not require any signature.

Note : 1. Vehicle owners to link their mobile numbers to registered vehicle by logging to https://puc.parivahan.gov.in

Authorised Signature with stamp of PUC Operator
60mm x 20 mm

T.L.S POLLUTION TESTING CENTRE
NAMAKKAL - 637 003.
Mobile : +91 94422 21556.

Sample Pollution Certificate for a Transport Vehicle

7.3. E- Vehicle:

- → **PEC** is more conscious about locally created environment pollution and are now running a **Battery-Operated Electrical Vehicle (BOEV)**.
- → This vehicle is mainly employed to carry the visitors for campus tour and is nearly running for 4-5 hours/day.
- → Charged every day and put in to service for operation. Nearly it runs **30-40 km** per charging. The charging point is located inside the college campus.
- → Battery powered vehicles are operated with posted speed limits within this campus for pick and drops the students and teachers from parking area to college campus.

7.4: Installation on Fire extinguishers:

- The list of Fire Extinguishers are given below:

S. No.	Type	Capacity	Quantity
1.	CO 2	4.5 kg	20
2.	CO 2	2.0 kg	15
3.	ABC	6.0 kg	30
4.	ABC	2.0 kg	10
5.	ABC	1.0 kg	10
Total			**85**

- Recommend to install adequate Fire extinguishers in all the vulnerable points.
- They are also inspected with refilled and in good condition (with adequate pressure indicated in the meter).
- The institution is recommended to conduct the following fire safety training Programmes to all levels of people at regular interval and list of the training programme along with the type & frequency is represented in the below table.

S. No	Training Description	Mode of Training	Subject	Frequency
1.	Fire mock drill	Internal faculty	✓ Alarm operation ✓ Isolation of power supply ✓ Fire brigade ✓ Evacuation Procedures ✓ Assembly & Roll call	Every 6 Months
2.	Fire mock drill & Fire Fighting Training	External Faculty	✦ Same as Mock drill ✦ Recognize the fire hazards ✦ Fire safety equipment's ✦ Hands on FE operation	Every 12 Months

7.5: List of Air Conditioning System along with its Refrigerant:

The list of AC available is shown in Table-6: indicating their quantity, tonnage, type of refrigerant, GWP and ODP.

Table-6: List of Multi-variant AC System, Type of Refrigerant, GWP and ODP Values

S. No.	Location	Star Rating	Quantity	Refrigerant	GWP	ODP
1.	Main Building	3 Star	68	R 22	1810	Medium
		5 Star	5	R 32	675	Zero
2.	Temple Tower Building	3 Star	10	R 22	1810	Medium
		3 Star	10	R 22	1810	Medium
3.	Additional Block	3 Star	5	R 22	1810	Medium
4.	First year Block	3 Star	12	R 22	1810	Medium
		3 Star	5	R 22	1810	Medium
		5 Star	2	R 22	1810	Medium

- **Note:** The most environment-friendly refrigerants that are available in Indian market currently are "R-290" and "R-600A". They are Hydrocarbons and their chemical names are "Propane" for R-290 and "Iso-Butane" for R-600A
- They are completely halogen free, have no ozone depletion potential and are lowest in terms of global warming potential. They also have high-energy efficiency but are highly flammable as they are hydrocarbons. (Kindly refer: https://www.bijlibachao.com/air-conditioners/comparison-of-various-refrigerants-r-410a-r-22-r-290-r-134a-used-for-air-conditioners-and-refrigerators.html).

Refrigerant	Global Warming Potential	Ozone Depletion Potential
R-22	1810	Medium
R-410A	2088	Zero
R-32	675	Zero
R-134A	1430	Zero
R-290	3	Zero
R-600A	3	Zero

ENERGY, ENVIRONMENT & GREEN AUDIT REPORT

PART-B: ENVIRONMENT AUDIT REPORT

8. USAGE OF CHEMICALS, SALTS & ACIDS

(STORAGE, HANDLING & BEST OPERATING PRACTICES)

8.1: Handling of Chemicals/Salts/Acids used in the Laboratories:

The science departments uses chemicals for experimental applications and are having strict safety rules as follows;

- Well trained faculty and lab assistants who have knowledge about the hazardous nature of each and every chemical are only allowed to handle the chemicals safely
- Strictly follow the manufacturer's instruction on the container in order to preventaccidents
- Volatile or highly odorous chemicals, fuming acids are stored in a ventilatedarea
- Chemicals are stored in eye level and never on the top shelf of storage unit
- All stored chemicals; especially flammable liquids are kept away from heat and direct sunlight. Reactive chemicals are not storedclosely
- Hazardous and corrosive chemicals are kept on sand platform to avoid corrosion
- First aid box and fire extinguishers are readily available in thelaboratory

8.2: Storage of Chemicals/Salts/Acids:

Less concentrated chemicals, salts and acids are stored in proper racks, cupboards and high concentrated acids are stored in separate area filled with sand.

- Most of the chemicals, salts and acids used in the science departments are inorganic in nature and no harmful effects are created during the experiment process
- However, after completion of each experiment, the wastes are washed in the water sink and are rooted to common choke pit.
- Only trained teaching and non-teaching staffs are handling the chemicals and also, they are well trained to handle any abnormal laboratories.
- **Recommend to fix adequate and correct sequence of fire extinguishers are placed near all the laboratories**

8.3: Recommendations:

- ⇒ Display the **Dos and Don'ts** inside the laboratory
- ⇒ Print the Dos & Don'ts in the Students laboratory manual
- ⇒ During the first class, demonstrate a PPT presentation and explain the safety procedures
- ⇒ Provide training to the teaching and technical staffs member on latest updates on chemical storage, handling, and safe disposal
- ⇒ Also encourage to conduct such type of training programmes by the faculty member to nearby schools and college (as an outreach programme)
- ⇒ Fix the First Aid Box (with all necessary medicines)
- ⇒ Place the names (along with their photo and mobile number) of the professionals training to handle fire extinguishers
- ⇒ Prepare & adopt a **Chemical Policy** (Including procurement, storage, handling, distribution, & disposal

8.4: Use of Chemical for Vessels & Floor Cleaning:

In order to maintain hygiene in the College campus; the administration regularly clean the floors and restrooms. In addition to this, the hostel management has to monitor i) the cleaning of vessels, kitchen floor, dining hall, store room and gas station. Table-6 shows the cleaning agents used to clean the above-mentioned area;

Table-7: Cleaning Agents used for Floor and Vessel Cleaning

S. No.	Cleaning Agent	Application
1.	Soap Oil	Vessel Cleaning
2.	Phenol	Floor Cleaning

8.5: Recommendations: Eco Friendly – Green Cleaning Agents:

- It is recommended to use natural ingredients like orange peel extract & vinegar. It leaves a mild and pleasant fragrance after use. The formula is free from all harmful chemicals & toxins. It is pH-neutral, gentle on the skin as well as on the surface where it is used
- Also, these products are **IGBC GreenPro** certified. GreenPro is a mark of guarantee that the product is environment friendly throughout its life cycle

Green Pro Certified Eco-Friendly Cleaning Agents

ENERGY, ENVIRONMENT & GREEN AUDIT REPORT

PART- C: GREEN AUDIT REPORT

9. WATER UTILIZATION, CONSERVATION & WATER MANAGEMENT

9.1: Source of Water, Storage and Distribution:

Table-8 shows the source of water, location of storage along with their application.

Table-8: Source of Water, Location of Storage and Application

Source of Water	Location	Application
Municipal Water	Separate sump of **20,000 Litre** capacity	◆ Only used for drinking application
Open well (01 No.)	Front of the College with nearly **70 Feet Depth**	Utensil Cleaning, Bathing, Cloth Washing, Gardening & Construction
Bore Water	**3 Nos** of bore wells located inside the college campus	
Rain Water Harvesting System (RWHS)	Centralised location named as **"Amarthavarshini"** with a storage capacitor of **2 Crore Litres.**	↗ To store building & road run-offs ↗ Used to increase the ground water

9.2: Details of the Water Utilities, Storage, Motor Capacity and Approximate Run Hours:

The following table provides the details of the Water Utilities, Storage, Motor Capacity and Approximate Run Hours available inside the college for regular application.

Table-9: Details of the Water Utilities, Storage, Motor Capacity and Approximate Run Hours

S. No.	Source of Water	Depth	Sump Capacity	Tank Capacity
1.	Open well	Nearly 70 ft	20,000 Litres	Main Building: **2,000 L x 2 No's** HDPF Tank (Interconnected) to store drinking water
				20,000 L; Cement tank is used to store Bore and Open well water
2.	Bore Well	Nearly 350 ft		Core Building: 20,000 L capacity Cement tank patrician with 12,000 L capacity each

Note:

- ☞ Over Head (OH) tanks drinking water tanks are High Density Polyehelne models.
- ☞ OH salt water tanks are Cement construction.
- ☞ The maintenance team ensure to clean the tank for three months once.
- ☞ Bleaching power is mostly used to clean the inside tank.
- ☞ Water Dispenser is located and used to distribute the drinking water with Normal, Hot and Cold options
- ☞ Nearly **09 Nos** of water dispensers are located inside the college campus.
- ☞ Treated water from the Sewage Treatment Plant (STP) is used for Gardening application.

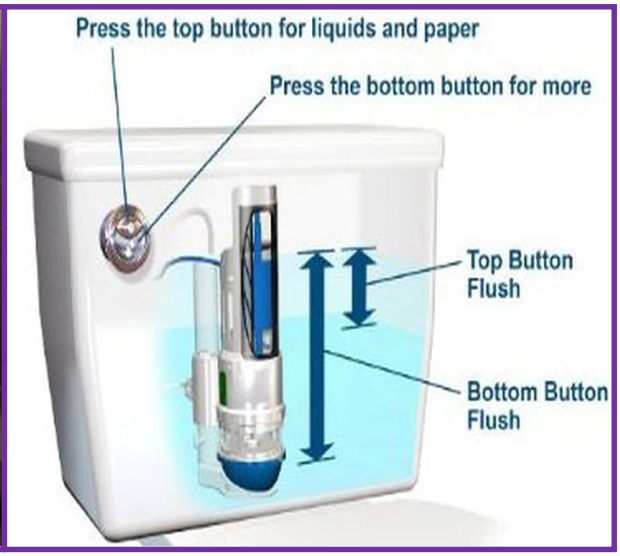
9.3: Water Savings in Foreign Toilets:

- The list of availability of Indian & Foreign style toilets are presented in the below Table-10.

Table – 10: List of Indian & Foreign Style Toiles available in the College

S. No.	Location	No. of Toilets	
		Indian	Foreign
1.	Main Building	34	08
2.	Temple Tower Building	30	08
3.	Additional Block	30	06
4.	First year Block	38	14
Total		**132**	**36**

- In general, the flush tank capacity may be 8 to 10 Litres (depends on make and model). Water savings also leads to power saving it saves the operating duration of the water pumps directly.



9.4: Rain Water Harvesting (RWH) – from Building Roof Area & Road Run-off Area:

- ☞ The audit team appreciates the effects taken by the management of **PAAVI ENGINEERING COLLEGE (Autonomous)** for harvesting the rain water almost in all buildings.
- ☞ The roof area is so arranged to collect the rainwater and then passed through proper piping system, and then bring back to a Common Collection System named as "**Amarthavarshini**" with a collection capacity of Nearly **2 Crore Liters**.
- ☞ It look like a Pond and many living species are available in and around the pond.
- ☞ Because of implementing this centralized storage facility; the ground water level in and around the college are in increased.

9.5: Sewage Treatment Plant:

- It must be appreciated that the management of PCE has implemented conventional wastewater treatment (with a capacity of **2,00,000 litres/day**).
- All the sewage waters are collected in main tank with a capacity of 1 Lakh Litres. It is then agitated using raw sewage pump for specified period of time and then let it out to filter tank.
- From the main tank; the treated water is then passed to Aerator tank having 11 HP blower used to deliver dissolved oxygen at 4-6 bar pressure. However this motor is running 24 hours. However this motor is operated based on the quantity of the sewage collected. If the quantity is less (during lean period of college operation), this motor is turned off manually.
- Urea + TFA (Trifluoroacetic Acid) urea acts as an effective catalyst for sludge removal and processing is being added at regular interval.
- **Sludge Treatment and Usage:** All the sludge's are settled in the tank and pumped back to main tank. Once the quantity of the sludge is appreciable; then it will be taken out and used as manure for gardening.

Various Stage of Sewage Treatment Plant (STP)

9.6: Recommendations for Water Distribution Network:

→ **Display of Water Consumption:** Water consumption is the major utility in the factory. The consumption pattern is not constant and all the stack holders should know the facts of usage of water (and also energy) metrics along with its financial debuts.

→ Hence monitor and display the water consumption at appropriate places and encourage everyone to save water.

→ All the pump motor must be controlled by floating sensor and hence the motors are automatically ON and OFF. It avoids the overflow and hence saves water and electrical energy.

→ All the buildings are fitted with water flow meters and hence the water utilization is properly accounted. **However clear picture of actual consumption must be recorded (either manually or digitally).**

→ Similar to the water flow meter; energy consumption of all pumping motors is recorded using panel board meters. Manually the readings are taken and computed to calculate the cost of the treated water.

→ Fault and leakage in the water distribution line will be promptly informed by the respective in-charges to the maintenance team and immediately arrested.

→ It is advisable to replace all the old taps without aerator into aerator-based taps in a phased manner.

→ Faucet aerators consists of a small screen which spans the opening of the faucet. Aerators helps to reduce and regulate water flow and also offer the following benefits;

- ✦ Decreased Faucet Noise & Consistent Water Pressure
- ✦ Lower Water Bills
- ✦ Improved Water Pressure
- ✦ Increased Filtration
- ✦ Minimized Splashing
- ✦ Simple and Quick Installation

ENERGY, ENVIRONMENT & GREEN AUDIT REPORT

PART – C: GREEN AUDIT REPORT

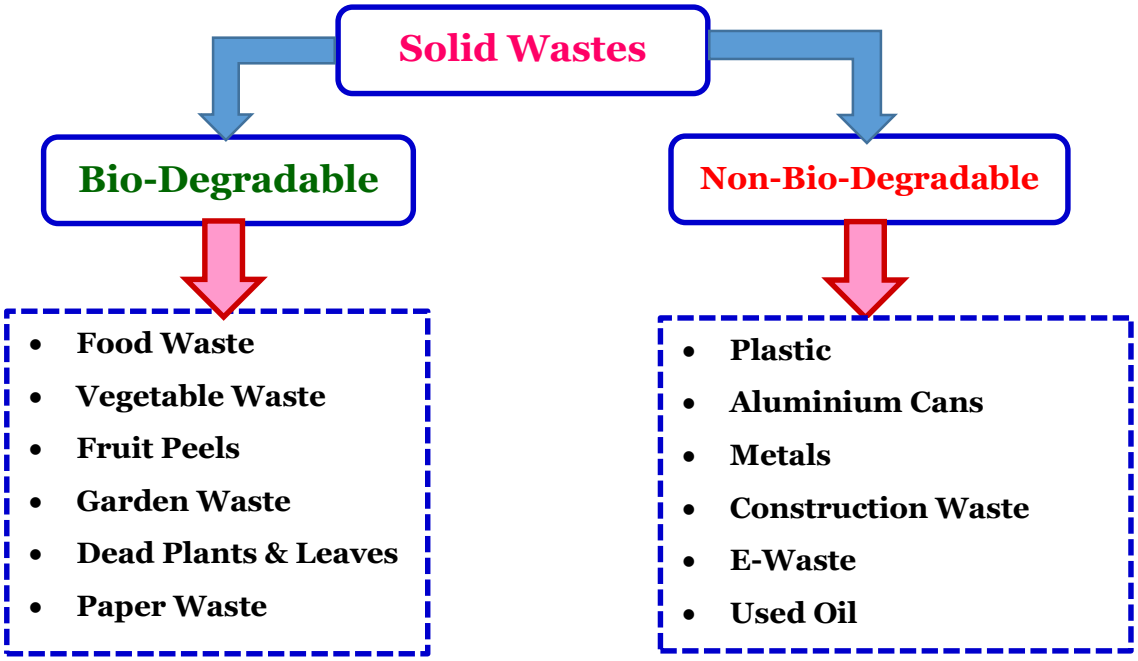
10. WASTE HANDLING

&

MANAGEMENT

10.1: Solid Waste Management System:

Different types of wastes generated inside the college premises are represented in the block diagram given below.



10.2: Process of Waste Management:

The college management practised some methods to treat the waste generated and Table-11 shows the process of treating the solid waste generated inside the college campus.

Table-11: Process of Waste Management

S. No.	Waste Type	Waste Treatment
Bio-Degradable Waste Management		
1.	Food and Vegetable Waste	• Collected and used as a input fuel for the Biogas Energy Generation System
2.	Garden Wastes and Plant Leaves	• Daily collected and dumped in a yard
3.	Paper Waste	• Collected and stored in a separate place
		• Sold to third party for recycling
		• Daily paper waste stored in a yard
Non-Bio-Degradable Waste Management		
4.	Plastics	• Banned in the college campus **(Welcome step).** • The chemical/salt storage containers are disposed to third party
5.	Construction Waste	• Mostly used by their own construction and used for internal land filling
6.	Metals	• Construction metals or metals from any other sources are stored & sale to third party for recycling

7.	Transport Oil + Tyres	• Stored in a separate place and sold to third party
8.	DG Engine oil & Coolant	• Stored in a separate place and sold to Construction Purpose Only
9.	Vehicle & Computer Batteries	• Procuring new batteries with buyback offer • (Old battery replacement)
10.	Used edible oil	• Almost zero waste. Mostly used for internal cooking and frying.
11.	E-Waste Management	• Used for sale to third party for recycling

10.3: Standards Followed for Waste Handling & Management:

1. Solid Waste Management Rules – 2016
2. E-Waste Management Rules – 2016
3. Hazardous Waste Management Rules – 2016 (Management & Trans boundary)
4. Battery Management Rules – 2001 (Management & Handling)

10.4: General Note:

- ❖ Prepare a flow chart for collection of E-waste from Generation to Disposal and paste it on appropriate places
- ❖ An electronic weighing scale (with suitable capacity) must be installed in the storage yard and should be properly calibrated
- ❖ One emergency lamp (with UPS supply) must be installed along with suitable fire extinguisher. Ensure proper ventilation in the yard
- ❖ Form rule for declaring the waste as E-Waste & Assign the singing authorities
- ❖ Identify a third-party vendor to procure the E-waste from the college
- ❖ Establish MoU with that party. Disseminate the following information at appropriate places i) E-Waste Policy, ii) Process Methodology, iii) Copy of MoU with third party vendor, iv) Contact persons mobile number and E-mail.
- ❖ Identify certain vehicle to carry the waste from generation to storage yard
- ❖ Provide training to the man power who are handling the waste
- ❖ Maintain separate Delivery Challan, Billing, weighing mechanism for handling the E-Waste
- ❖ Update the status of E-waste (through digital circular) to all the concerned management representatives, faculty members and staff at regular intervals (month wise is good)

Solid Waste Management (Collection, Segregation, Storage & Safe Disposal)

10.5: E-Waste Management:

- ⊕ With the proliferation of electronics also comes the challenge of their proper disposal. The institute has very efficient mechanism to dispose E wastes generated from various sources.
- ⊕ The major e-waste such as written-off instruments/equipment, old version computers, printers, electronic gadgets/circuits, kits have been written off on regular basis and condemned devices and materials from computer lab are sold to the e-waste management companies/buyers in Coimbatore.
- ⊕ All the miscellaneous e-waste such as CDs, batteries, fluorescent bulbs, PCBs, and electronic items are collected and delivered for safe disposal. Minor repairs are addressed by the lab technician with the support of staff members whereas the major issues are repaired by professionally trained personnel.

GKV Computers & Solutions Pvt Limited.

CERTIFICATE OF E-WASTE DISPOSAL

This is to certify that e-waste received from **Paavai Engineering College, Pachal, Namakkal** has been disposed in an environment friendly manner. Date/Period of receipt of material 27.06.2023.

We thank you for your effort in contributing towards a **CLEAN & GREEN** environment.

Place : Pachal

Date : 27.06.2023

For **GKV COMPUTERS AND SOLUTIONS P LTD**

Authorized Signature

Certificate for E-Disposal

#82, NGN Street, New Sidhapudur, Coimbatore 641044 Phone: 0422 2525349 : FAX : 0422 2525369:

ASUS ZEBRONICS IBM

ENERGY, ENVIRONMENT & GREEN AUDIT REPORT

PART - C: GREEN AUDIT REPORT

11. ASSESSMENT ON MATURE TREES & BIO-DIVERSITY

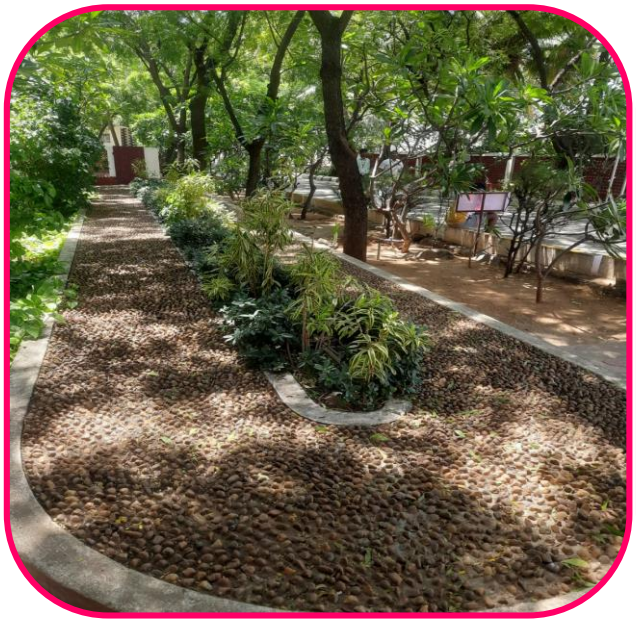
11.1: Campus Greenery:

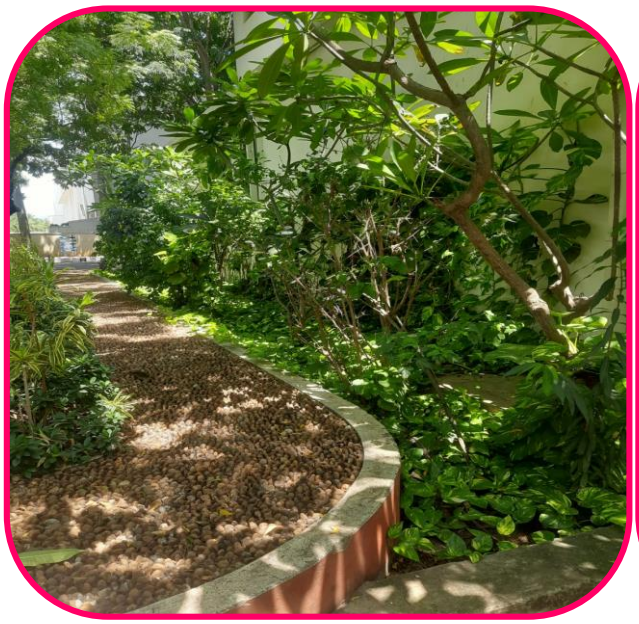
The college is completely covered with mature trees grown for more than 10 years. The total number of mature trees available in the college campus is ***500 with many varieties of trees.***

Table-12: List of Mature Trees available in the College Campus

S. No.	Location	Name of the Tree	Quantity
1	Entire Campus Location	Variety of Mature Trees	**570**

Total No. of Mature Trees available in the college campus is **570** which contributes for reduction of **12.4 Tons of CO_2 emission/Annum**





11.2: Roof Top Solar Photovoltaic System:

- The college has installed solar PV plants with a capacity of **5.7 kW**, generate and feed power to the respective LT services and are utilized by the campus load.
- All the conductive parts are properly earthed at respective buildings and ensures safety.
- Table-13 shows the Specifications of Roof Top Solar PV Plant.

Table-13: Specifications of Roof Top Solar PV Plant

Total Capacity (kWp)					**5.72 kWp**				
Specifications of Individual Panel									
Panel Make/Model					GOLDI / GOLDI060F260PY24				
P_{max}	260 W	V_{max}	30.40 V	I_{max}	8.57 A	V_{oc}	38.12 V	I_{sc}	8.9 A
Location of SPV Plant					Temple Tower Building				
Panel Orientation					South				
Availability of Tracking					20°				
No. of Panels per Inverter & Panels					22 Each				
DC Bus Voltage					54 V				
Inverter Specifications									
No. of Inverters					1				
Make and Model No.					KEVIN (Power of Belief)				
Power Rating					8.5 kVA				
Output Voltage and Frequency					220 V and 50 Hz				
General Specifications									
Number of Inverter Earthing					1 Body Earth and 1 Neutral Earty				
Frequency of Panel Cleaning					3 Months once				
Average Units Generated per Day					Approximately 20 kWh				
Year of Installation					2018				

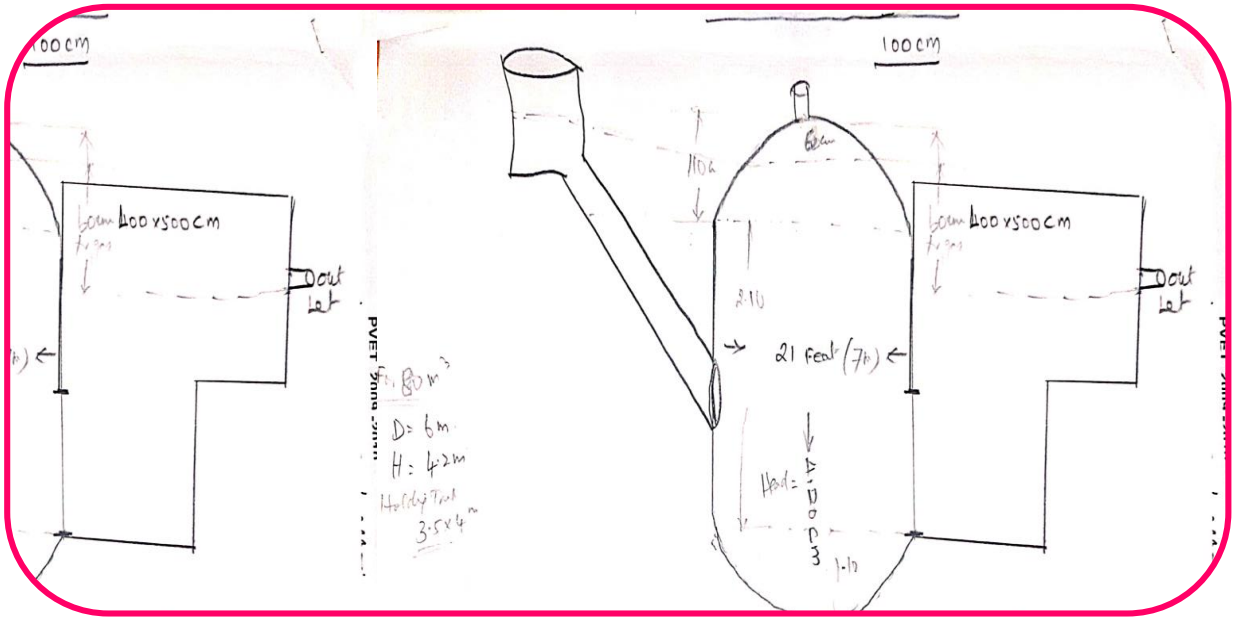
Energy saving from solar PV system (from the year 2023-24) is ***5,968 kWh*** which reduces

43.9 Tons of CO_2 Emission.

Fig.16: Components of Roof Top Solar PV Plants

11.3: Bio-gas Plant Generating Cooking Gas:

- Again to voice for Green Energy; **PCE** has implemented a Bio-gas (natural fuel) plant generating energy from food and vegetable wastes daily generated in mess and canteen.
- Production of biogas obtained from **"anaerobic digestion"** which consists in micro-organisms breaking down complex organic substances (lipids, protides, and glucides), contained in plants, sludge and by-products of animal origin.
- Biogas is primarily methane (CH_4) and carbon dioxide (CO_2) and may have small amounts of hydrogen sulphide (H_2S), moisture and siloxanes. The gases methane, hydrogen, and carbon monoxide (CO) can be combusted or oxidized with oxygen.
- Food waste generated from cooked rice, cut portions of vegetables and non-used vegetables waste. This waste is crushed by mixer grinder and slurry was prepared by adding water.
- The college has installed a biogas plant having capacity of **80 Cubic Meter** (2 Nos of Cu.M) at hostel of **Paavai College of Engineering** to process food waste and other biodegradable garbage generated on the campus. The plant capable of processing up to 680 kg of waste daily.



11.4: Recommendations to Grow Indoor Plants as Natural Air Purifier:

- Indoor plants not only do plants look good while bringing life to our living space, they also help purify the air, according to a NASA study that explains that even a small plant inside the workspace can help remove at least three household toxins (think benzene, formaldehyde, and trichloroethylene, which are carcinogenic chemicals commonly found in stagnant indoor environments).
- Here are the list of the indoor plants acts as a natural air purifier one can try with indoor area to remove toxins and improve air quality

TULSI: Generates more oxygen per day

Aloe Vera:

- **Removes benzene and formaldehyde**
- **Eliminate harmful microorganism and absorb dust**

Snake Plant:

- **Removes Xylene, Benzene, Formaldehyde, Trichloroethylene toxins.**

Spider Plant:

- **Removes CO and Formaldehyde**
- **Absorbs Nicotine**

Money Plant (Devil IVY):

- **Best air purifying plant**
- **Remove benzene & Formaldehyde**

Bosten Fern:

- **High humidity application**
- **Remove xylene & Formaldehyde**

Chrysanthemum:

- **Removes Ammonia, Xylene, Benzene & Formaldehyde**

Kimberly Queen Fern:

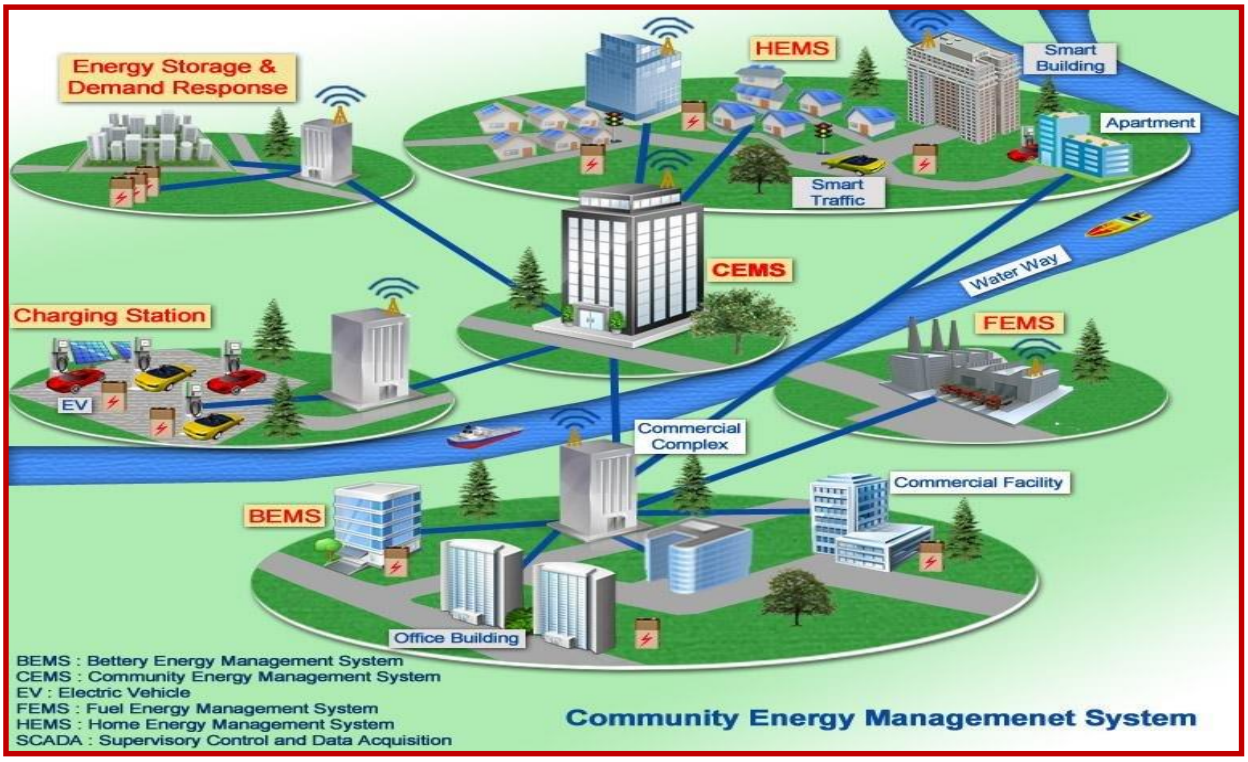
- **Works well in carriage**
- **Absorb vehicular exhaust**

11.5: Recommendations for Miyawaki Forest:

Miyawaki is a technique (also called *Potted Seedling Method*) as that helps build dense, native, multi-layered forests. The approach is supposed to ensure that plant growth is 10 times faster and the resulting plantation is 30 times denser than usual. It involves planting dozens of native species in the same area, and becomes maintenance-free after the first three years. The overall density of the forest is beneficial in lowering temperature, making soil nutritious, supporting local wildlife and sequestration of carbon.

11.6: Integrated Green Building – Future Plan for Today's Requirement:

- Green concepts also realize some indirect benefits like superior air quality, excellent day lighting, health and well-being of the occupants and visitors. Implementation of Green Building Concepts ensures the energy savings to the tune of 20-30%.
- Hence the audit team recommended to the management, plan and construct the future building as per the guidelines of Green Building System (IGBC/GRIHA/GEM) to save Energy, Environment and Ecology.



11.7: Bio-Diversity in the Campus:

- Biodiversity is all the different kinds of life you'll find in one area—the variety of animals, plants, fungi, and even microorganisms like bacteria that make up our natural world.
- Each of these species and organisms work together in ecosystems, like an intricate web, to maintain balance and support life.

11.8: Recommendations to maintain Bio-Diversity:

- **Bird Sighting and Survey:** Conduct a dedicated bird sighting and identify the list of birds both residing birds and migratory birds available in the college campus
- Prepare the list of birds with their local name, scientific name, their average life time, nesting facility created by the bird and photo of the bird. Show case the result to all the stake holder and inculcate a habit of friendly environment
- Discuss with the ornithologists and facilitate the environment with more birds coming to the campus and especially migratory birds.
- **Reptile & Amphibian survey:** Similar to bird survey; conduct a survey to list the amphibians available in the campus
- Amphibian and reptile surveys are often performed as part of the Green Audit process or terrestrial survey. These surveys are effective at detecting the presence of even the most elusive species.

11.9: Formation of Green Energy Team (GET):

- It is essential and the right time to form an Energy Management Team comprising of the following members with their roles and responsibilities as shown in Table-14:

Table-14: Roles of Responsibilities of Green Energy Team (GET)

S. No	Members	Roles	Responsibilities
1.	Management Commitment	Overall Monitoring	• Encourage members to carry out activities • Propose possible think tank ideas to be implemented in the college campus
2.	Head of the Institution	Team Head	• Monitoring all energy related activities • Report to the Management
3.	Heads of various Departments	Team Manager	• Assessing the energy target • Monitoring the energy performance • Revising the target based on performance • Projects/activities/implementation
4.	Faculty members from various department	Team Members	• Identify the viable energy saving projects • Prepare the detailed work plan/time frame • Project guides for energy related projects
5.	Student volunteers	Energy Ambassadors	• Responsible of identified areas • Floor in-charge for energy utilities • Development energy saving projects • Testing and Implementation

- Educate all the faculty, staff and students about the need for the energy conservation
- Energy conservation related projects are to be implemented in the college premises
- Nominate brand ambassadors for energy saving among students (for each building/floor)
- Cash incentives/awards may be given to the prominent energy achievers
- Circulate the success stories as energy conservation measures

ENERGY, ENVIRONMENT & GREEN AUDIT REPORT

12. AUDIT SUMMARY

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CONCLUSION

I. Energy Conservation & Management – Electrical Energy:

- In a phased manner, ceiling fans must be changed from conventional fans into BLDC fans. Also change FTL into LED with adequate illumination levels
- Implement Energy Management System (EMS) to accurately measure & monitor energy flow
- Implement automatic street light controller to turn on and off based on different time in a day. Use astrological timer for better results and energy savings
- Diesel flow meter must be fitted with each DG and calculate the UPL accurately
- Prepare suitable formats for all energy consumption and regularly follow the records. At regular intervals conduct internal audits to assess the effectiveness of the practice. Make proper corrections; if it deviates from the standard operating procedure
- Regularly conduct i) Illumination study, ii) Thermal comfort study, iii) Flue gas study on DG, and Boiler, iv) Water quality assessment (for all types of water utilized) and v) Indoor and ambient air quality study.
- Regularly clean the stove burners and ensure that the flame should be in light bluish colour

II. Water Conservation & Management:

- Utilize more amount of treated water; since most of the approving agencies like AICTE, UGC etc., are now requesting to utilize the treated water
- To check the quantity of water utilized by each building by connecting digital water flow meter and optimize the water usage
- Prepare and maintain a Single Line Diagram (SLD) for water distribution network.
- Try to reduce water tapped from the ground water source since it is not environmentally friendly
- Paste water and energy saving slogans at appropriate places
- Generate your own power and water for regular activities and move towards Net Zero Energy and Net Zero Water Building
- Retrofit aerator-based water taps for good water savings. For hand washing applications, all the pipes must be fitted with aerators
- Captures almost 100 % rain water harvesting through i) Recharging pits and ii) Open well type storage pits
- Properly follow scientific method of handling chemicals/Acids/Salts and safe disposal through 3rd party
- Water treatment log must be maintained indicating the water inlet, treated and outlet water quantity
- Install **sensor-based water controller** in each Over Head Tanks and reduce the water waste and power required to operate the pump
- With the advent of smart technologies, it is possible to have centralized monitoring in real-time using Internet of Things (IoT), Geographic Information System (GIS) software, etc. as per **Jal Jeevan Mission,** Department of Drinking Water & Sanitation **Ministry of Jal Shakti**
- Awareness campus must be conducted to all the stakeholders at regular interval. Through this initiative; Painting, Photography, Slogan and Poster making contest are conducted to create consciousness among the students and faculties

III. Impart Training to Faculty and Technical Staffs:

- **Energy Conservation and Management**
- **Environmental impact and assessment**
- **Fire and Safety (Operation and Handling)**
- **Electrical maintenance, AC, Battery Maintenance & Safety**
- **Emergency Preparedness**
- **E-Waste, Chemicals Handling & Solid Waste Management**
- **Training for Transport employees**
- **Training for Faculty and Students on Vehicle Operation**
- **Training for Kitchen Employees**
- **General Medical Camps for Employees**
- **Training on Stress Management and Yoga**

IV. Way Forward towards Energy & Environmental Sustainability:

- Prepare an exclusive **Energy and Environment Policy** based on the energy and environment practices followed in the campus. This must reflect the i) Present energy consumption & generation, ii) Projection of energy need, iii) Commitment by the college to conserve energy (in terms of percentage), iv) Road map to achieve the commitment, v) Facilities needed to achieve the same, vi) Roles and responsibilities of all stake holders, vii) Interim and final review mechanism, viii) Corrective measures, if the results deviates from the committed value and ix) Benchmarking, Case study preparation, Knowledge sharing and rewards
- Practice appropriate ISO standards for System Management. The audit team highly recommend to follow **i) ISO-9001 (Quality Management System), ISO-14001 (Environmental Management System) and ISO-50001 (Energy Management System)**
- Working towards Net Zero Energy and Net Zero Water Campus and achieve **Platinum rated Global Leadership campus (as per IGBC rating)** and/or **5-star rated campus** (as per GRIHA rating) and/or **GEM-5 rated campus** (as per ASSOCHEM GEM rating)

COMPLETION OF THE REPORT

This report is prepared as a part of the Energy, Environment and Green Audit process conducted at **M/s. PAAVAI ENGINEERING COLLEGE,** Paavai Nagar, NH-44, Pachal - 637 018, Namakkal (Dt), Tamilnadu by **RAM-KALAM CENTRE FOR ENERGY CONSULTANCY AND TRAINING,** Coimbatore-641 109 Tamil Nadu, India.

ENERGY, ENVIRONMENT & GREEN AUDIT REPORT

ANNEXURE:

AUTHORISED CERTIFICATES OF THE AUDITOR

ZERTIFIKAT ◆ CERTIFICATE ◆ 認証書 ◆ СЕРТИФИКАТ ◆ CERTIFICADO ◆ CERTIFICAT

South Asia

CERTIFICATE

The Certification Body
of TÜV SÜD South Asia Private Limited

certifies that

M/S RAMKALAM CENTRE FOR ENERGY CONSULTANCY & TRAINING

No.8, VPK Garden, Velanaipatti, Coimbatore – 641 062, India

has implemented Quality Management System

in accordance with **ISO 9001:2015**

for the scope of

Providing Energy, Environment, Green audits to industry, Academic institutions and organizations

The certificate is valid from **2023-11-22** until **2026-11-21**

Subject to successful completion of annual periodic audits

The present status of this certificate can be obtained through TUV SUD website by scanning below QR code and by entering the certificate number (without spaces) on web page. Further clarifications regarding the status & scope of this certificate may be obtained by consulting the certification body at info.in@tuvsud.com

Certificate Registration No. **99 100 23573**

Date of Initial certification: **2023-11-22**

Issue Date: **2023-11-22** Rev. **00**

Rahul Kale
Head of Certification Body
of TÜV SÜD South Asia Private Limited,
Mumbai
Member of TÜV SÜD Group

QM011

TÜV SÜD South Asia Pvt. Ltd. ● TÜV SÜD House ● Saki Naka ● Andheri (East) ● Mumbai – 400072 ● Maharashtra ● India

Reg No.: EA-27299

Certificate No.: 9645/19

NATIONAL PRODUCTIVITY COUNCIL

National Productivity Council

(National Certifying Agency)

PROVISIONAL CERTIFICATE

This is to certify that Mr./ Mrs./ Ms. **SIVARASU SULUR RATHINAVELU**

son / daughter of Mr. **P RATHINAVELU** *has passed the National certification Examination for Energy Auditors held in September 2018, conducted on behalf of the Bureau of Energy Efficiency, Ministry of Power, Government of India. He / She is qualified as* ***Certified Energy Manager*** *as well as* ***Certified Energy Auditor.***

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

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

Digitally Signed by:K V R RAJU
Mon Apr 22 16:22:42 IST 2019
Controller of Examination, NPC AIP Chennai

Place : Chennai, India
Date : **22nd April, 2019**

Controller of Examination

TÜV NORD

ISO 14001:2015 Lead Auditor
(Environmental Management Systems)
Training course

it is hereby certified that

Dr. S. R. Sivarasu

has successfully completed the above mentioned course and examination

08th - 12th December 2017

Coimbatore, India

Certificate No. 3521 2982 02

Delegate No. 71968

for TÜV NORD CERT GmbH

Essen, 2018-01-11

Course 18125 is certified by CQI/IRCA and meets the training requirements for those seeking certification under the IRCA EMS auditor certification scheme.

TÜV NORD CERT GmbH Langemarckstraße 20 45141 Essen www.tuev-nord-cert.com

CQI | IRCA CERTIFIED COURSE

CQI | IRCA APPROVED TRAINING PARTNER

IGBC

Confederation of Indian Industry

The Indian Green Building Council

hereby certifies that

Sivarasu S R

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

IGBC Accredited Professional

K S Venkatagiri
Executive Director
CII-Godrej GBC

V Suresh
Chairman
Indian Green Building Council

Gurmit Singh Arora
Vice-Chairman
Indian Green Building Council

200239

20 June 2020

GRIHA

GREEN RATING FOR INTEGRATED HABITAT ASSESSMENT

GRIHA CERTIFIED PROFESSIONAL CERTIFICATE

This is to certify that

Sivarasu sr

has qualified as a **GRIHA** Certified Professional For V. 2015

Date of issue: 18th September 2020

Note : This certification is valid only for GRIHA version 2015.

Chief Executive Officer
GRIHA Council

Confederation of Indian Industry

This is to certify that

SIVARASU S R

is a

CII Certified Professional in Sustainable Waste Management

K S Venkatagiri
Executive Director
CII - Godrej GBC

Pradeep Bhargava
Chairman
CII GreenCo Council

IGBC

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ISO 14064-1:2018
ISO 14064-2:2019
ISO 14064-3:2019
ISO 14066:2011
ISO 14067:2018

AND CERTIFY HIM/ HER AS

IMPLEMENTOR & AUDITOR
CARBON FOOTPRINT MANAGEMENT

This certificate is awarded for successful completion of Global Virtual Training course conducted from August 27, 2021 to September 01, 2021. It's serves as a proof of his/her knowledge, competence and ability to implement, verify and validate carbon footprint as per above mentioned standards and methods. This certificate was awarded on August 01, 2021.

01.09.21
DATE

Abhash
SIGNATURE

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