ENERGY & ENVIRONMENTAL AUDIT REPORT

OF

Pavanatma College, Murikkasserry

AMAL JYOTHI ENERGY CENTRE

AMAL JYOTHI COLLEGE OF ENGINEERING, KANJIRAPPALLY

2022

EXECUTIVE SUMMARY

Nowadays colleges are in a unique position as educational institutions to be leaders in pursuing environmentally sustainable solutions. Energy and Environmental Audit is linked to sustainable development process. Through green audit, one gets a direction as how to improve the condition of environment and there are various factors that have determined the progress of a green audit process. The green audit practically involves energy conservation, use of renewable sources, rain water harvesting, efforts of carbon neutrality, planting of trees, hazardous waste management and E-waste management.

Amal Jyothi College of Engineering, Kanjirapally, one of the top-rated technical higher education institutions in Kerala, hogs the limelight as a hot destination in engineering education by virtue of a slew of unique features. In addition to the regular academic activities, the institution is actively involved in various research and developmental activities and external consultancy works, into various areas. Amal Jyothi Energy Centre is the energy consultancy wing of the department of Electrical and Electronics Engineering, which is headed by Prof. K J Thomas (Contact mobile no. 9447349827, email: kjthomas@amaljyothi.ac.in, energycentre@amaljyothi.ac.in) who was a former Chief Engineer in KSEB Ltd. The energy and environmental audit of Pavanatma College, Murikkasserry is conducted by the team lead by Prof. Richu Zachariah (BEE Certified Energy Auditor, EA-27720) with the assistance of Prof. Victor Jose, Prof. Bobin K Mathew and PG Scholars Akhil S and Lijo Joseph. As part of the energy audit, the team has visited the college on 25-March-2022, and made the necessary data collection for the energy audit. This report covers all the findings and observations of the audit team at Pavanatma College, Murikkasserry.

Richu Zachariah

(15-04-2022)

Part-1

ENERGY AUDIT REPORT

OF

Pavanatma College, Murikkasserry

April 2022

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CHAPTER 1
INTRODUCTION

Nestled on a hillock, Pavanatma College, the beacon of knowledge, evokes mingled feelings of pride and hope in the passersby. Surrounded by hills and foregrounded by coconut trees, the college affords a picturesque view, beckoning young minds to make intellectual pursuits by utilizing its tranquil ambience.

NAAC Reaccredited A Grade College, located at Murickassery, about 15 kms away from Idukki en route to Thopramkudy, in Vathikudy Panchayath, Udumbanchola Taluk, Idukki District. Pavanatma is affiliated to Mahatma Gandhi University, Kottayam. It was established in 1982. Under the efficient guidance of the corporate Educational Agency of the Catholic Dioceses of Idukki, the College marches forward along the path of progress with 9 UG and 5 PG Programmes.

There are twelve departments in the college offering various degree, PG and research specializations. The various government aided courses conducted by the college are, BSc- Physics, BSc- Chemistry (2 batches), B Com, BA - English, History, M Com, MA-Malayalam and Master of Commerce & Management with a total student capacity of 647. The various self-financed (SF) courses conducted by the college are BA Malayalam, BA Economics, B Voc-Business Accounting and Taxation, B Voc - Animation and Graphics Designing, M Sc-Chemistry, M Sc-Mathematics and MA – History with a total student capacity of 495. In addition various short term certificate courses and add-on courses are also offered by various departments of the college. The total number of faculty and supporting staff in the college is about 80.

1.1 VISION & MISSION OF THE COLLEGE

Vision

- A vibrant, enlightened and responsible community founded on a relentless pursuit of excellence.

Mission

- Assist the individual in fostering spiritual and humane values to become a blessing to the society and to the nation at large.
- Enable individuals to become intellectually powerful, socially responsible, emotionally mature and self-reliant.
- Infuse a genuine love for Nature and interest in protecting the Environment.

- Inculcate sound moral values in the individual.
- Be a pioneer in providing quality cum holistic education, responsive to the needs of the society.

GOALS AND OBJECTIVES

- To inculcate Christian ideals, intellectual vigour and moral rectitude
- To pursue academic excellence in teaching and learning
- To awaken social consciousness and mould socially committed citizens.
- To equip global ready individuals for employability.
- Enhance teaching and learning through the use of instructional technology.

1.2 CAMPUS AREA AND OCCUPANCY

The college is situated in a total land area of 28 acres including various buildings, playground, gardens, cultivated area/green area, water reservoir and rain water collection spaces etc., as indicated in the campus layout.

Fig. 1.1, Site Plan and Layout of Pavanatma College

A summary of buildings in the campus is given below. The KSEB electricity supply to the academic area is with two supply connections ie, to the aided academic courses with general areas of the campus and to SF academic section of the campus.

Table 1.1, Built-up area of Pavanatma College

No.	Type of Building	Built-up Area
1	Administrative block housing all aided courses	5322 m2
2	Library block housing all SF courses and Auditorium	3092 m2
3	Indoor Stadium	1919 m2
4	Fitness Centre	162 m2
5	College Chapel	272 m2

The campus is blessed with ample greenery and a pleasant cold climate, due to its location in the hilly area and a lot of vegetation around. Drinking water is available around the year, and watering of plants is not a common need here. The pleasant and cold climate reduces the need of room conditioning; lighting and ceiling fans are not needed except for a short duration of the year. All these contribute to a clean, low energy consuming and eco-friendly campus here.

CHAPTER 2
PRELIMINARY ENERGY ANALYSIS OF CAMPUS

In this section, we discuss the energy consumption of electricity and diesel in the campus, as they are the only energy sources used in the campus. The scope of energy audit of the campus is limited to the energy consumption of the academic building and the surrounding areas.

2.1 ENERGY SUPPLY

The power supply to the campus is availed from the KSEBL distributing mains through service connection (SC) as shown in the table below.

Table 2.1 Electric power supply to the Campus

Connection Reference	Consumer No.	Type	Connected Load (KW)	Area Covered
SC-1	1157110000001	LT-6A Three Phase	45.75	Administrative area and Aided Courses Block
SC-2	1157119013930	LT-6F Three Phase	16.1	Auditorium, Library, Indoor Stadium, Academic area for SF courses
SC-3	1157112000720	LT-6A Three Phase	4	Water Pump
SC-4	1157110004561	LT-6A Single Phase	0.98	College Chapel

Captive power supply availed through a DG set of Capacity 62.5 kVA operated manually, only under necessity. The primary water supply to the campus is through the pumping system having a 3.7kW mono-block pump placed in the campus. A diesel powered auxiliary water pump is used as a standby from a second water pond outside the campus. LPG is used for heating purpose in laboratories and for preparing coffee/tea cafeteria. Special laboratory equipment with Electric heaters, centrifuge, compressor etc were observed, and as the annual operational duration of these were found to be few hours. A snacks counter provides beverages and snacks and canteen facility is not provided in the campus. The college does not have its own bus service, and staff and students make use of either public transport or own vehicles to commute.

2.2 METHODOLOGY

Pre-audit of the campus was conducted on the basis of energy and operational data availed from the college. The audit team visited the campus on 25-March-2022 and made the necessary site study and measurements. A detailed study about the power consumption and condition of lighting, pump and other loads, lighting system efficiency etc are included in the energy and environmental audit report of the college.

2.3 SCOPE & OBSERVATIONS

The following are the general observations relating to energy and environmental aspects of the college.

i. As the academic and administrative areas are situated in the same building and the only energy sources utilized in the campus is electricity, an electrical energy audit of the academic building and the water pumping system is defined as the scope of this study.

ii. The college does not include hostel facility and only a snacks counter is present in the campus, the waste management issues are not to be studied in detail. However, the management of chemical waste from various laboratories are a matter of concern.

iii. The fuel consumption and operational details of the DG set are not included in this report, as the operational data of the DG set was not available. Also considering that the operation time of the DG set is not phenomenal, a detailed study and analysis of the DG set is not included in this study.

iv. Special laboratory equipment with Electric heaters, centrifuge, compressor etc with the annual operational duration of a few hours, were not considered in the scope of this energy study.

CHAPTER 3
ELECTRICAL ENERGY AUDIT OF CAMPUS

The electrical loads of the campus consist of LED lamps, fluorescent lamps, various fans, LCD Projectors, UPS for power supply to computers, Flood lights and a water pump. Details of the connected load comprising different types of electrical gadgets with its capacity is given in Table 3.1, and the total connected load to the campus is around 66.8kW. The power supply to the campus is availed from the KSEBL distributing mains through a 3-phase service connection and Captive power supply availed through a DG set of Capacity 62.5kVA.

3.1 ELECTRICITY COST ANALYSIS

A brief study of the monthly KSEB electricity cost for the year 2021 for the four service connections is covered in this section. Table 3.1 shows the monthly average energy consumption and electricity consumption for the year 2021.

Table 3.1 KSEB Service Connection details

Electricity Supply	**KSEB Service Connection 1 (SC-1)**	**KSEB Service Connection 2 (SC-2)**	**KSEB Service Connection 3 (SC-3)**	**KSEB Service Connection 4 (SC-4)**
Load Sections	**Administrative Block**	**Self-Financed Courses Block, Auditorium, Indoor Stadium, Library**	**Water Pump**	**College Chapel**
Consumer No.	1157110000001	115711901330	115711000720	1157110004561
Connection Type	LT-6A Three phase	LT-6A Three phase	LT-6A Three phase	LT-6A Single phase
Connected Load (W)	45750	16100	4000	980
Meter	L&T 5180018288972	L&T 5180018288966	L&T 07/160015644547	L&T 10/170071395495
Monthly average Energy (kWh)	1000 kWh	850 kWh	150 kWh	10 kWh
Monthly average Electricity Bill (Rs.)	Rs. 10,342	Rs. 10,885	Rs. 1220	Rs. 136

It can be observed that SC-1 and SC-2 are the main energy supplying connections to the academic area, whereas SC-3 is used exclusively for water pumping and SC-4 is having a minimal energy supply. The monthly energy consumption from various feeders is shown in the tables below.

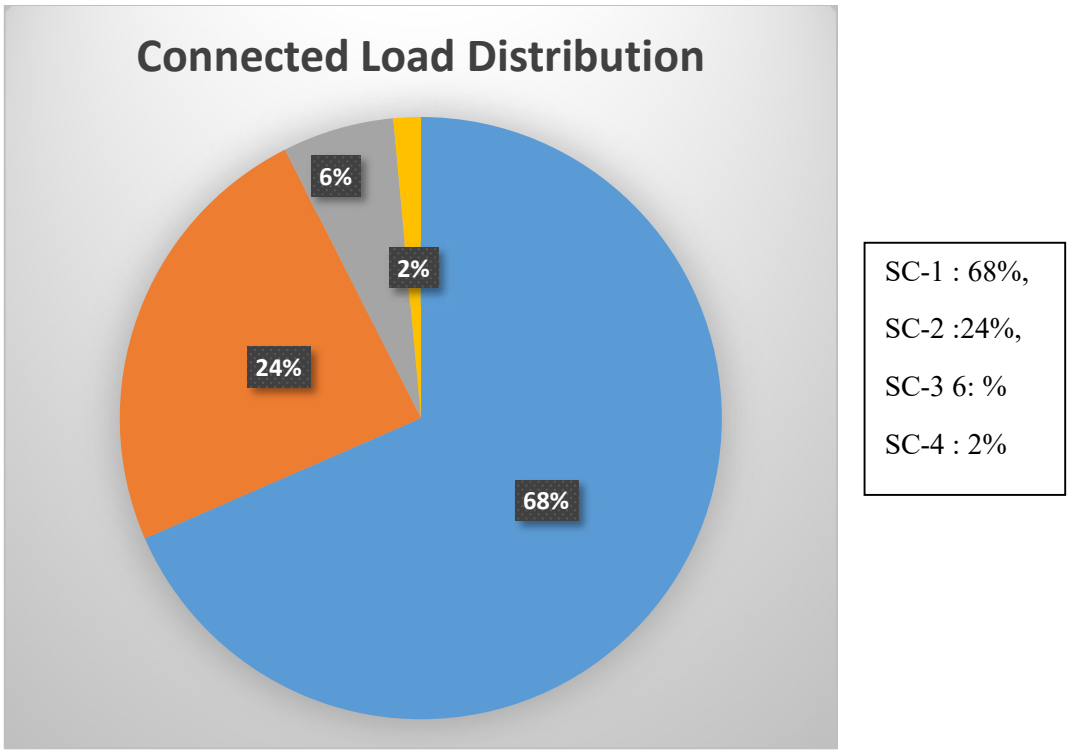

Fig. 3.1 Load distribution Service Connections

From the above fig, the load distribution among Service Connections show major load in SC-1 & SC-2.

Table 3.2 Monthly Energy Consumption and tariff for the whole campus for the year 2021

Month and Year	Energy Consumption (kWh)	Total Charges (Rs.)	Average Unit Cost (Rs/kWh)
Jan-21	2586	23914	9.25
Feb-21	2560	28911	11.29
Mar-21	3027	28717	9.49
Apr-21	1961	23121	11.79
May-21	1294	14853	11.48
Jun-21	1476	18555	12.57
Jul-21	1358	16434	12.10
Aug-21	1643	20008	12.18
Sep-21	1533	17241	11.25
Oct-21	1937	23314	12.04
Nov-21	2381	24233	10.18
Dec-21	2833	31742	11.20
Annual	**24589**	**271043**	
Monthly Average	**2049.1**	**22586.9**	**11.2**

A split-up of monthly electricity consumption of the college is presented in Table 3.2. Maximum energy consumption is observed in March and minimum is observed in May.

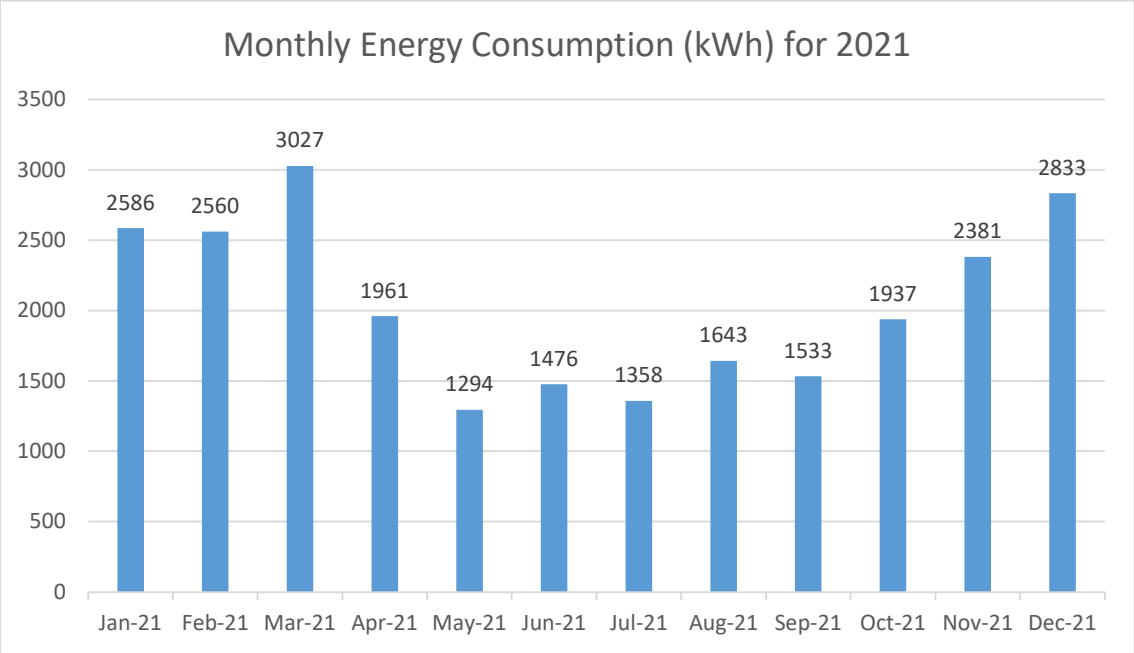

Fig 3.2 Plot of monthly energy consumption in the campus for the year 2021

Table 3.3 Monthly Energy Consumption and tariff for the Administrative Block for the year 2021

Month and Year	Energy Consumption (kWh)	Fixed Charge	Energy Charge	Total Charges (Rs.)	Average Unit Cost (Rs/kWh)
Jan-21	1413	2990	9185	13111	9.28
Feb-21	1235	2990	8028	11839	9.59
Mar-21	1708	2990	11103	15221	8.91
Apr-21	1063	2990	6910	10609	9.98
May-21	780	2990	5070	8585	11.01
Jun-21	847	2990	5506	9064	10.70
Jul-21	637	2990	4140	7562	11.87
Aug-21	926	2990	6019	9629	10.40
Sep-21	729	2990	4739	8220	11.28
Oct-21	843	2990	5480	9035	10.72
Nov-21	1081	2990	7027	10737	9.93
Dec-21	1048	2990	6812	10501	10.02
Annual	**12310**	**35880**	**80019**	**124113**	
Monthly Average	**1025.8**	**2990.0**	**6668.3**	**10342.8**	**10.3**

Table 3.4 Monthly Energy Consumption and tariff for the Self-Financed courses block for the year 2021

Month and Year	Energy Consumption (kWh)	Fixed Charge	Energy Charge	Total Charges (Rs.)	Average Unit Cost (Rs/kWh)
Jan-21	849	2380	7641	10803	12.72
Feb-21	1001	2380	9009	12308	12.30
Mar-21	1121	2380	10089	13496	12.04
Apr-21	700	2380	6300	9328	13.33
May-21	451	2380	3518	6268	13.90
Jun-21	566	2380	5094	8001	14.14
Jul-21	654	2380	5886	8872	13.57
Aug-21	650	2380	5850	8833	13.59
Sep-21	669	2380	6021	9021	13.48
Oct-21	959	2380	8631	11892	12.40
Nov-21	1121	2380	10089	13496	12.04
Dec-21	1606	2380	14454	18297	11.39
Annual	**10347**	**28560**	**92582**	**130615**	
Monthly Average	**862.3**	**2380.0**	**7715.2**	**10884.6**	**12.9**

3.2 LOAD AND ENERGY ANALYSIS

The load distribution arrangement in the campus is through an LT DB and feeders as shown in table below.

Table 3.5 Electricity Distribution system (DB) and feeders

Incomer to DB	160A RCCB
Feeder Details	**MCCB Capacity**
Feeder F1	63A
Feeder F2	63A
Feeder F3	63A
Feeder F4	63A
Feeder F5	63A

In this section, the electric loads and the energy monthly consumption pattern is studied and analyzed. The quantification of various loads in the campus is shown in Table 3.1.

Table 3.6 Quantification of electric loads of the campus

Load Type	Lamp-LED (10W)	FTL-El Choke (40W)	FTL-LED (20W)	Ceiling Fan (60W)	Pedestal (50W)	Socket (6A)	Socket (16A)	Projector (300W)	UPS (KVA)	Computer with LCD Monitor	Other Loads (W)
Quantity	269	21	134	141	56	251	44	17	36.45	79	7493

The major loads of the campus are lighting and fan loads, and about 50% of the connected load is UPS load, intended for supplying to computers, PA system, computer network components etc. The monthly electricity consumption from KSEB was available for the months indicated in Table 3.2, and the average energy consumption during the months of normal academic classes is around 2000kWh. As the supply system is three phase, power factor correction is not a mandate for the consumer.

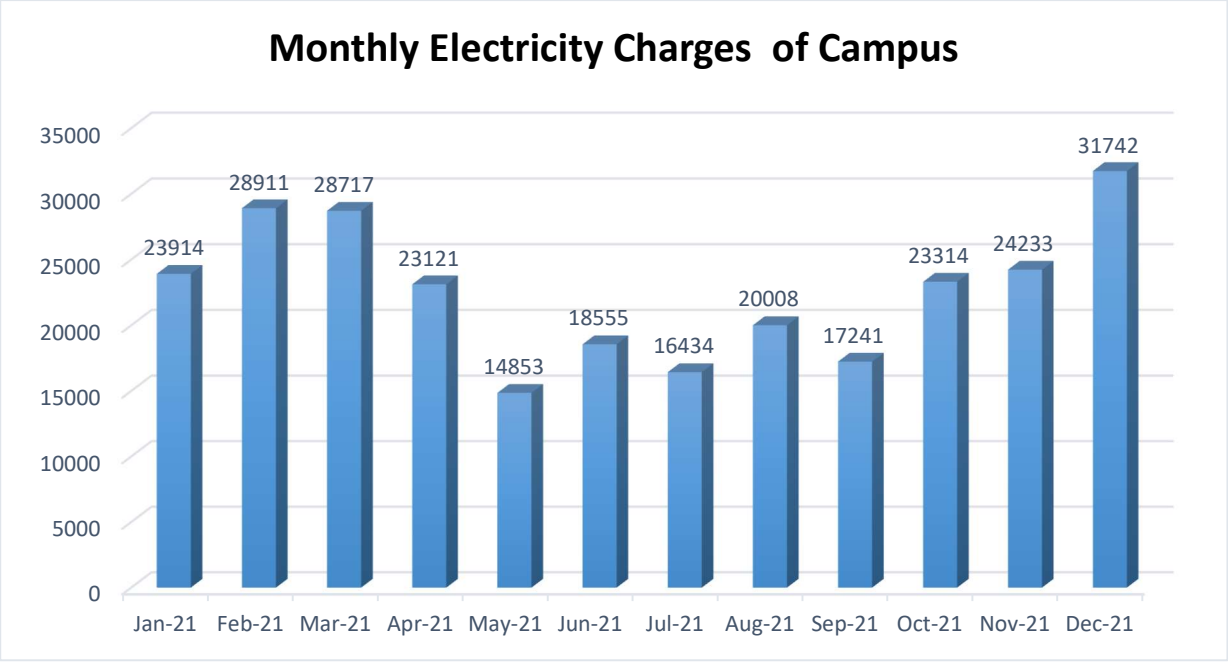

Fig 3.3, KSEBL monthly electricity charges of the campus

As an educational institution, the main load requirement of the college will only be during the office hours of the college, which is 9AM to 4PM. Hence the load is suitable for Solar PV based power generation system.

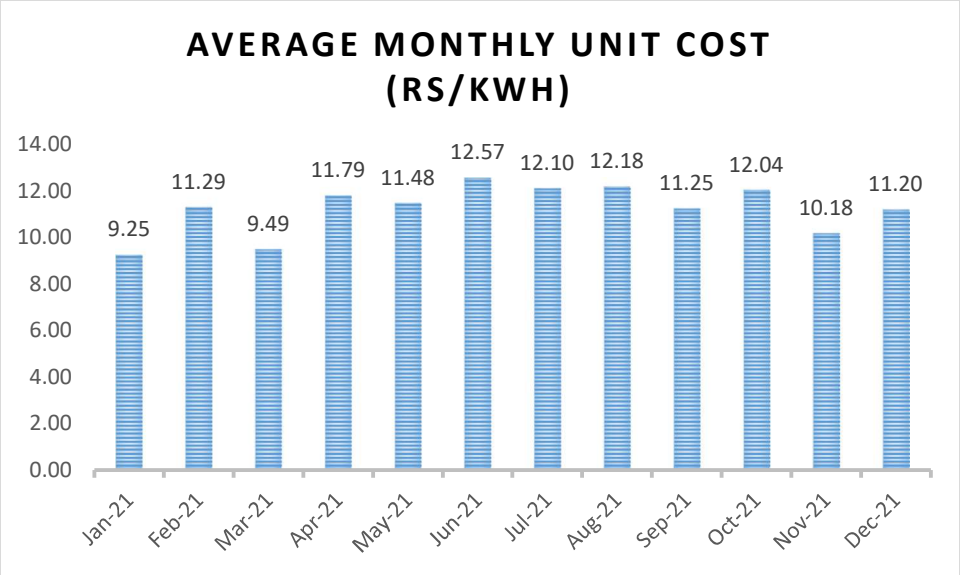

Fig.3.4, KSEBL average monthly unit charges of the campus

The tariff plan of KSEB for the college is LT-6A, and the energy cost according to this plan is shown in Table 3.7, and this value is found to be varying from Rs. 13.5 to Rs. 17 per unit of electricity. The average cost of electricity is found higher during the months following March due to the effect of fixed charges in the tariff calculation.

Table 3.7, KSEB Tariff structure for LT-6A

LT - VI GENERAL (A)	
(a) Fixed Charge (Rs. per kW or part thereof per Month)	50
(b) Energy Charge (Paise/kWh) (i) Of and Below 500 kWh (ii) Above 500 kWh	 550 630

[Ref: ANNUAL REVENUE REQUIREMENTS (ARR), EXPECTED REVENUE FROM CHARGES (ERC) AND TARIFF ORDER FOR KSEBL - 2014-15, KSERC]

The energy meter reading on site is shown in Table 3.8, which indicates a maximum load on around 10KW in the system. The power factor is found to be good at 0.98 from the energy meter. But the currents in the three phases indicate unbalanced distribution of loads.

Table 3.8, Direct Power measurement at incoming supply at 12PM on 25-03-2022

KSEB Connection	SC-1	SC-2
Voltage (V)	225	225
R Phase Current (A)	12.4	9.4
Y Phase Current (A)	7.1	0.8
B Phase Current (A)	5.8	1.7
N Current (A)	9	6.7

That B-Phase is under loaded compared to the other two phases and there is no phase balance for the loads. There is a considerable neutral current in the system because of this load unbalance. The observation was made when most of the loads in the college was operating and classes were going on in the morning session. It is desirable to re-distribute the loads in the system in such a manner that the three phase currents will remain more or less balanced.

Table 3.9, Diesel Generator Details

Year	**2011**
Make	**Mahindra**
Series	**Powerol**
KVA Capacity	**62.5 KVA**
Life of Gen (Hrs)	**1435**
Battery Voltage	**12.7V**
Engine Power	**90hp, 66kW**
Engine RPM	**1500**
Tank Cap.	**50lit**
Maintenance	**ok, company service**
Type of changeover	**Manuel**
Daily Operation	**Average 30 min. per working day**
Diesel Fuel usage	**7 lit diesel/hour**

The live operating parameters of the DG set is indicated in Table 3.9, which shows that Y and B Phases are totally unloaded, showing phase imbalance. The operating power factor, mechanical operating parameters of the engine and service history were found to be satisfactory and the maintenance was done promptly.

Table 3.10, DG Set Power Generation

	Terminal Voltage (V)	Phase Current (A)	Power Generated (kW)
R Phare	240	13	2.8
Y Phase	243	0	0
B Phase	238	0	0
TOTAL			2.8

3.3 LIGHT METER AUDIT

Light meter audit was conducted in a few rooms of the college, and the results obtained are summarized in Table 3.11.

Table 3.11, Lux Meter Audit of the College on 25-03-2022

No.	Room	Lux Meter Reading (Daytime, All lamps ON)	Lux Meter Reading (Daytime, All lamps OFF)	No. of Luminaires	No. of Fans	Remarks
1	Chemistry Lab on First Floor	155	120	8	4	Lux level is below the requirement
		150	125			
		160	116			
		175	121			
2	Physics lab on First Floor	300	240	8	3	Lux level is below the requirement
		100	90			
		120	111			
		121	108			
3	BSc Physics III Year Class on Ground Floor (6Mx8Mx4M)	230	220	1	2	Lux level is below the requirement
		110	50			
		145	75			
		155	85			
4	Computer Lab on First Floor	40	10	8	0	Lux level is below the requirement
		20	16			
		30	18			
		35	14			

The illumination level in the rooms are found to be severely low under all conditions, and hence installation of more number of lighting fixtures is required, and a proper distribution of luminaires is recommended for a uniform illumination level in the rooms.

3.4 UPS AUDIT

Table 3.12, UPS Audit of the College

No.	UPS Location	Make & Year	UPS Rating (KVA)	Battery (Ah)	Battery Voltage (V)	Battery Current (A)	UPS input Current (A)	Remarks
1	CS Comp Laboratory	Local - Sine Wave type	2500	150Ah x 2	25.2V	0.5A	1A	Dusty Room, Battery not maintained
2		Microtek	3600	150Ah x 4			0.2A	Battery needs replacement
3	Physics Comp Laboratory	Microtek	3600	150Ah x 4	55.1V	0.3A	0.7A	Battery needs cleaning
4	Bursar	Microtek	1100	150Ah x 1				
5	College Office	Luminous	4000	150Ah x 4	55.2	0.6A	1A	
6		Microtek	2300	150Ah x 2	26.5V	1.3A	0	
7		V-Guard	1050	100Ah x 1	13.4V	0.5A	0	
8	Library	Luminous	4000	150Ah x 4	54.7	0.5A		
9	IQAC Room	Luminous	2000	100Ah x 2				
10	PG and Research Centre		3600	150Ah x 4				Damaged
11			1600	150Ah x 2	27.3	0.2A		
12			2000	150Ah x 2				
13	History Department Staff Room		2000	150Ah x 2	26.3A	0.8A		Damaged
14	Physics Department Staff Room		2000	150Ah x 2				
15	English Department Staff Room		1100	150Ah x 1	13.3V	0.1A	.4A	
		Total	**36,450**	**KVA**				

As the major load in the educational institution are computers, about 50% of the connected load is UPS systems with battery backup. Hence a UPS audit was conducted and the results are tabulated in Table 3.12. Few batteries were found to be damaged, causing losses in the system, and redundant capacity of UPS may also be causing excess electricity bill. Multiple number of small UPS systems used in computer lab can be replaced with a single 3 phase UPS for better load balancing and energy saving.

Fig. 3.5 Photos of UPS systems

3.5 Water supply system analysis

The water supply, pumping and water storage system of the college is summarized in Table 3.13. The operational strategy of the pump and the water supply system is found to be in an energy efficient manner. The storage capacity of overhead tank is 1 Lakh litres and is located near the pond 1, mounted on the ground. A rain water harvesting system is also located beside Pond-1.

Table 3.13, Water Supply System of the College

Water Source	Location	Capacity	Pump used	Usage
Pond - 1	Campus	6 Lakh Lit	Pump-1: 3.7kW Centrifugal Pump with 3 phase induction motor	Regular, Operated from 7.30AM to 9.30AM on working days
Pond - 2	Outside Campus	4 Lakh Lit	Pump-2: Diesel Pump	Operated only during April, May for 3 hours per day

The operating parameters of the Pump-1 is shown in table 3.14.

Fig. 3.6 Overhead tank and Pond-1 of campus

Table 3.14, Pump-1 operation parameters and power consumption

Terminal Voltage (V)	R Phase Current (A)	Y Phase Current (A)	B Phase Current (A)	Power Consumption n (kW)
415V	8.1A	7.5A	6.8A	4.4kW

The operating time of the pump is in the morning peak period of the grid, but as the time of day tariff is not employed in LT6A supply category, the operating schedule of the pump does not require any modification as of now.

3.6 Fuel Cost Analysis

The fuel consumption in the campus for various applications is indicated in table 3.15 for the year 2022.

Table 3.15, Fuel consumption on the campus in 2022

No.	Fuel Type	Location or Equipment	Annual Usage		Cost (Rs)
1	Diesel	DG Set	550 Lit	630 Lit	59,850
		Diesel Pump	80 Lit		
2	LPG	DG Set - Physics Lab	14 Kg	214 Kg	12,840
		Refreshment Room	130 Kg		
		Various Laboratories	70 Kg		
				Total	**72,690**

The usage of diesel is for DG set on a regular basis and to operate the water pump from Pond-2 during summer. LPG is used cooking, laboratory and electricity generation (in Physics lab). The cost of fuels is estimated based on the average cost of fuel for the year 2022. Compared to the annual electricity cost of the campus, the fuel costs are not phenomenal, and the fuel requirement in the laboratory systems are not included in the scope of the energy audit due to the special requirements.

CHAPTER 4
RECOMMENDATIONS OF THE AUDIT

The recommendations while conducting energy and environmental audit of the campus, and about the general operation of the campus are listed here.

i. Installation of grid connected Solar PV power plant is suitable for the campus.
   - The roof area of around 200m^2 is suitable for installing around 100KWp solar power plant, which could produce 10,000 kWh of electricity annually.
   - For balancing the energy consumption of approximately 1000kWh/month, a grid connected Solar PV plant of capacity 15KWp will be sufficient, which could cost around 8 Lakh Rupees.

ii. The use of LED lamps and LED tube lights for all lighting applications are will result in a lower power consumption

iii. Induction motor based ceiling fans can be replaced with BLDC type fans for reducing the power consumption.

iv. Water conservation measures and load and operation management of the water pumping system are recommended for energy conservation in these areas.

v. Minimum 80% loading of the DG set may be ensured for obtaining a better fuel efficiency.

vi. The adequacy or over design of lighting systems in indoor apace need to be investigated.

vii. The suitability of size of current carrying cables need to be investigated.

viii. The operation of circuit breakers and RCCBs need to be ensured for safety and proper operation of the system.

ix. Rooftop Solar PV system (Grid tied type) of suitable capacity may be considered for utility bill reduction and reduction in heating of top floor rooms of the building.

x. The operating power factor of the system and power quality issues needs further investigation

Part-II

ENVIRONMENTAL & GREEN AUDIT REPORT

OF

Pavanatma College, Murikkasserry

April 2022

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1.2 Campus Infrastructure and Occupancy

2. Environmental audit of Campus

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2.2 Water Management and Rain water harvesting system

2.3 Waste Management

2.4 CO_2 Emission

3. Recommendations of Environmental & Green Audit

CHAPTER 1
INTRODUCTION

Nestled on a hillock, Pavanatma College, the beacon of knowledge, evokes mingled feelings of pride and hope in the passersby. Surrounded by hills and foregrounded by coconut trees, the college affords a picturesque view, beckoning young minds to make intellectual pursuits by utilizing its tranquil ambience.

NAAC Reaccredited A Grade College, located at Murickassery, about 15 kms away from Idukki en route to Thopramkudy, in Vathikudy Panchayath, Udumbanchola Taluk, Idukki District. Pavanatma is affiliated to Mahatma Gandhi University, Kottayam. It was established in 1982. Under the efficient guidance of the corporate Educational Agency of the Catholic Dioceses of Idukki, the College marches forward along the path of progress with 9 UG and 5 PG Programmes.

There are twelve departments in the college offering various degree, PG and research specializations. The various government aided courses conducted by the college are, BSc- Physics, BSc- Chemistry (2 batches), B Com, BA - English, History, M Com, MA-Malayalam and Master of Commerce & Management with a total student capacity of 647. The various self-financed (SF) courses conducted by the college are BA Malayalam, BA Economics, B Voc-Business Accounting and Taxation, B Voc - Animation and Graphics Designing, M Sc-Chemistry, M Sc-Mathematics and MA – History with a total student capacity of 495. In addition various short term certificate courses and add-on courses are also offered by various departments of the college. The total number of faculty and supporting staff in the college is about 80.

1.1 VISION & MISSION OF THE COLLEGE

Vision

- A vibrant, enlightened and responsible community founded on a relentless pursuit of excellence.

Mission

- Assist the individual in fostering spiritual and humane values to become a blessing to the society and to the nation at large.
- Enable individuals to become intellectually powerful, socially responsible, emotionally mature and self-reliant.
- Infuse a genuine love for Nature and interest in protecting the Environment.

- Inculcate sound moral values in the individual.
- Be a pioneer in providing quality cum holistic education, responsive to the needs of the society.

GOALS AND OBJECTIVES

- To inculcate Christian ideals, intellectual vigour and moral rectitude
- To pursue academic excellence in teaching and learning
- To awaken social consciousness and mould socially committed citizens.
- To equip global ready individuals for employability.
- Enhance teaching and learning through the use of instructional technology.

1.2 CAMPUS AREA AND OCCUPANCY

The college is situated in a total land area of 28 acres including various buildings, playground, gardens, cultivated area/green area, water reservoir and rain water collection spaces etc., as indicated in the campus layout.

Fig. 1.1, Site Plan and Layout of Pavanatma College

A summary of buildings in the campus is given below. The KSEB electricity supply to the academic area is with two supply connections ie, to the aided academic courses with general areas of the campus and to SF academic section of the campus.

Table 1.1, Built-up area of Pavanatma College

No.	Type of Building	Built-up Area
1	Administrative block housing all aided courses	5322 m2
2	Library block housing all SF courses and Auditorium	3092 m2
3	Indoor Stadium	1919 m2
4	Fitness Centre	162 m2
5	College Chapel	272 m2

The campus is blessed with ample greenery and a pleasant cold climate, due to its location in the hilly area and a lot of vegetation around. Drinking water is available around the year, and watering of plants is not a common need here. The pleasant and cold climate reduces the need of room conditioning; lighting and ceiling fans are not needed except for a short duration of the year. All these contribute to a clean, low energy consuming and eco-friendly campus here.

CHAPTER 2
ENVIRONMENTAL AUDIT OF CAMPUS

The construction and operation of an institution should cause minimum disturbance to the environment around, to ensure sustainability of the human race. The environmental impacts of the college and the eco-friendliness is studied in this section.

2.1 AIR QUALITY & CAMPUS GREENERY

The campus is located in a hill side of the Western Ghats, covering a land area of 32374 square meters. The fogy mountains around the campus and floral diversity of the campus and overall greenery around gifts the students the perfect condition for study.

Fig. 2.1 Campus View of Pavanatma College

There are more than 800 trees in and around the campus. The plant species in the campus is shown in Table 2.1. The diversity of the trees in the campus is exemplary.

Table 2.1, Floral Diversity of the campus

No	Name of Trees	Number of trees
1	Teak	11
2	Mango tree	24
3	Jackfruit tree	12
4	Bamboo	4
5	Guava	13
6	Coconut tree	22
7	Vaka tree	1
8	Athi	3
9	Magnolia	1
10	Njaval tree	5
11	Manchiyam	2
12	Almond tree	3
13	Jathi tree	1
14	Champa tree	3
15	Cypress	15
16	Ramputtan	1
17	Cempakam	1
18	Anjili	4
19	Eucalyptus	1
20	Tamarind	2
21	Ilannji tree	1
22	Spruce tree	2
23	Lakshmitharu	1
24	Yukkali	1
25	Magnolia	1
26	Chaukka	38
27	Rubber	
28	Unrecognized trees	412

A herbal plant garden is located on the sloping land of the campus and plant bio-diversity and preservation is thus ensured here.

The Air Quality Index of Idukki District of Kerala is found to be good due to the presence of vegetation and absence of industries. Murikkasserry in special, is not an exception to this and the air quality is found to be very good.

Fig. 2.2 Central garden of the college and Entry gate of the college showing the Self-financed courses building

The construction and location of the college on the side of a hill ensures sufficient cross-ventilation in the class rooms and Laboratories. The general atmosphere is pleasant and windy, resulting in a healthy ventilation rate and avoiding increased humidity and air quality problems. The human comfort conditions are thus satisfactory in the college.

2.2 WATER MANAGEMENT AND RAIN WATER HARVESTING SYSTEM

The source for pure water to the college is two open wells situated near the campus, having a combined water retention capacity of 1 Lakh liters. Water is pumped to an overhead storage tank, having a capacity of 1 Lakh liters. The gravity circulated water is used in all washrooms and three water purifiers around the academic building.

Fig. 2.3 Overhead tank and Pond-1 of campus

Around 1 Lakh litres of water is used in the campus on a daily basis on all working days. The waste water is processed in sewage tanks and drained to the underground. The water drain pits are all located below the location of the main water source Pond-1, and at sufficient clearance, ensuring good water quality in the campus. The water used in the campus is not hard water and the soluble salts are ensures the usage of water without any pre-processing in all the systems and drinking purpose.

The top floor rooftop is open to sky, and the rain water falling here is collected from here, directed to the nearby basin near Pond-2 by natural flow. Also, the rain water collected in open areas and play ground of the campus is directed to a rain water harvesting pond near the Pond-1. Thus the rain water obtained in the campus is fully utilized in an eco-friendly manner.

2.3 WASTE MANAGEMENT

From the study, it is revealed that the major solid wastes generated in the campus falls under seven categories The waste mainly comprises paper, plastic, glass, damaged furniture, biodegradable (food, sweeping, crop waste etc.), e-waste and others (sandals, clothes, napkins etc.). The bio-degradable food and related waste produced in the campus is of a very minimal amount due to the lack of canteen facilities and hostel facilities.

The paper waste, that can be recycled is collected by third parties at a minimal cost for recycling purpose. Examination related paper waste, which cannot be handed over for recycling is burnt in the open air behind the campus. Paper and plastic waste generated are collected, segregated and sold to scrap merchants periodically. Incinerator is installed and used for disposing napkins, masks etc. is a noteworthy best practice of the college. Repair and reuse of damaged furniture is considered as a positive approach. Healthy practices like buy back policy with suppliers, handing over the used computers to schools and hardware training laboratories are also implemented. Such practices accounts for the lower quantity of e-waste in the campus. Apart from the above mentioned waste categories, construction and demolition wastes also accounts to the waste production in the campus. It is noted that these types of wastes are largely used for reclamation activities.

There are 70 toilets in the college and the waste water in the campus from them is collected locally and processed through septic tanks or natural soil absorption, without causing any pollution to the ground water system.

2.4 CO_2 EMISSION

The CO_2 emission from the college includes the vehicular emissions due to the college buses, student/staff vehicles, Diesel Generator set operation and indirect pollution due to the usage of electricity

in the campus. The CO_2 emission from electricity and various fuels are calculated based on the average emission factor method as a standard practice.

The on-campus diesel power generator is operated only when it is absolutely necessary to ensure continuous supply. The operation of the DG set is by manual turn-on operation. Also, multiple incoming service feeders to the campus from various feeding transformers ensure continuous power delivery. The emission factor from the DG operation and the equivalent emission are shown in Table 2.2.

The college is located beside Murikkasserry town and there are two entries to the campus from the main road. Hence additional transport facility is not required for students travelling by public transport vehicles. The equivalent emission due to students travelling by public transport is neglected, for this study. Around 50 students and staff travel by own vehicle (bike or car) on a daily basis, by a daily average distance of 5 to 10KM, resulting in an addition CO_2 footage to the campus due to transportation. The college does not operate any means of student transport as its own, because of the accessibility of the campus to public road and transport. Summarising, the transportation fuel consumption by the staff and students excluding the college vehicles can be considered as shown in Table 2.2.

The emission resulting due to LPG fuel being used for power generation and heating purposes in the campus is considered for the study and emission factor based estimation method is adopted here as shown in Table 2.2.

Table 2.2, Approximate Monthly CO2e Emission from the Campus

No.	Energy Source	Application	Annual Consumption	Emission Factor	Equivalent CO_2 Emission (Ton)
1	Electricity	Direct	24589 kWh	0.2 kg//kWh	4.92
2	Diesel	DG Set, Pump	630 Lit	2.7 kg/Lit	1.7
3	LPG	Laboratory	214 kg	2.2 kg/Kg	0.47
4	Petrol	Staff and Student Transport	5500 Lit	2.3 kg/Lit	12.65
				Total	**19.74 Ton CO_2**

Thus the monthly CO2e emission is approximately obtained as 19.7 Tons/month, which is mostly balanced by the trees and green vegetation present in the campus and surroundings.

CHAPTER 3

RECOMMENDATIONS OF ENVIRONMENTAL & GREEN AUDIT

- Use different coloured bins (eg. Green – biodegradable waste, Blue –plastic and metal waste, Yellow – Paper waste, Black – E-waste, Red – Bio medical waste) for collecting, segregating different categories of waste from the buildings.
- Ash remaining at the bottom of the combustion chambers of incinerators requires a proper hazardous waste disposal mechanism.
- Regarding e-waste, instead of selling the electronic waste to scrap merchants, ensure that these electronic wastes should be handed out to authorized e-waste collection centers that are approved by Kerala State Pollution Board (KSPCB). Details can be obtained from the KSPCB website.
- In the case of non-biodegradable waste (especially plastic, glass waste), a tie-up is recommended with local body authorities (Panchayath) for their collection and disposal. With the approval of local body authorities, these wastes can be handed out to Haritha Karma Sena (HKS) members of concerned local body. This campaign is being executed with the support of Suchithwa Mission, Haritha Kerala Mission, Clean Kerala Company (CKC), local bodies and Kudambashree Mission.
- A kind of accountability is required for the Construction and Demolition waste produced in the campus. The collection, transportation, processing and disposal of these wastes should be treated under the provisions of Construction and Demolition Waste Management Rules, 2016.
- For the construction of new buildings in future, it is advisable to follow a Green Buildings rating system that facilitates a holistic approach to create environment friendly buildings, through architectural design, water efficiency, effective handling of waste, energy efficiency, sustainable buildings, and focus on occupant comfort and well-being. The predominant green rating frameworks in India are GRIHA (Green Rating for Integrated Habitat Assessment), IGBC (Indian Green Building Council), LEED (Leadership in Energy and Environmental Design), and BEE (Bureau of Energy Efficiency).
- Damaged furniture and glass waste are the other prominent institutional wastes that are found missing in this waste management strategies of Marian. So a proper, constructive mechanism is needed for the management of above mentioned wastes. It is advisable to have a quantified data about various kinds of biomedical waste (expired medicines, gloves, masks, napkins etc.) generated in the campus.
- Periodic appraisal of different kinds of waste generated is required and hence recommended for the campus.

- Installation of biogas and sewage treatment plants may be useful for better water management
- Various kinds of start-up programme related to waste management can be promoted in the Campus (toy making from waste raw materials, decorative items and other fancy items from waste materials etc.).
- Popularize various Waste Management Act and Rules, themes, day and year of importance, national level and state level campaigns (e.g. Swachh Bharat Mission, Suchithwa Keralam etc.) and slogan like My waste, My responsibility', which is adopted from the 'Polluter Pays Principle' in the campus.