ENERGY & ENVIRONMENTAL AUDIT REPORT

OF

JPM ARTS & SCIENCE COLLEGE,

LABBAKKADA, KANCHIYAR

AMAL JYOTHI ENERGY CENTRE

AMAL JYOTHI COLLEGE OF ENGINEERING, KANJIRAPPALLY

2020-2021

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 JPM Arts and Science College, Kanchiyar is conducted by the team lead by Prof. Richu Zachariah (BEE Certified Energy Auditor, EA-27720) with the assistance of Prof. Victor Jose and Prof. Bobin K Mathew. As part of the energy audit, the team has visited the college on 20-January-2021, and made the necessary data collection for the energy audit. This report covers all the findings and observations of the audit team at JPM college, Kanchiyar.

Richu Zachariah

(30-06-2021)

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CHAPTER 1
INTRODUCTION

John Paul Memorial(JPM) Educational Institutions is established in 2008 under the management of St. Joseph's province of CST Fathers, Aluva. JPM Arts and Science College campus is situated beside the Kattappana-Kuttikkanam stretch of the Kattappana- Kottayam state highway. At present JPM runs eight UG courses and five PG courses namely B.Com (Computer Application), B.Com (Co-operation), B.Com (Finance & Taxation), BCA, BBA, BA English (Language and Literature), Bachelor of Tourism and Travel Management, BSW, M.Sc. Computer Science, MA English (Language and Literature), M.Com (Finance), MA Economics and MSW.

The college aim at offering quality education and value education and is maintains one of the top positions among the educational institutions in the district of Idukki. To enhance the quality of students the college periodically conduct national seminars, add-on-courses, department wise intercollegiate fests, industrial visits, training programmes etc. The college is keen in maintenance high discipline among the students which will go a long way in fine tuning their potential. The college also provides excellent lab and library facilities for its students including the subscription of various magazines, national and international journals, Civil Service, UPSC, SSC competition materials etc.

JPM Arts and Science College has been maintaining excellent results in university examinations since its inception. In order to enhance the quality of the teaching and learning process, the college regularly conducts national seminars, add-on-courses, department-wise and intercollegiate fests, industrial visits, training programmes etc. The college maintains high standards of discipline in the campus which will go a long way in fine tuning the potential of the learners. The college also provides excellent lab and library facilities for its students and subscribes to various magazines, national and international journals, books and materials for competitive exams such as Civil Services exams, UPSC, and SSC etc.

JPM Arts and Science College was granted Minority Status by Central Government of India on 30/05/2013 and was given the number 1230/2013/7078 in their official records. In connection with the decennial celebration of the college (2005-2015) JPM Career Academy-a coaching center for competitive examinations was started in October 2015. In the same year the college became the first ISO - 9001:2008 certified college in Idukki district. In 2016 ‘JPM’ became a registered trademark. In 2017 a regular study center of Indira Gandhi National Open University (IGNOU) started to function on the campus.

1.1 VISION & MISSION

JPM Arts and Science College has as its motto 'Lighted to Enlighten'. The college makes every effort to realize its mission of developing competent human resources through quality education, by creating an innovative educational environment and promoting creativity to develop skilled human resources.

VISION

To mould and to transform the students of a marginalized region in accordance with the constitutional value of antyodaya- upliftment of the least- into responsible and committed citizens.

MISSION

1. To impart quality education to the people of this land-locked, marginalized, migrant population.
2. To provide comprehensive training to live and flourish in the digitalized world.
3. To inculcate the students with faith in God, self-esteem, and constitutional values of fraternity, equality, justice and universal love through an integral teaching learning system.
4. To empower the weak and the minority in all respects by an inclusive education.
5. Equip to become intellectually powerful, socially committed, emotionally mature and physically strong.

1.2 CAMPUS AREA AND OCCUPANCY

The college is situated at Labbakada in Kanchiyar Grama Panchayat, Idukki District, Kerala, on the Kottayam - Kattappana State Highway, the College is easily reachable and has state of the art facilities for effective teaching and learning. The sylvan ambience of the college is highly refreshing and conducive to spiritual, intellectual and emotional growth.

The built-up area of the college includes a main building having three floors, which houses academic and administrative divisions. The plan profile of the building is C shaped. and the approximate floor area is 1400 square meters per floor of the building. As per the building plan total area of campus is 20234 square meters, Built-up area is 4364 square meters, and the Class room area (carpet area) 2059.23 square meters. The campus is located in a land area of 22220 square meters (5.24 acres), and the surrounding 5 acre area is used for Cardamom cultivation. A site plan of the campus is shown in Fig. 1.1.

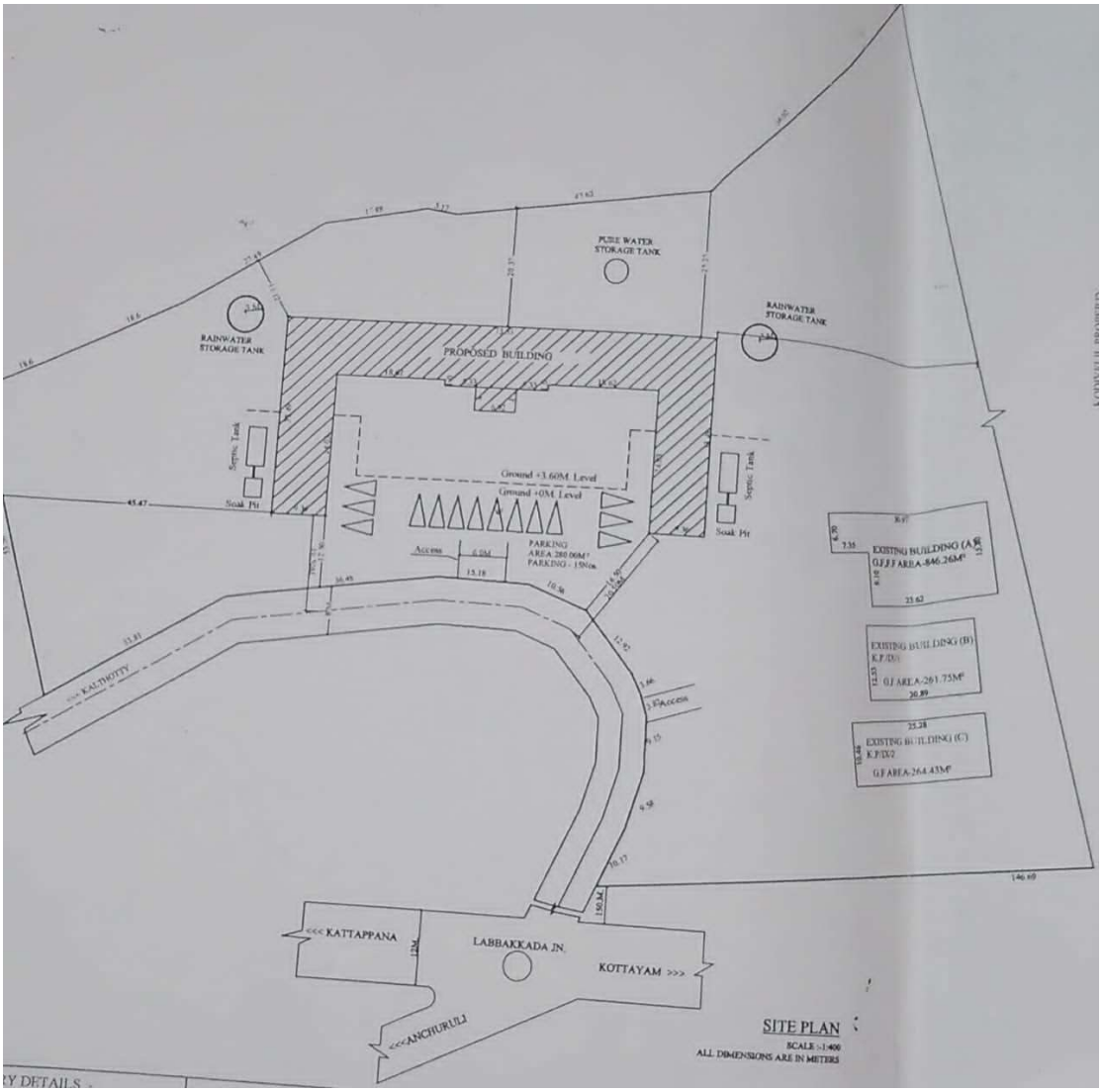

Fig. 1.1, Site Plan and Layout of JPM Arts and Science College, Kanchiyar

The college has a student strength of 1120 currently with 58 faculty members and 14 supporting staff, totaling to an occupancy of 1192 people during normal working hours. The college does not provide hostel or canteen facility in the campus. A priests residential building situated outside the academic area is not included in the scope of this audit, as it is not in the academic area of the campus.

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.

The power supply to the campus is availed from the KSEBL distributing mains through a 3 phase service connection with Consumer number 1157462007800, having the connected load of 26920W. Captive power supply availed through a DG set of Capacity 40 kVA comprising of a diesel engine and 40 kVA three phase brushless alternator. The water supply to the campus is through the pumping system having a 3.7kW mono-block pump.

2.1 ENERGY CONSUMPTION

The main energy sources for the college building is three phase utility power supply from KSEB. The tariff plan is LT-6F, which is applicable for commercial and self-financed educational institutions. The monthly energy consumption and utility bill for a few months is shown in Fig 2.1.

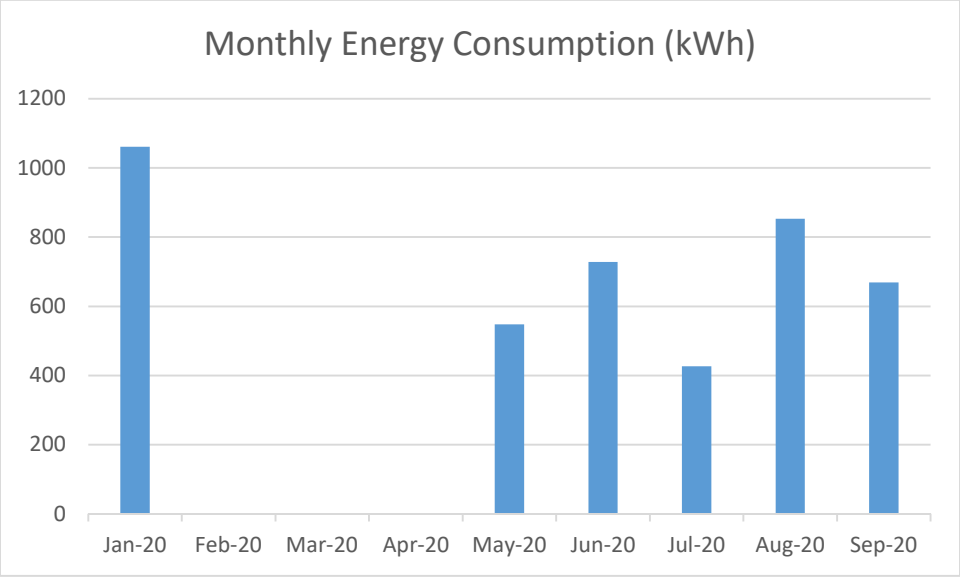

Fig.2.1, Monthly Energy Consumption of the College

The college campus also has a 40KVA Kirloskar Green make Diesel generator set and the production from it till date is indicated as 4163 kWh, which averages to an annual energy production of about 700kWh from the year 2014.

2.2 METHODOLOGY

Pre-audit of the campus was conducted on the basis of energy and operational data availed from the college, as a site visit was not recommended due to Covid-19 precautions. A detailed study about the power consumption and condition of lighting, pump and other loads, lighting system efficiency etc was conducted in the college campus on 20th January 2021.

2.3 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.

ii. The college does not include hostel/canteen facilities and hence waste management issues will be minimal.

iii. Classroom space, Staff-room area, administrative and other areas need to be studied separately for studying about reducing the energy consumption of the campus.

iv. The fuel consumption and operational details of the DG set need to be investigated.

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 58KW. 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 40 kVA.

3.1 LOAD AND ENERGY ANALYSIS

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 3.1, Quantification of electric loads of the campus

LED Lamp	Tube Lamp	LED Tube Lamp	Ceiling Fan	Other Fans	Socket (6A)	Classroom Projector	UPS	Computer with LCD Monitor	Other Loads (W)
219	109	114	109	11	217	17	13	144	17040

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. Table 3.1 shows the connected load on the campus as on 20-January-2021, which is obtained as58KW. If the load of 6A socket is removed, then the remaining loads connected to the system comes to 41KW of connected equipments.

Table 3.2, Connected loads of the campus

Location	Lamp -LED	Fluorescent Tube (40W)	Tube LED (20W)	Ceiling Fan	Pedestal & Ex. Fan	Power Socket (6A)	LCD Projector (300W)	UPS (KVA)	Other Loads (W)
Ground Floor	3	3	6	3	1	7	1	0	250
First Floor	72	20	15	17	2	35	2	6.4	3885
Second Floor	12	26	11	19	1	31	3	17.7	200
Third Floor	24	7	28	17	2	39	3	2.8	160
Outdoor Lighting									450
Water Pump									3700
Total Quantity	**111**	**56**	**60**	**56**	**6**	**112**	**9**	**26.9**	**8645**
Equipment wise Power (W)	**1110**	**2240**	**1200**	**3360**	**300**	**16800**	**2700**	**21520**	**8645**
Conn. Load (KW)	**57.88**								

The monthly electricity consumption from KSEB was available for the months indicated in Table 3.3, and the average energy consumption during the months of normal academic classes is around 1000kWh. As the supply system is three phase, power factor correction is not a mandate for the consumer.

Table 3.3, KSEBL monthly electricity charges of the campus

Month and Year	Energy Consumption (kWh)	Fixed Charge (Rs.)	Energy Charge (Rs.)	Total Charges (Rs.)	Average Unit Cost (Rs/kWh)
Jan-20	1061	3780	9549	14347	13.52
May-20	548	3780	4986	9277	16.93
Jun-20	728	3780	6553	11006	15.12
Jul-20	427	3780	3331	7462	17.48
Aug-20	853	3780	7677	12243	14.35
Sep-20	669	3780	6021	10421	15.58

The monthly cost of electricity calculated from Table 3.3 is represented graphically in Fig. 3.1. After the month of March, there was full lockdown for around two months, and classes or examinations partially started only in July 2020. Hence the observations from these electricity bills cannot be generalized. The average electricity charges were around Rs. 15,000 monthly.

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.

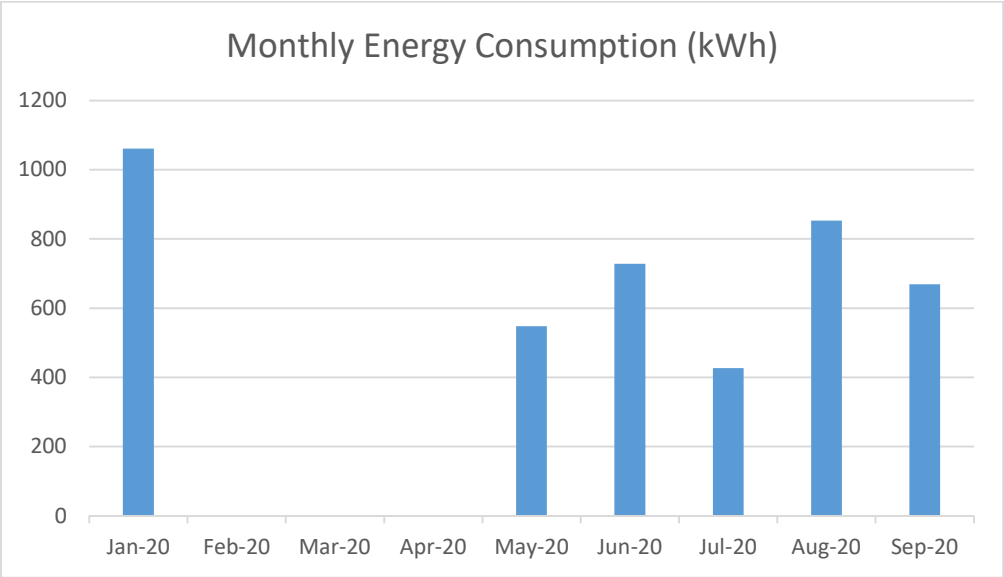

Fig.3.1, Monthly Energy Consumption of the College

The out of the obtained electrical energy consumption of the college, the reading of January 2020 only indicates the reading with student presence in the campus. The readings of May, June and July are lower due to lockdown of the college due to Covid Pandemic. After March 2020, the college was closed due to pandemic and partial on-campus academic activities only happened afterwards. This is reflected in the lower energy consumption of the college from May 2020.

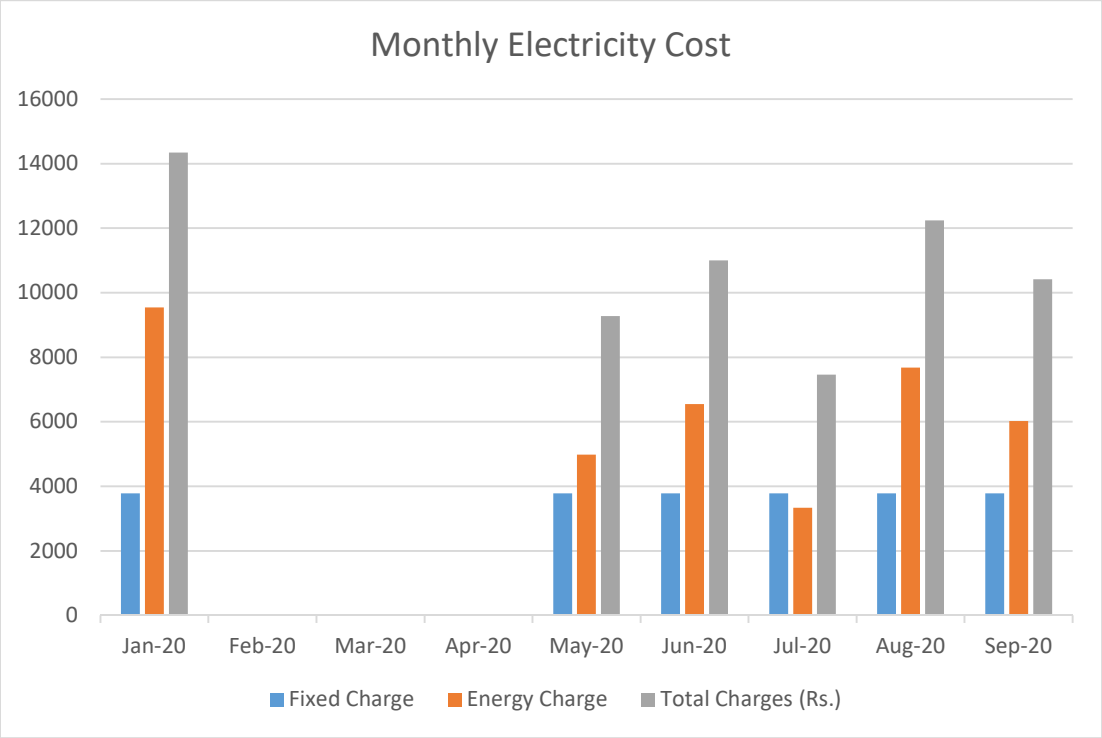

Fig.3.2, Split-up of Monthly Energy Consumption of the College

A split-up of monthly electricity consumption of the college is presented in fig 3. The fixed cost is comparable to the monthly energy cost for months post lock-down, and energy consumption is found to be lesser. As the temporary regulations in academic activities due to the pandemic situation is expected to be temporary, conclusions cannot be made based on these details.

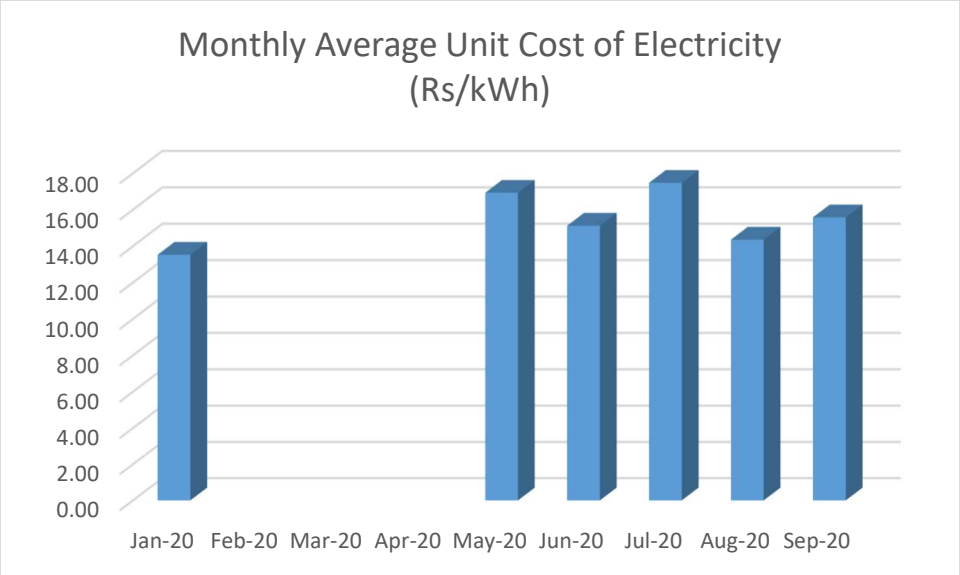

Fig.3.3, Monthly Average Energy cost of the College

The tariff plan of KSEB for the college is LT-6F, which is applicable for commercial and self-financed educational institutions The energy cost according to this plan is shown in Table 3.4, 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 3.4, KSEB Tariff structure for LT-6F

LT VI GENERAL (F)	
Fixed charge (Rs/ kW per month)	
Single Phase	60
Three phase	120
Energy Charge (paise per unit)	
0 to 100 units per month	580
0 to 200 units per month	650
0 to 300 units per month	720
0 to 500 units per month	780
above 500 units per month	900

The energy meter reading on site is shown in Table 3.5, which indicates a maximum load on around 10KW in the system. The power factor is found to be good at 0.98. But the currents in the three phases indicate unbalanced distribution of loads.

Table 3.5, Energy Mater Reading at 12PM on 20 Jan 2021

Parameter	Value	Unit
Serial No.	10414401	
Energy	68932.7	kWh
Energy	71283.5	kVAh
Power Factor	0.984	
Load Demand	9.45	kW
Voltage - R	234	V
Voltage - Y	237	V
Voltage - B	231	V
Current - R	6.1	A
Current - Y	6.5	A
Current - B	2.3	A
Frequency	49.98	Hz

Energy Meter: L&T ER300P (No CT connected)

That B-Phase is under loaded compared to the other two phases and there is no phase balance for the loads. The observation was made when most of the loads in the college was operating and classes were going on in the morning session.

Table 3.6, Clamp on A/M reading at the incoming terminals of KSEB Energy Meter

Supply Phase	Current
IR	6.1A
IY	6.5A
IB	1.3A
IN	7.7A

The readings in Table 3.6 also indicate that the B- Phase is quite underloaded and hence a large neutral current is seen in the system due to unbalance. 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.

The auxiliary power is supplied to the college using a 40KVA Diesel Generator unit, and the specification and operating details of this are shown in Table 3.7. Six years of operation of the device shows

a total production of 4352 kWh, which averages to around 725 kWh annual generation and 60 kWh of monthly power generation.

Table 3.7, Diesel Generator Details

MANUFACTURE:	GENLITE: 40KVA, 3 PHASE, Make: 2014 KIRLOSKAR GREEN, SERIAL NO. 146R2692014
ENGINE DETAILS	Engine: KOEL (3R-1040-TA-GI), 41.2KW/56HP, 1500 RPM, DIESEL TANK :100Lit
OPERATIONAL DETAILS	LIFE TIME GENERATION: 4352KWH LIFE HRS: 867 HRS TOTAL STARTS: 594 RPM: 1529 14.6V BATTERY VOLTAGE

The live operating parameters of the DG set is indicated in Table 3.8, which shows that B-Phase is totally unloaded, showing phase imbalance. The operating power factor, mechanical operating parameters of the engine and service history were found to be satisfactory

Table 3.8, 40KVA DG Set Generation at 11.45AM on 20 Jan 2021

Parameter or Phase	**VOLTAGE**	**CURRENT**	**KW**	**PF**
R	240	8	1.9	1
Y	241	8	1.9	1
B	241	0	0	1
TOTAL			3.8	
Line Values	**415V**	**5.3A**		

3.2 LIGHT METER AUDIT

Light meter audit was conducted in a few rooms of the college, and the results obtained are summarized in Table 3.9.

Table 3.9, Lux Meter Audit of the College

No.	Room	Lux Meter Reading (Daytime, All lamps ON)	Lux Meter Reading (Daytime, All lamps OFF)	No. of Luminaires	Remarks
1	First Floor - Reading Room (10mx7mx3m)	Average: 124 Lux, Minimum: 78 Lux, Maximum: 171 Lux	Average: 79 Lux, Minimum: 45 Lux, Maximum: 112 Lux	3 LED Tube Lights	Illumination level insufficient compared to recommended value of 350 Lux
2	First Floor - Library (10mx7mx3m)	Average: 55 Lux, Minimum: 30 Lux, Maximum: 75 Lux	Average: 45 Lux, Minimum: 20 Lux, Maximum: 90 Lux	4 LED Tube Lights	Illumination level insufficient compared to recommended value of 350 Lux
3	First Floor - Class Room (7mx7mx3m)	Average: 128 Lux, Minimum: 110 Lux, Maximum: 155 Lux	Average: 105 Lux, Minimum: 75 Lux, Maximum: 140 Lux	2 LED Tube Lights	Illumination level insufficient compared to recommended value of 350 Lux

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.

3.3 UPS AUDIT

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 3.10. 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.

Table 3.10, UPS Audit of the College

No.	UPS Rating (KVA)	Location	Battery	DC Battery Current (A)	UPS Current (A)	Remarks
1	2	First Floor, Reading Room	12V, 2 No.s	4A	0.4A	Generic Make
2	3.5	First Floor, Office Room	12V, 150Ah, 4 No.s	0.1A	4.6A	Luminous Make
3	0.9	First Floor, IQAC Room				Generic Make
4	3	Second Floor, Computer Lab	12V, 150Ah, 2No.s	0	1.5A	Generic Make
5	3		12V, 100Ah, 2No.s	0	1A	Generic Make
6	3		12V, 150Ah, 2No.s	9.2A	2A	Generic Make
7	2.5		12V, 150Ah, 2No.s	0.2A	0	Generic Make
8	2.5		12V, 150Ah, 2No.s	0	0	Generic Make
9	3		12V, 150Ah, 2No.s	0.5A	2A	Generic Make
10	0.7					
11	1.4	Third Floor, Common Room	12V, 150Ah, 2No.s	0.1A	0	Amaron Make
12	0.7					
13	0.7	Third Floor, Staff Room				
26.9 KVA Total UPS Capacity						

3.4 Water supply system analysis

The water supply, pumping and water storage system of the college is summarized in Table 3.11. The operational strategy of the pump and the water supply system is found to be in an energy efficient manner.

Table 3.11, Water Supply System of the College

Water Source	Open Well - 2 No.s with 3Lakhs and 1 Lakhs Liters capacity Combined open well capacity – 4 Lakh Liters Location: Around 75m away from the mail building
Water Storage	Enclosed Overhead Tank Storage Capacity: 25000 Liters Location: Roof top of the Academic Building
Pump Details	Make: Texmo Industries Type: Mono-block Pump set – 1 No. 3.7KW/5HP, 3 Phase supply with DOL starter Cable: Three core, 6mm2 fed directly from the main panel of the college

CHAPTER 4
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.

4.1 CAMPUS GREENERY

The campus is located in a hill side of the Western Ghats, covering a land area of 22220 square meters (5.24 acre), and the surrounding 5 acres of land is used for Cardamom cultivation. The fogy mountains around the campus and floral diversity of the campus and overall greenery around gifts the students the perfect condition for study.

There are more than 60 trees in and around the campus, and more than 4000 yielding cardamom plants. The fertilization of the plants of the campus is using bio gas plant manure, vermi-compost and cow dung. The plant species in the campus is shown in Table 4.1,.

Table 4.1, Floral Diversity of the campus

Sl. No	Scientific Name	Common Name	Malayalam Name
1.	Artocarpus heterophyllus	Jackfruit Tree	Plavu
2.	Mangifera indica	Mango	Mavu
3.	Mimuspos elengi	Bullet Wood	Elanji
4.	Macaranga peltata	Macaranga	Vatta
5.	Gmelina arborea	Beech wood	kumbil
6.	Cocos nucifera	Coconut Tree	Thengu
7.	Artocarpus hirsutus	Wild Jack	aanjili
8.	Roystonea regia	Royal palm	Royal palm
9.	Sapodilla	Chikoo	Sappota

10.	Areca catechu	Areca palm	Koungu
11.	Muntingia calabura	Jamaican Cherry	panjasaara pazham
12.	Erythrina variegate	Erythrina variegate	Murikku
13.	Hibiscus rosa-sinensis	Hibiscus	Chembaruthi
14.	Rosa spp. tdmkv	Garden Rose	Rosa chedi
15.	Musa paradisiaca	Banana	Vazha
16.	Carica papaya	Papaya	Kaplangya
17.	Sidar hombifolia	Country Mallow	Kurunthotti
18.	Hemidesmus indicus	Indian Sarsaparilla	naruneendi
19.	Colocasia esculenta	Taro	Shemma cheambu
20.	Psidium guajava	Guava Tree	Pera
21.	Peltophorum pterocarpum	Copper Pod	Manjavaga
22.	Myristica fragrans	Nutmeg	Jathi
23.	Genera Elettaria	Cardamom	Elakka
24.	Gliricidia sepium	Gliricidia	Cheemakonna
25.	Grevillea robusta	Silver Oak	Kattadi
26.	Murrayakoenigii	curry tree	Kariveppu
27.	Citrus sp	Citrus sinensis	Narakam
28.	Artocarpus altilis	Breadfruit	Kadachakka
29.	Rubiaceae	Coffee Plant	Kappi chedi

4.2 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 4 Lakh liters. Water is pumped to an overhead storage tank on top of the academic building, having a capacity of 25,000 liters. The gravity circulated water is used in 16 washrooms and three water purifiers around the academic building. The waste water is processed in sewage tanks and drained to the underground.

The top floor rooftop of approximately 1000 sq. meters is open to sky, and the rain water falling here is collected from here, and shifted to a nearby rainwater tank through piping. The capacity of the rainwater

collection tank is around Two Lakh Litres. The rain water collected is used for irrigation of the cardamom cultivation around the campus. The ground water obtained through rain is drained to the agricultural field and is absorbed to ground for the well recharging purpose. Thus the rain water obtained in the campus is fully utilized in an eco-friendly manner.

4.3 WASTE MANAGEMENT

The wastage produced in the campus is of a very minimal amount due to the lack of canteen facilities and hostel facilities. The food waste, if any is fed to the biogas plant, located beside the campus.

The paper waste, that can be recycled is collected by third parties at a minimal cost for recycling purpose. Paper waste, which cannot be handed over for recycling is burnt in the open air behind the campus. The usage of a paper shredder or an incinerator is recommended for safe disposal of paper in the campus.

There are 16 toilets in the college and the waste water in the campus from them is collected separately and processed through septic tanks or natural soil absorption, without causing any pollution to the ground water system.

4.4 CO_2 EMISSION

The CO2 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 college owns and operates four college buses for student and staff transport. The bus routes and approximate distance is shown below.

1. Thankamani to Labbakkada - 78 KM/day
2. Bathel to Labbakkada - 84 KM/day
3. Nedumkandam to Labbakkada – 66 KM/day
4. Anavilasam to Labbakkada – 80 KM/day

The combined distance covered by all the buses is 308 KM a day, and this causes environment emissions due to air pollution. The average monthly consumption of diesel for the operation of the buses is around 1100 litres and monthly expenses incurred on account of diesel range from Rs. 75,000 – 90,000.

Around 330 students and staff travel by own vehicle (bike or car) on a daily basis, by an daily average distance of 15 to 20KM, resulting in an addition CO2 footage to the campus. Summarising, the transportation fuel consumption by the staff and students excluding the college vehicles can be considered as around 550 litres of diesel and 750 litres of petrol.

The on-campus diesel power generator is operated only when it is absolutely necessary to ensure continuous supply. The monthly average diesel power generation is less than 100kWh of electricity and the expenses incurred on account of generator fuel range from 5000 to 15000, and a quantity of around 100 litres of diesel is used on a monthly average basis. Electricity usage in the campus on normal academic operation is around 1000kWh/month.

Table 4.2, Approximate Monthly CO2e Emission from the Campus

No.	**Monthly Energy or Fuel Consumption**	**Emission Factor (Kg CO2e/unit)**	**Total CO2 Emission (Kg/Month)**
1	College Bus – 1100 Litres Diesel/month	2.34	2574
2	Staff and Student Transport – 550 Lit Diesel/month 750 Lit Petrol/month	 2.34 2.2	 1287 1650
3	Diesel Generator Set – 100 lit Diesel/month	2.34	234
4	Electricity from Grid – 1000kwh/Month	0.13	130
	Total Monthly Eq. Carbon dioxide emission		**5875 Kg/Month**

Thus the monthly CO2e emission is approximately obtained as 5.87 Tons/month.

CHAPTER 5
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 1100m2 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