ENERGY AUDIT REPORT

ST. ALOYSIUS COLLEGE

EDATHUA, ALAPUZHA

EXECUTED BY

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PREFACE

Every institution should be imparting knowledge about the campus environment and its surroundings through activities that follow the principles of sustainability. An energy audit is the essential first step to reduce energy cost and greenhouse emissions. Audit is defined as a systematic examination of data, statements, records, operations and performance of an enterprise for a purpose. Energy audit is a systematic study or survey to identify how energy is being used in its own facility by identifying the energy saving opportunities in the building. Even small savings in each house-hold will make dramatic change in the society and nation. The idea of energy conservation and sustainability will be percolated to society through students. It will have a long standing effect and will be successful too.

This report is compiled by the BEE certified energy auditor along with the project engineers who are experienced in the field of energy, environment and management. The student volunteers made a mammoth contribution with data collection and preparing an initial skeleton for the report.

ACKNOWLEDGEMENTS

We express our sincere gratitude to St. Aloysius, Edathua, for giving us an opportunity to carry out this Energy Audit. We are extremely thankful to all the members of the staff for their support to carry out the studies and for getting input data, and measurements related to this audit.

1.	**Dr. Jochan Joseph**	**Principal**
2.	**Dr. Jubin Antony**	**Coordinator, IQAC**
3.	**Dr. Indulal. G**	**Coordinator, NAAC**
4.	**Smt. Rosmin John, Asst. Prof.**	**Coordinator-(Energy, Environment and Green Audit)**
5.	**Mr. Tinu Joseph**	**College Mechanic**

Also congratulating our Energy audit team members for successfully completing the assignment in time and making their best efforts to add value.

GREEN AUDIT TEAM

1. **Mr. Santhosh A**
   Registered Energy Auditor of Bureau of Energy Efficiency (BEE – Govt. of India)
   Accredited Energy Auditor No – EA 7597

2. **Mr. Hari Krishnan K**
   Project Engineer

ATHUL ENERGY CONSULTANTS PVT. LTD
THRISSUR
680 020

Yours faithfully

Managing Director
Athul Energy Consultants Pvt Ltd

EXECUTIVE SUMMARY

I. ENERGY SAVING PROPOSALS:

TABLE 1: EXECUTIVE SUMMARY

Sl. no	Energy conservation measures	Annual Energy Savings	Annual Financial Savings	Investment	Simple payback period
		kWh	Rs	Rs	Months
1	Replacement of 30 ceiling fan (60W)with BLDC Fans (30W)	1536	9,984	105000	126
2	Replacement of 20 No:mT12 (40W)Tube with LED Tube light (20W)	320	1920	7000	44
	Total	**1856**	**11904**	**112000**	

II. AUDIT SUMMARY – ACTIONS

The actionable summary of the audit report is given in the table below.

TABLE 2: ENERGY AUDIT SUMMARY – ACTIONS

Sl No:	Particulars	Location	Action to be taken	Remarks
1	Energy efficiency – Replacement of ceiling fans with BLDC fans	Office, staff rooms, Classrooms	Change the existing old ceiling fans with BLDC fans	Power Consumption will get reduced
2	Energy efficiency – Replacement of fluorescent lights with LED lights	Office, staff rooms, Classrooms	Change the existing lights with LED lights	Power Consumption will get lowered
3	Energy consumption – Set temperature of AC in between 24 – 27 °C		Change the temperature using the remote	Power consumption will reduce.

III. ENERGY PERFORMANCE INDEX (EPI)

EPI is based on the energy consumption during the last year. The projected energy consumption after the implementation of energy saving proposals is given in the table below.

TABLE 3: ENERGY PERFORMANCE INDEX

Sl. No:	Energy Performance and climate impact	Unit	Baseline	Projection
1	Annual Electricity Consumption	kWh	42,053	40,255
2	Annual electricity consumption	TOE	3.62	3.46
3	Total Energy Consumption	kWh	42053.0	40255.0
4	Total Energy consumption	TOE	3.62	3.46
5	Energy Performance Index	kWh/Sq.m	3.346	3.202
6	Annual Energy Cost	Rs in lakhs	2.73	2.61
7	Annual Carbon Footprint	Ton CO2	29.44	28.18
Sl. No:	**Energy Performance and climate impact**	**Unit**		
1	Electricity	kWh	42,053	40,255

Note: Unit conversions:

TOE	=	10 million kCal (BEE energy audit manual)
MWh of electricity	=	0.82 Ton of CO_2 (www.cea.gov.in)
Kg of LPG	=	10500 kCal (BEE energy audit manual)
Liters of Diesel	=	9729 kCal (BEE energy audit manual)
kWh of electricity	=	860 kCal (BEE energy audit manual)

IV. ANNUAL CARBON FOOTPRINT OF APPLIANCES

The present carbon dioxide generation by appliances in the college and the projected value after the implementation of the energy conservation measures are given in the following figure.

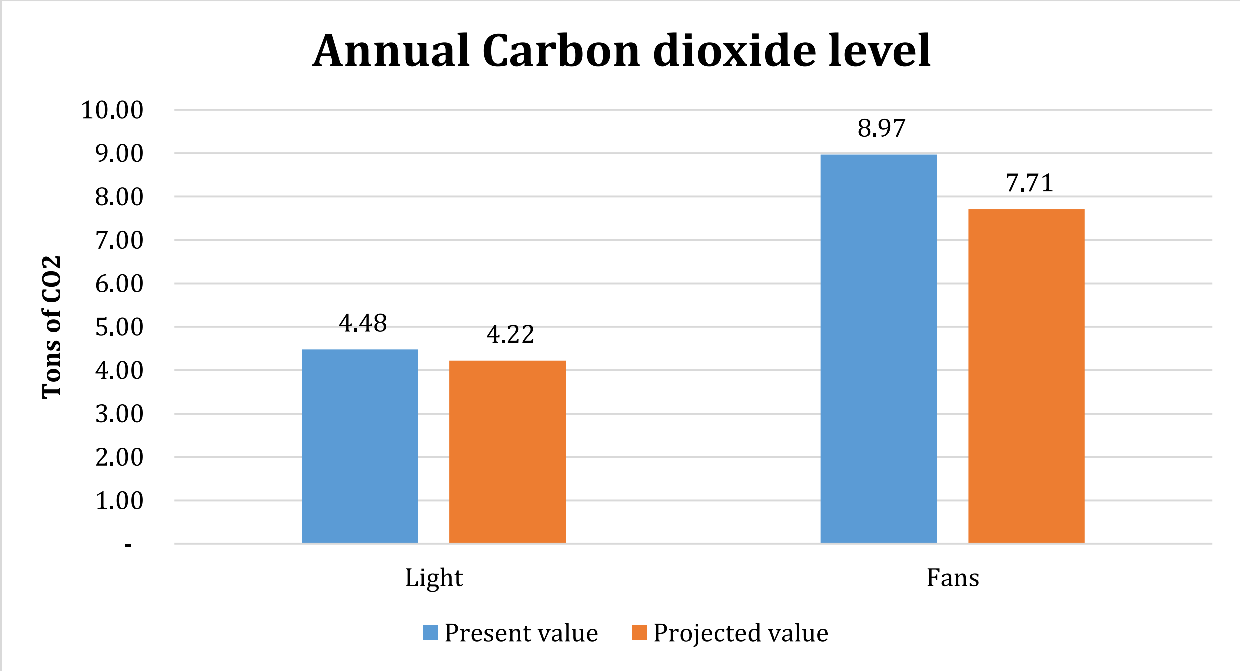


FIGURE 1: ANNUAL CO_2 EMISSION

V. CARBON FOOT PRINT

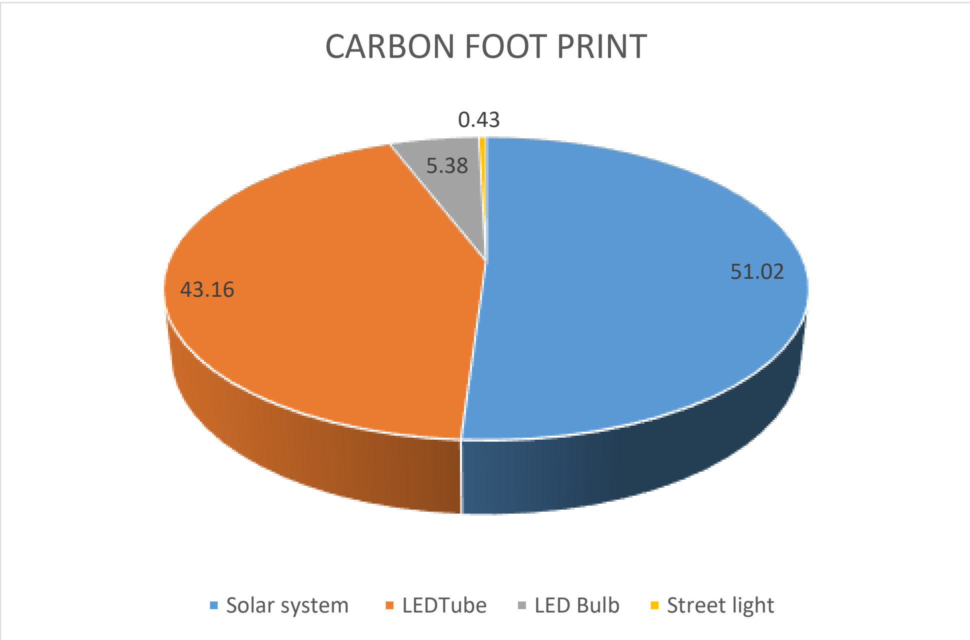
Carbon foot-print is often used as a short hand for measuring the amount of carbon emission (usually in Tons) which is being emitted by an activity or by organization. This is an important component in ecological foot print or the depicting the biological space reduction in the earth. Various environment protection and energy conservation measures are connected with the carbon footprint. The college management took its accountability to protect nature and has taken a few following steps for a carbon neutral campus.

1. Protecting and conserving trees inside and outside the campus through various students' activities
2. Replacement of old CFL s and tube lights with energy efficient LED lights
3. Installation of 5kW solar power plant and solar street lights in the college campus
4. Sustainable construction of buildings with natural ventilation and light in the classrooms and laboratories.

TABLE 4 CARBON FOOT PRINT

Particulars	**Energy consumption reduction (kWh)**	**Carbon Emission reduction**	**% of reduction in Carbon Emission**
Solar power 5kW installation	6000	4.74	51.02
Replacement of 318 Tube light with LED	5088	4.01	43.16
Replacement of 88 18W CFL with 9W LED	633	0.50	5.38
Installation of 7 solar street light	60	0.04	0.43
Total	**11781**	**9.29**	**100**

FIGURE 2: CARBON FOOT PRINT



INTRODUCTION

I. ENERGY AUDIT

An energy audit is a key to assess the energy performance of an energy consuming facility. It can be used to develop an energy management program. The typical steps of the energy audit are:

- Preparation and planning
- Data collection and review
- Plant surveys and system measurements
- Observation and review of operating practices
- Data documentation and analysis
- Reporting of the results and recommendations

1.1. Definition of energy auditing

In the Indian Energy Conservation Act of 2001 **(BEE 2008)**, an energy audit is defined as: **"The verification, monitoring and analysis of the use of energy and submission of technical report containing recommendations for improving energy efficiency with cost-benefit analysis and an action plan to reduce energy consumption."**

1.2. Objectives of Energy Auditing

The objectives of an energy audit can vary from one institution to another. However it is usually conducted to understand how much energy is utilised within the Institution and also to find opportunities for its improvement with energy saving. Sometimes, energy audits are conducted to evaluate the effectiveness of an energy efficiency project or program.

Methodology for the study

The methodology adopted for energy audit starts from historical energy data analysis, power quality analysis, monitoring of operational practices, system evaluation, cost benefit analysis of the energy conservation opportunities, and preparation of plan for implementation. The proposals given in the report includes economical energy efficiency measures to reduce unnecessary energy consumption and cost. The energy conservation options, recommendations and cost benefit ratio, indicating payback period are included in this report.

Scope of Work

The Scope of Work includes:

1. Historical energy data analysis.
2. Electrical, Mechanical and Thermal energy analysis.
3. Power Quality Analysis.

II. ST. ALOYSIUS COLLEGE

St. Aloysius College, Edathua is a first-grade Arts and Science college which has completed fifty-five years of glorious service to the cause of higher education. Now, it is a well-established NAAC re-accredited centre of learning offering a variety of undergraduate, postgraduate and Ph D programs.

The college is situated in Edathua Panchayat of the Kuttanad Taluk in the lake district of Alappuzha. It is the only temple of higher education of its kind in the entire region of the onetime granary of Kerala, Kuttanad. Standing atop the main building of the college gives a panoramic view of the paddy fields, clothed in the richest green. The luxuriant greenery, meandering rivulets and the placid tranquillity altogether provide a congenial atmosphere for learning and development.

St. Aloysius College was founded in 1965 by the St.George's Forane Church, Edathua. It is the fruit of the vision and long perspective of late Very. Rev. Fr. Zacharias Punnappadom (the first Manager) and Dr. P.T. Joseph (the first Principal) under the patronage of Servant of God Mar Mathew Kavukattu. The great visionaries had in their mind the noble task of imparting quality higher education in the backward agrarian region of Kuttanad which lacked any facility for higher education. The college admits students of all castes and creeds with due respect to different faiths and religious denominations.

The College had a very humble beginning. It started functioning in St. Aloysius High School as a junior college affiliated to the University of Kerala with 189 students, 9 teachers and 7 non-teaching staff. In 1966, the college was shifted to the present site. The institution owes an immense debt of gratitude to late Very Rev. Fr. Cyriac Kottayil who in his capacity as the manager was instrumental in erecting the main building of the college. In 1983, following the bifurcation of Kerala University, the college came under the jurisdiction of the newly established Mahatma Gandhi University.

As a first step to meet the ever-growing demand of higher education in the region, the college was upgraded in 1977 by introducing an undergraduate programme in Economics. Post graduate programme was introduced in1984. The College has now grown into a leading educational institution with 71 teaching staff, 19 non-teaching staff and 1012 students on the rolls. It has now to its credit 9 UG, 6 PG programs and 2Ph.D programs.

Motto

"Let Thy divine light shine miraculously"

Vision

"*"Formation of global citizens with academic excellence and integrity of character"*

Mission

The mission of the college is to mould the students into skilled, worthy, global citizens who can uphold the core values of the college.

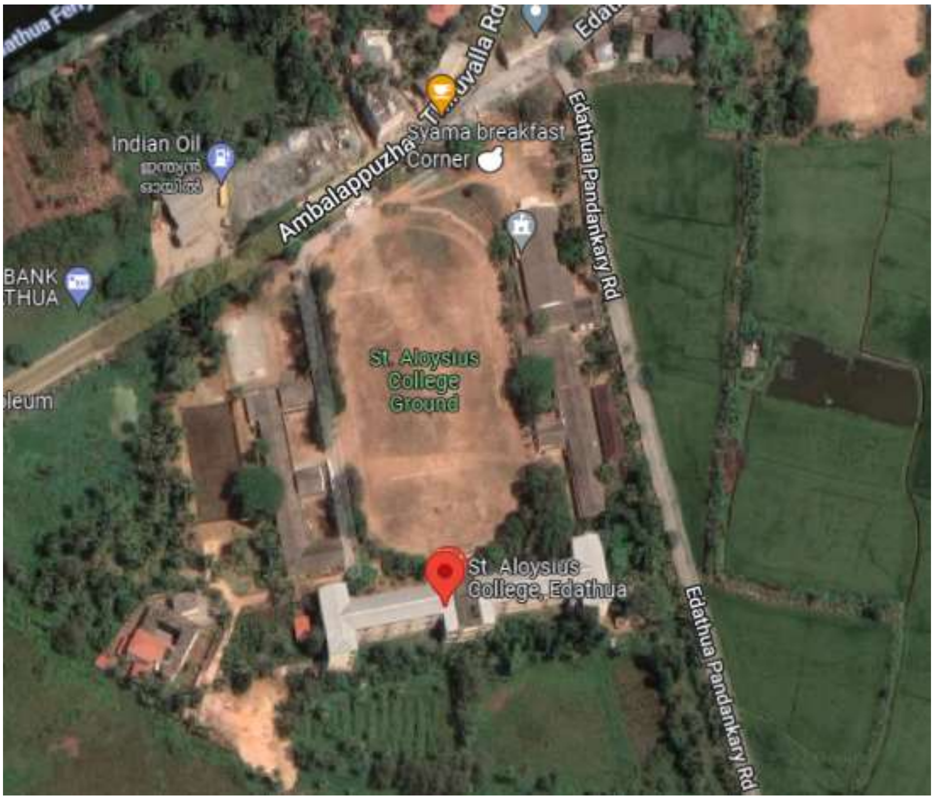


FIGURE 3: GOOGLE LAYOUT

III. GENERAL DETAILS

The general details of the College are given below.

TABLE 5: GENERAL DETAILS

Sl.No:	Particulars	Details
1	Name of the College	St Aloysius college
2	Address	St Aloysius college, Edathua Alappuzha, Kerala. India
3	Contact Person	Dr.Jochan Joseph ,Principal Ph: 9447596975
4	E-mail ID	sacedathua@gmail.com
5	Website Details	ww.aloysiuscollege.ac.in
6	No: of Shifts	01
7	No: of students	1012
8	No: of teaching staff	70
9	No: of non-teaching staff	19
10	Total built up area(M^2)	12570 m^2

IV. LOAD BALANCE- ELECTRICAL

Load balance among the connected loads in the college is given in the figure below. The detailed connected load details are given in Annexure 2

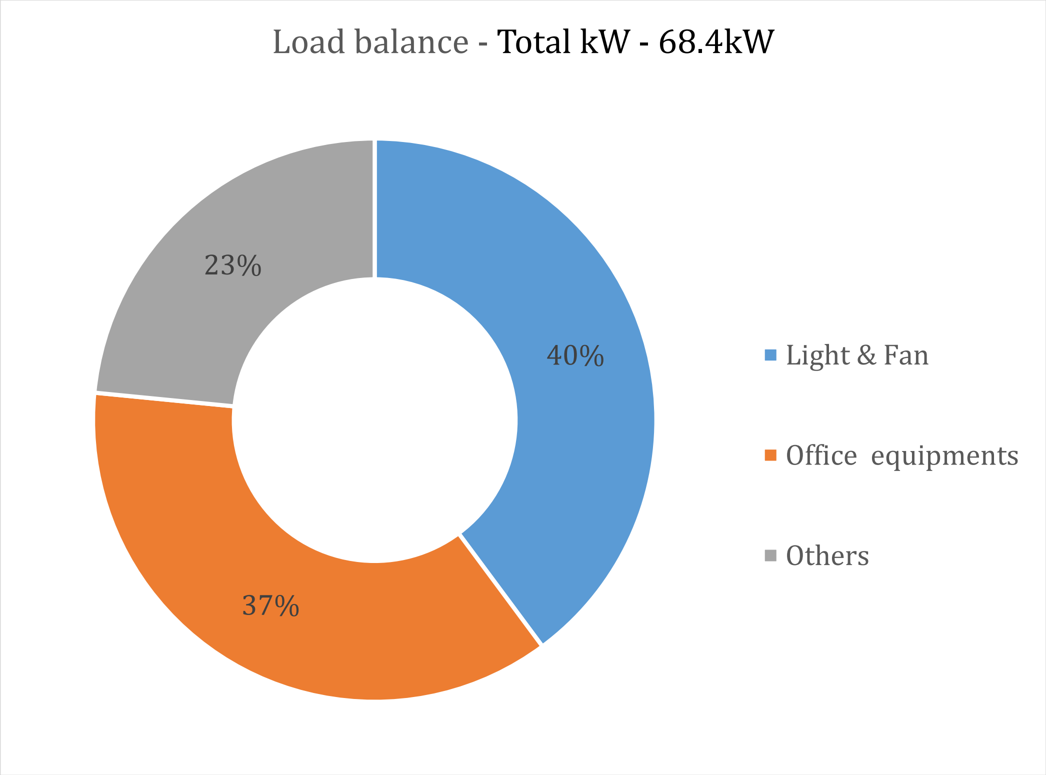


FIGURE 4: LOAD BALANCE-COLLEGE

ELECTRICITY CONSUMPTION ANALYSIS

The major source of electricity to the college is electrical connection from the KSEB. A diesel generator is provided in the college, but it is only used during the power failures.

I. DESCRIPTION OF ELECTRICITY BILL

Base line data given below is based on the Electricity bill provided by the electricity supplier to the College.

TABLE 6: KSEB BILL DESCRIPTION

Particulars	
Consumer No	1155076003808
Electrical section	Edathua
Approved connected Load (as per bill) in KW	29.9
Tariff	LT-6A/Three
Average monthly consumption (kWh)	3504
Annual Energy consumption (kWh)	42,053
Annual Energy charge (Rs)	2,73,347

II. TARIFF RATES ANALYSIS

The average monthly energy and demand charges for the period July 2020 to March 2021 is represented in Fig.

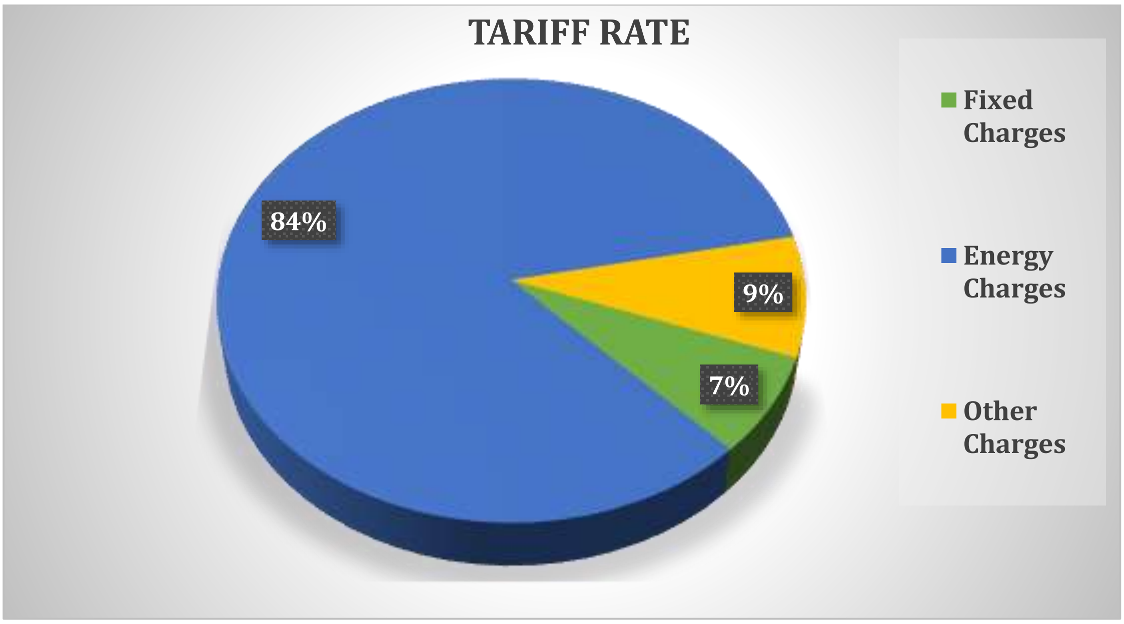


FIGURE 5: TARIFF RATE ANALYSIS

Inference

i. Average fixed charges for the past one year were Rs 1,950/ per month

ii. The total energy charges during the past one year were Rs 2,73,347

III. SPECIFIC ELECTRICITY CONSUMPTION (kWh/M²)

The electricity consumption from July 2020 to March 2021 has been taken for the benchmarking. Here the comparison is done with electricity consumption and the building area. The following table shows the specific electricity consumption of the college.

TABLE 7: SPECIFIC ELECTRICITY CONSUMPTION

Month	Average Electricity Consumption	Building Area	SEC
	kWh	Sq. Metre	kWh/Sq. Metre
Jul-20	3040	12570	0.24
Aug-20	3900	12570	0.31
Sep-20	3260	12570	0.26
Oct-20	3260	12570	0.26
Nov-20	2880	12570	0.23
Dec-20	4000	12570	0.32
Jan-21	4060	12570	0.32
Feb-21	2240	12570	0.18
Mar-21	4900	12570	0.39
Total			**Avg =0.28**

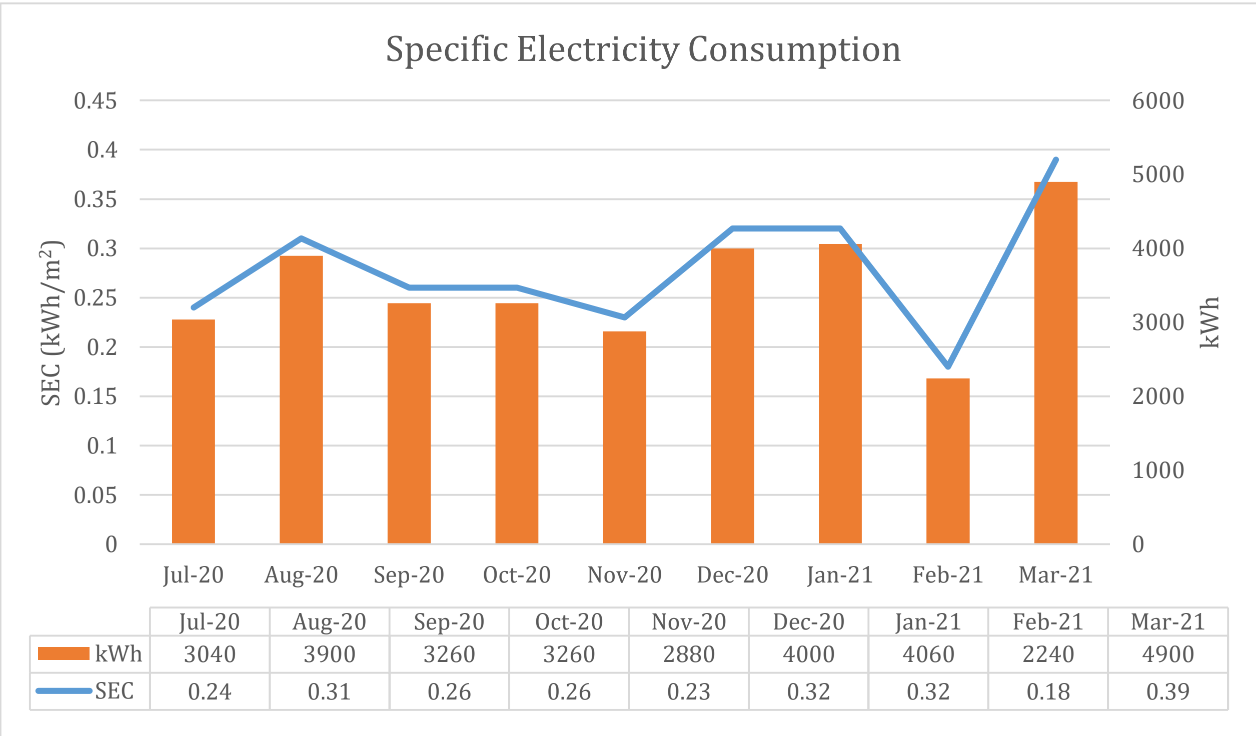


FIGURE 6: SPECIFIC ELECTRICITY CONSUMPTION

RENEWABLE ENERGY

The Sun is an inexhaustible, reliable and non-polluting source of power. Since the origin of life on earth, the only energy that was available has been coming from the sun. As there is an alarming shortage on other natural energy resources mankind will again depend upon the sun as dominant energy source. The fossil fuels are depleting at a rapid rate. A growing worldwide concern for conservation of energy has reignited the interest in ecologically sustainable materials, processes and sources of energy. The advantages of solar power are:

- The solar energy is more evenly distributed in the world than wind or bio-mass.
- It is a well proven and demonstrated technology.
- It promises to be most cost effective renewable power at high volumes.
- The solar energy potential in India is immense due to its convenient location near the Equator. India receives nearly 3000 hours of sunshine every year, which is equivalent to 5000 trillion kWh of energy.

The College has installed a 5kW off-grid solar system on top of college building.

FIGURE 7: SOLAR INSTALLATION

FIGURE 8: SOLAR SYSTEM INVERTER AND BATTERIES

The college has also installed 7 solar street light on campus at various points.

FIGURE 9: SOLAR STREET LIGHT

ANNEXURE - 1

ENERGY SAVING PROPOSAL - 1

REPLACEMENT OF CEILING FANS IN THE OFFICE WITH ENERGY EFFICIENT BLDC FANS

Background

A BLDC fan takes in AC voltage and internally converts it into DC using SMPS. The main difference between BLDC and ordinary DC fans is the commutation method. A commutation is basically the technique of changing the direction of current in the motor for the rotational movement. In a BLDC motor, as there are no brushes, the commutation is done by the driving algorithm in Electronics. Owing to mechanical contact in a brushed motor the commutator can undergo wear and tear. This thing is eliminated in BLDC Motor making the motor more rugged for long-term use and this is the main advantage of BLDC motor. To explain, BLDC technology in simpler terms, BLDC uses a combination of Permanent Magnets and Electronics to achieve the kind of efficiency and performance, it delivers. A BLDC fan composes 3 main components: - 1. Stator 2. Rotor 3. Electronic items

Proposal

Replace the ceiling fans with BLDC as per preference of operating hours in Class rooms, office areas, Staff rooms, security cabin and hostel. If so the calculation for savings is as given in the following table.

TABLE 8: EC PROPOSAL 1

Particulars	Units	BLDC fan
Existing Ceiling Fans	Watts	60
Proposed BLDC Fans	Watts	28
Difference in Wattage	Watts	32
Avg No: of working hours/day	Hrs.	8
No: of working days per year (Average)	Days	200
No: of working hours per annum	Hrs.	1600
Number of Fans operating	Nos	30
Energy Saving per Annum	kWh	1536
Cost per kWh	Rs	6.5
Annual Financial Savings	Rs	9984
Cost of BLDC Fans	Rs	3500
Investment for Fans	Rs	105000
Simple Payback period	Months	126

ENERGY SAVING PROPOSAL – 2

REPLACEMENT OF FLUORESCENT TUBES WITH ENERGY EFFICIENT LED LIGHTS

At present LED lights are used in some areas. The Fluorescent lights had been replaces by LED lights as per preference of operating hours in office areas, staff rooms, security cabin and hostel. The calculation for the savings is given in the table.

TABLE 9: EC PROPOSAL 2

Particulars	Units	T12
Existing Fluorescent lights	Watts	40
Proposed LED light	Watts	20
Difference in Wattage	Watts	20
Avg No: of working hours/day	Hrs	4
No: of working days per year (Average)	Nos	200
No: of working hours per annum	Hrs	800
Number of Lights operating for change	Nos	20
Energy Saving per Annum	kWh	320
Cost per kWh (Average)	Rs	6
Annual Financial Savings	Rs	1920
Cost of LED light	Rs	350
Investment for LED lights	Rs	7000
Simple Payback period	Months	44

Reason for change in the lighting system

- Lighting quality have a dramatic influence on the attitude and performance of working persons, if they have an environment with proper uniform lighting.
- Lighting quality can be divided into Uniformity, Glare, Colour rendering Index, coordinated colour temperature.
- In case of consistency and in uniformity, the life time of LED is far better than CFL s and FTLs.
- Deterioration of lumens or lux level in FTLs and CFL are more as compared with LED which is consistent during in its lifetime.
- Considering VCP (Visual Comfort Probability) LED is better option than FTLs and CFL because the glare value is lesser.
- The LED are whitish in colour than FTLs which is giving a better feeling of brightness to the persons occupied or working
- CCT of LED is 5000k which is white as compared with lesser CCT for FTLS of 4500k
- There is no mercury content in the LED as compared with CFL and FTL s hence it is environmentally supportive.
- The life cycle data of tube lights with LED is given in the table below.

TABLE 10: LIFECYCLE DATA OF LIGHT TYPES

Type of lamp	Typical life in Hours	Cost per lamp	No: of lamps required during LED lifetime (led 60,000 Hours)	Replacement cost per lamp	Approximate maintenance expense for replacement	Total cost per lamp
T12	5000	45	12	540	500	1040
T8	5000	45	12	540	500	1040
T5	5000	100	12	1200	500	1700
LED	60000	800	1	800	0	800

ANNEXURE 2

CONNECTED ELECTRICAL LOADS

I. LIGHT AND FAN LOADS

TABLE 11: LIGHT AND FAN LOADS

	LED tube	T12 tube	LED	LED	LED	LED	CFL	Metal Halide	Fan
Wattage	20	40	30	12	9	6	165	250	60
Quantity	333	20	7	6	40	8	2	2	305
Total (kW)	6.66	0.8	0.21	0.072	0.36	0.048	0.33	0.5	18.3
Net total(kW)	**27.28**								

II. OFICE EQUIPMENTS

TABLE 12: OFFICE EQUIPMENTS

	PC	Printer	Printer	Xerox	Projector	Projector
Wattage	200	100	683	1242	260	410
Quantity	59	1	9	4	5	2
Total (kW)	11.8	0.1	6.147	4.968	1.3	0.82
Net total (kW)	**25.135**					

III. OTHERS

TABLE 13: OTHERS

	AC	Water cooler	Induction Cooker	Electric Kettle	Fridge	Incinerator
Wattage	1500	520	2000	1500	300	250
Quantity	2	5	3	2	4	1
Total (kW)	3	2.6	6	3	1.2	0.25
Net total (kW)	**16.05**					

ANNEXURE-3

I. ABBREVIATIONS

AVG	:	Average
BEE	:	Bureau of energy efficiency
CO_2	:	Carbon-dioxide
KSEB	:	Kerala State Electricity Board.
DB	:	Distribution Board
EC	:	Energy Conservation
IEEE	:	The Institute of electrical and electronics engineers
IS	:	Indian Standard
kL	:	kilo Liter
KVA	:	kilo Volt Ampere
kVAh	:	kilo volt Ampere Hour
kVAr	:	kilo volt ampere
kW	:	kilo Watts
kWh	:	kilo watt hour
LT	:	Low tension
MAX	:	Maximum
NSS	:	National Service Scheme
SLD	:	Single Line Diagram

II. REFERENCES:

- Handbook on energy audit and environment management by TERI.
- Bureau of Energy Efficiency (BEE) books for certification of Energy Auditors & Managers.

III. CERTIFICATES

I. BEE Accreditation Certificate

ENERGY IS LIFE
BEE
CONSERVE IT

BUREAU OF ENERGY EFFICIENCY

Examination Registration No.: EA- 7597

Accreditation Registration No.: AEA-0275

Certificate of Accreditation

This is to certify that Mr./Ms. Santhosh. A having its trade/registered office at Kerala has been given accreditation as accredited energy auditor. The certificate shall be effective from 2nd day of November, 2017

The certificate is subject to the provisions of the Bureau of Energy Efficiency (Qualifications for Accredited Energy Auditors and Maintenance of their List) Regulations, 2010.

This certificate shall be valid until it is cancelled under regulation 9 of the Bureau of Energy Efficiency (Qualifications for Accredited Energy Auditors and Maintenance of their List) Regulations, 2010.

On cancellation, the certificate of accreditation shall be surrendered to the Bureau within fifteen days from the date of receipt of order of cancellation.

Your name has been entered at AEA No. 0275 in the register of list of accredited energy auditors. Your name shall be liable to be struck out on the grounds specified in regulation 8 of the Bureau of Energy Efficiency (Qualifications for Accredited Energy Auditors and Maintenance of their List) Regulations, 2010.

Given under the seal of the Bureau of Energy Efficiency, Ministry of Power, this 12th day of February, 2018

Secretary,
Bureau of Energy Efficiency
New Delhi