ENERGY AUDIT

ST. EDMUND'S COLLEGE
SHILLONG

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Forwarded to
IQAC, SEC, SHILLONG

St. Edmund's College **Energy Audit Report**

Shillong

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CONTENTS:

1. BACKGROUND

Energy is a basic requirement for economic development in almost all major sectors of Indian economy i.e., agriculture, industry, transport, commercial, residential (domestic) and educational institutions. Consequently, consumption of energy in different forms has been steadily rising all over the country, which has maintained a steady growth pattern in the past and the trend is likely to continue in future as well. This has increased the dependence of the state on fossil fuels and electricity. The Government of India enacted the Energy Conservation Act, 2001 in October 2001. The Energy Conservation Act, 2001 became effective from 1st March 2002. The Act provides for institutionalizing and strengthening delivery mechanism for energy efficiency programs in the country and provides a framework for the much-needed coordination between various Government entities. The Bureau of Energy Efficiency is an agency of the Government of India, under the Ministry of Power created in March 2002 under the provisions of the nation's 2001 Energy Conservation Act. The agency's function is to develop programs which will increase the conservation and efficient use of energy in India.

St Edmund's College, an educational institute in East Khasi Hills district of Meghalaya taking voluntary objective of reducing energy intensity in the College Campus entrusted its own Teaching Staffs for conducting Energy Audit. To conduct the energy audit, the campus was surveyed several times starting from 11th of April 2022 to collect data and to take some measurement for assessment of different energy consuming components.

2. ENERGY AUDIT

As per the Energy Conservation Act, 2001, Energy Audit is defined as "the verification, monitoring and analysis of use of energy including submission of technical report containing recommendations for improving energy efficiency with cost benefit analysis and an action plan to reduce energy consumption".

There are three phases of Energy Audit

1. Pre-audit phase
2. Audit phase
3. Post audit phase

Above phase include following stages

1. Data Collection - In preliminary data collection phase, exhaustive data collection was performed using different tools such as observation, survey communicating with responsible persons and measurements.

Following steps were taken for data collection:

- The team went to each department, centres. Library, canteen etc.
- Data about the general information was collected by observation and interview.
- The power consumption of appliances was recorded by taking an average value in some cases.

2. Data Analysis - Detailed analysis of data collected include calculation of energy consumption, analysis of latest electricity bill of the campus, understanding the tariff plan provided by the Meghalaya Energy Corporation Limited.

3. Recommendation - Based on results of data analysis and observations, some steps for reducing power and water consumption were recommended.

2.1 Pre-audit Phase

Step 1 - Interview with Key Facility Personnel

During the preliminary audit, a meeting is scheduled between the audit team and key operating personnel to start the assignment. The meeting agenda focuses on audit objectives and scope of work, facility rules and regulations, roles and responsibilities of audit team members, and description of scheduled project activities. During this meeting the team enlightened about operating characteristics of the facility, energy system specifications, operating and maintenance procedures.

Step 2 - Facility Tour

After the initial meeting, a tour of the facility is arranged to observe the various operations, focusing on the major energy consuming systems identified during the interview, including the building structure, lighting and power, mechanical energy systems.

Step 3 - Document Review

During the initial visit, available facility documentation is reviewed with facility representatives. This documentation review includes all facility operation and maintenance procedures and logs – sheets/ registers for the previous years.

Step 4 - Facility Inspection

After a thorough review of the construction and operating documentation, the major energy consuming processes in the facility are further investigated. Where appropriate, field measurements are collected to substantiate operating parameters.

Step 5 - Utility Analysis

The utility analysis is a detailed review for the previous months. Data reviewed includes energy usage, energy demand and energy consumption pattern.

2.2 Audit Phase

The energy audit began with the teams walking through all the different facilities at the college, determining the different types of appliances and utilities (lights, Pumps, Equipment, LPG etc.) as well as measuring the usage per item (Watts indicated on the appliance) and identifying the relevant consumption patterns (such as how often an appliance is used) and their impacts. The staff or in charge were interviewed to get details of usage, frequency, or general characteristics of certain appliances.

1. Data collection

Data collection was done in the sectors such as sources of Energy and energy consumption pattern, College records and documents were verified several times to clarify the data received through survey and discussions.

2. Site Tour

Site inspection was done along with staffs in charge (Pump operators, Electricity controller etc).

Review of Documents and Records

Documents such as electricity bills, fuel consumption were collected from the concern staff and reviewed.

3. Site inspection

College and its premises were visited and analyzed by the audit-teams several times to gather information. Number and type of vehicles used by the stakeholders were counted and fuel consumption for each vehicle was verified with the staff. Data related to LPG cylinders used in canteen are also collected.

3. ENERGY SOURCES AND CONSUMPTION AREAS IN THE COLLEGE CAMPUS

There are 10 Science departments, 7 Arts departments, Commerce, Computer Application and Social work as academic centres as well as supporting infrastructures like library, Principal and Administrative office, auditorium, café, Canteen and Hostels.

Sl. No	Basic Building Data	Value
1	Connected Load	139 kW
2	Installed capacity of DG set	50 kVA (1 Nos) 50 kVA (1 Nos)
3	Annual electricity consumption (June 2021 to May 2022)	83131 kWh
4	Annual cost of electricity consumption @6.1/unit	₹ 7,72,710
5	Total Numbers of building covered	2 Nos
6	Working hours (Academic and Administration building)	8 Hrs. (9AM to 5PM)
7	Working Days/week	6 Days
8	Whether sub-metering of electricity consumption for each building	No

3.1 Energy Sources

A dedicated Three phase Transformer has been installed in campus for distribution of power to different parts of the campus.

3.2 Diesel Generator (DG) set

In case of power cut, the power is supplied to fulfil demands with help of Diesel generator (DG) set.

Review of present Diesel Generator (DG) Set:

There are three DG sets with capacity of 50 kVA each. The first two DG set are dedicated to supply power to entire campus except Library block, while the other one is dedicated to supply power to the library block. The salient technical specifications are as follows:

DG set of 50 kVA (2 Nos):

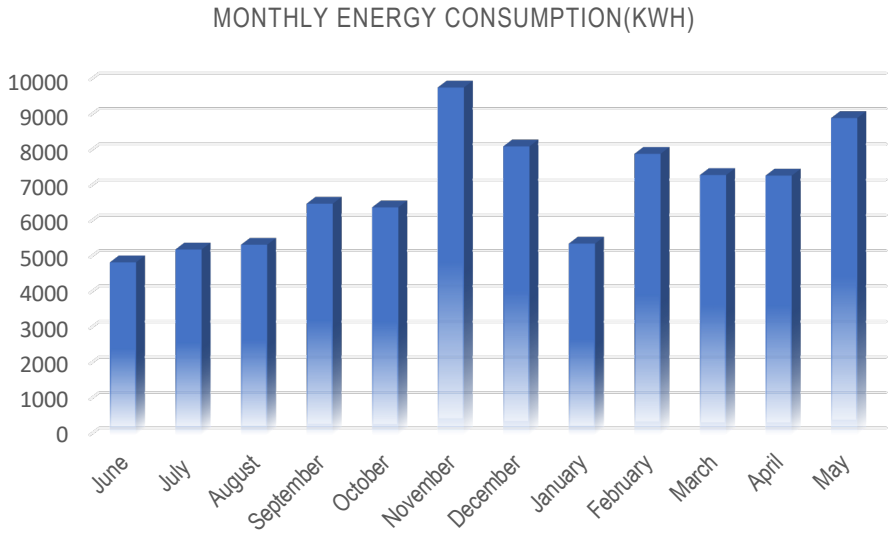
Make:	Kirloskar Oil Engines Limited
Machine No	5H.3045/1320268, 4H.8905/1820897
Rated kVA	50 kVA
Rated kW	2045.63/62
Voltage	380-440 V
Current	69.6 Amps
Frequency	50 Hz
Phase	3 Phase
Ambient	40°C
Excitation	35 V/3.4 Amps

4.0 ENERGY CONSUMPTION

4.1 Details of the monthly energy consumption and energy bill of St Edmund's College are as follows

Annual Electricity consumption in SEC from June 2021 to May 2022		
Months	Unit Consumed (kWh)	Cost in ₹
June	4859	110504
July	5222	49316
August	5356	48846
September	6512	56461
October	6410	55620
November	9787	76481
December	8128	66622
January	5388	49103
February	7918	65355
March	7321	61896
April	7304	60585
May	8926	71921
TOTAL	83131	772710
AVERAGE	**6928**	**64393**

4.2 Graphical representation of monthly electricity consumption.



4. PERFORMANCE EVALUATION, OBSERVATION AND ANALYSIS

5.1 Energy Consumption in various Loads

Presently the College campus relates to the electrical power of the state electricity corporation (MeECL) and own DG set supplying power to different parts of the buildings. The major energy consuming equipment/ utilities available in the building are

- Lighting Load
- Laboratory equipment and other loads
- Water pumps

5.2 Review of Present lighting scenario

The lighting load of most parts of the buildings is in the form of LED (20W). Total number of LED used in the main buildings is 542. The average use of LED/month in peak semester period (8 hours per day for 26 days).

Total power consumption of LED lighting (in kWh) per month average by different departments.

5.3 Cost Analysis of LED light with Conventional tube light

LED	No.	Power	Total power W	Average Use of LED per months (in Hours)	kWh
EVS	16	20	320	208	66.56
Electronics	13	20	260	208	54.08
Zoology	28	20	560	208	116.48
Chemistry	46	20	920	208	191.36
Computer Science	14	20	280	208	58.24
Biotechnology	42	20	840	208	174.72
Biochemistry	68	20	1360	208	282.88
Mathematics	1	20	20	208	4.16
Physics	26	20	520	208	108.16
Botany	53	20	1060	208	220.48
Economics	2	20	40	208	8.32
Khasi	2	20	40	208	8.32
Sociology	2	20	40	208	8.32
Commerce	3	20	60	208	12.48
BCA	14	20	280	208	58.24
MSW	8	20	160	208	33.28
Geography	21	20	420	208	87.36
English	4	20	80	208	16.64
History	2	20	40	208	8.32
Political Science	2	20	40	208	8.32
Common classrooms	175	20	3500	208	728
Total	542		10,840		2,255

Total No. of conventional tube lights in campus = 542

Conventional Tube light average power = 40 W

LED Tube light average power = 20 W

Different in power saved per tube light = (40-20) W = 20 W

Total power saving = 542 x 20 W = 10840 W = 10.84 kW

Average use of tube light per year = 180 x 8h = 1440 h

Energy saves per year = 10.84 x 1440 kWh = 15609 kWh

Per year saving = 15609 x 6.10*= Rs 93657

LED Tube light average cost = Rs 490

Total cost of replacing all conventional tube lights = 542 x 490 = Rs 265580

Payback Period =265580/ 93657 = **2.8 Years**

*(*Rs 6.1 is the rate charged by MeECL per unit beyond 200 units.)*

It requires 2.8 years of time for the college to recover the cost for replacement of LED consumption. This is an initial process of proper management towards sustainable development. From the above information it is concluded that most of the energy used is in form of electricity which leads to the attention for adopting energy conservation equipment. Use of high energy saving lamps instead of ordinary fluorescent t8, auto-diming control system to manage lightning system unified, monitors, used of motion sensors in corridors and toilets are some of the remedies for electricity consumption.

5.4 Laboratory Equipment

Few departments consumed more energy in terms of their usage as per requirement of the laboratory equipment. These departments not only have the maximum number of equipment, but they have few instruments which consume the maximum based on the time of use per day.

DEPARTMENT	TOTAL CUNSUMPTION (kW)
EVS	20.959
Electronics	20.28
Zoology	9.007
Chemistry	7.7135
Biotechnology	29.7125
Biochemistry	16.922

Physics	35.32
Botany	34.229
Total	174.144 kW

Considering 8 hours of usage of equipment as an average, with the point that some instruments were used for 24 hours and some other for only few hours during practical's and other experiments, the consumption in kWh by the equipment alone can be calculated.

Total consumption in kWh = 174.144 kW x 8 h **= 1393.152 kWh**

5.5 Water Pumping System

The campus has total nine (9) numbers of water pumps all of which are used for supplying water to different parts of the campus. Detail specification of water pumps are given below-

2 HP Surface water Pump (2 Nos)	
Make:	Kirloskar Brothers Limited
Pump No	A6ABX000980 AND A5ACN000460
Head Range	15-25 mtr
Power	1.5/2 HP
Voltage	230
Ampere	9.5
Power Consumption VxA	2 kW each
3 HP Surface water Pump	
Make:	Kirloskar Brothers Limited
Pump No	A3LAL00404
Head Range	33-60 mtr
Power	3.7/3 HP
Voltage	440
Ampere	8.5
Power Consumption VxA	3.7 kW
3 HP Surface water Pump	
Make:	Kirloskar Brothers Limited
Pump No	B2GAP00321
Head Range	33-60 mtr
Power	3.7/3 HP
Voltage	440
Ampere	8.5
Power Consumption VxA	3.7 kW
1.5 HP Surface water Pump (2 Nos)	
Make:	Crompton Greaves Limited
Pump No	OLAFC002419 AND PEAFC003343
Head Range	24-54 mtr
Power	1.10/1.50 Kw/HP

Voltage	220
Ampere	8.6
Power Consumption VxA	1.89 kW each
1.5 HP Surface water Pump	
Make:	Aquapump Industries
Pump No	43130927
Head Range	19-26 mtr
Power	1.1/1.5 kW/HP
Voltage	240
Ampere	9
Power Consumption VxA	2.2 kW
1 HP Surface water Pump	
Make:	Kirloskar Brothers Limited
Pump No	G19PPH017280
Head Range	6-28 mtr
Power	750 W/1.02 HP
Voltage	230 V
Ampere	4.5 Amp
Power Consumption VxA	1 kW
0.5 HP Surface water Pump	
Make:	Kirloskar Brothers Limited
Pump No	
Head Range	6-26 m
Power	0.5 HP
Voltage	220 V
Ampere	2 Amp
Power Consumption VxA	0.4 kW

Energy consumption by Water pumps of the campus is calculated below.

Total number of water pumps	**9**
Total Energy consumed by all the pumps	18.78 kW
Hours use daily	2 hours
Daily consumption of energy (kWh)	(18.78 x 2) 37.56 kWh
Total Energy consumed by all the pumps in a month (kWh)	(18.78 x 60) 1126.8 kWh

In a month, water pumps consumed up to 1126.8 kWh. Overall efficiency of the water pumps ranges from 30% to 38% as mentioned in the specification. This is being ignored as the time of usage is low.

If any changes and new installation is required to be done management may take initiative to purchase energy efficient motor (EEM) only.

5.6 LPG Usage

For Cooking purposes, canteen uses LPG as the main source of energy. LPG commercial cylinders were acquired from the local suppliers. The monthly average consumption was estimated based on the peak months of usage by the canteen staffs. During Winter breaks that is the month of December and January, usage is low.

Average No. of LPG Used per month	Weight of LPG (Propane) in Kg	Total weight in a month in Kg
20	**19**	**380**

Total power (of LPG) consumed in a month = *14 x 380 = 5320 kWh

*1 Kg of LPG = 14 kWh (www.flogas.com)

5.7 Petrol and HSD Usage

From the monthly records and bills of the college, the data regarding usage of HSD (High Speed Diesel) and Petrol by the College Busses, cars, DG sets, Gas plant of Chemistry department is given below

Average Litres of Petrol Used Per month	Average Litres of HSD Used Per month
55.8	673.3

*1 litre of HSD (High Speed Diesel) is equal to 10kWh (ballpark figure) and 1 litre of Petrol is equivalent to 8.9 kWh (https://www.nrcan.gc.ca)

Therefore, Power equivalent of the fuel consumed is as following:

Total power of Petrol consumed in a month = 55.8 x *8.9 = 496.6 kWh

Total power of HSD consumed in a month = 673.3 x *10 = 6733 kWh

6. PERFORMANCE ASSESSMENT OF THE DIESEL GENERATOR SETS

To meet the electrical requirement during load shedding or any interception by the gird power, the campus is also generating their own electricity by using three DG sets.

6.1 Fuel Oil Consumption for Electricity Generation

For the performance assessment of the DG sets its need to study specific fuel consumption [SFC= Total fuel consumed (liters)/ total power generated (kW)]. For which at least Twelve (12) months data of monthly fuel consumption and monthly energy generated by the DG set is required to analyze the specific fuel consumption. As monthly energy generation data is not available while the DG set was kept in automatic mode, therefore the performance assessment of DG sets is not able to conduct.

Although the design value of fuel consumption/hr. of 50 kVA DG set are Shown below-

	Load %	Fuel Consumption	Unit
Fuel Consumption	At 100 % load	12.35	Ltr/Hr
	At 75 % load	9.9	Ltr/Hr
	At 50 % load	7.2	Ltr/Hr

6.2 Recommendation:

It is strongly recommended the data recording or data logging of monthly fuel consumption and monthly energy generation practices for both the DG set.

7. Observation and Recommendation

- It has been observed that the college building has one energy meter to measure the electrical energy consumption from the grid. Since the college consist of numbers of departments with high energy consuming equipment, therefore it is recommended to install separate submeter for these departments to identify and energy consumption of each. This will help the management to take energy conservation measures as well as it will help to do the performance assessment of electrical uses.
- Presently the total installed load of the campus is 139 KW (Which include lighting load, Fan load, equipment, pumps and motor etc.) but it is consuming/loading a maximum of 6928 kW per month average in the last financial year (2021-22), it may be due to the maximum classes occurred and use of equipment and lighting has exceeded.
- There is no evidence of recording data of energy generation and consumption by DG set. Management may take initiative to record in the log book for future performance assessment of energy profile of the systems as well as preventive and regular maintenance work. (Please refer annexures for reference)

8. Good Practices

8.1 Guidelines for Energy Management in Buildings

8.1.1 Illumination:

Natural light should be used as far as possible to meet the required illumination level. Especially requirement of artificial light is less during daytime. While using the artificial lights care should be taken so as the lights in each area can be switched off partially when not in use. (e.g., The illumination level required for working on computers is 150 - 300 lux, but when the area is not used for work illumination level of 110 lux is sufficient. (This can be achieved by switching off some of the lights.) Also, proper naming or numbering of the switches will facilitate the use of them by occupants or staff.

8.1.2 Air-Conditioning System

The St Edmund's College campus has 8 air conditioning units as cooling load in the Department of Biotechnology which are 5-star energy rankings.

8.1.3 Preventive Maintenance

Inspect & monitor equipment operations. Maintain regular operation & maintenance log for major equipment. Fix minor problems before they result in major repairs. For this regular inspection of all equipment by trained staff is necessary. If necessary, maintenance shutdown should be taken at least once in 6 months. During this wiring, contacts & other components should be thoroughly inspected for voltage imbalance, loose connections, or self-heating. If major repairs are required, evaluate the economic benefit of replacing the old equipment with more efficient and compact equipment before doing the repairs. Such study should be done well in advance, so that in case of breakdown a decision can be taken quickly. Adjust schedules to keep all equipment on only when necessary. Adjust temperature & humidity set points for AC within comfort zones seasonally.

8.1.4 Training & Awareness

Maintenance & operating staff should be trained / informed about the energy management issues & procedures. To implement an effective preventive maintenance program, the operational staff must be given comprehensive training on each type of equipment, regarding system fundamentals, use of reference material & manuals, maintenance procedures, service guidelines & warranty information. Proper maintenance schedules could be supplied to them for different equipment.

8.1.5 Other Savings

New computers available in the market offer built in power saving modes. These monitors are called as Energy Star compliant monitors. However, it was found that most of the users are not aware of this facility. Therefore, steps should be taken to inform every one of this & any such future options. Switches for computers should be made more accessible, so that employee can turn off their terminals when not in use.

Annexure 1

Data logging format for DG Set:

Month/Year: ……. /……..					Generator Operator Name: ……					
Date	Generator Name	Capacity Location	Time		Meter Reading		Fuel Added	Total Running Hrs	Total Meter Reading	Signature of Operator
			Start	End	Start	End				

Annexure 2

Data logging format for periodic maintenance of DG Set:

Month/Year: ……. /……..			Generator Operator Name: ……			
Date	Lub oil Level	Coolant Level	Fuel Filter	Lub Oil Filter	Battery Water Level	Coolant Filter


ADVANCED
BIOTECHNOLOGY
RESEARCH LABORATORY


SOLAR LIGHT


SOLAR HEATER


CYANOBACTERIA
REPOSITORY FACILITY


KIRLOSKAR
GREEN

Executive Summary of the Report

⇒ The college has 2 (two) feeder lines from Meghalaya Energy Corporation Limited (MeECL) and 3 phase transformer installed at the southern part of the campus for stabilisation/distribution of power supply in the campus.

⇒ The college has 3 (three) diesel green generators installed which supplies power during power disruption due to load shedding and otherwise.

⇒ Solar panel lights are installed in the campus that lighten the campus. Also college hostels are fitted with solar heaters for hot water supply.

⇒ Energy efficient LED lights are installed in all the work places [laboratories, offices, classrooms etc].

⇒ The monthly energy consumption of the college is approximately 6927 kWh during the peak season and the college pays an approximate amount of ₹ 64400/- per month in its electricity bill.

⇒ The monthly consumption of fossil fuel (Petrol/Diesel) for running Generator/Gas plant is approximately 160 litres per month.

⇒ Only one research laboratory uses 5 star rated AC's which are used during warm season to maintain the ambient temperature in the laboratory.

⇒ The college has 9 no's of water pumps that consumes approximately 18.78 kW of energy.

⇒ The transmission electrical lines may be made underground. More numbers of MCB's to be in place to avoid short circuits. Periodical checking and maintenance is recommended especially after rainy seasons.

⇒ The load distributions on the generator set (s) to be balanced equally for smooth running of the sets.

⇒ Faulty connections (if any) to be replaced immediately.

⇒ The lights/exhaust fans to be switched off when not in use to save energy.

⇒ More solar lights may be installed in the campus.

⇒ All instruments/equipment's to be checked frequently to avoid any untoward short circuits/overheating for optimum efficiency.

⇒ The diesel green generators to be serviced frequently.

⇒ Energy efficient motors (EEM) to be installed for pumping of water for optimum distributions.