JUNE 24, 2024

A REPORT
ON
ENERGY AUDIT IN BIKALI COLLEGE, DHUPDHARA

SUBMITTED TO
THE PRINCIPAL
BIKALI COLLEGE
P.O. DHUPDHARA, P.S. DHUPDHARA
DIST. GOALPARA, PIN-783123 (ASSAM)

SUBMITTED BY
ADD SQUARE SOLUTIONS
VILL: DEURIPARA (BEHIND DEEO OFFICE, BONGAIGAON),
P. O+DIST: BONGAIGAON, ASSAM-783380

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We are sincerely thankful to the Bikali College management for giving us the opportunity to conduct energy audit.

We are also grateful to Dr. Monoj Gogoi, Principal, Bikali College, Assam whose valuable comments / feedback, during various reviews have helped us to bring the report in the present format.

We express our sincere gratitude to all other concerned officials for their support and guidance during the conduct of this exercise.

For Add Square Solutions

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(Proprietor)

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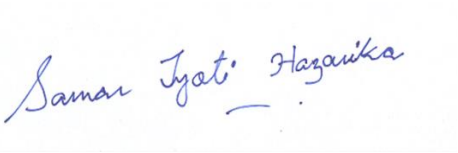

Mr. Samar Jyoti Hazarika
B.E. E Certified energy auditor (EA15266)

1. BACKGROUND:

Energy consumption in different forms has been continuously rising almost in all the sectors- agriculture, industry, transport, commercial, residential (domestic) and educational institutions. This has increased the dependency on fossil fuels and electricity. Therefore, energy efficiency improvement and possible energy conservation became a necessary objective for energy consumers. 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. Bikali College, an educational institute in Goalpara district of Assam taking initiative for reducing energy intensity in the college campus and entrusted Add Square Solutions for conducting energy audit. To conduct the energy audit, the audit team visited the campus on 6th of June 2024 to collect data and to take some measurement for assessment of different energy consuming components.

2. SCOPE OF WORK

2.1 Assessment of actual operating load and scope for optimizing the same

- Review of present electrical load in the campus
- Assessment of building wise electrical load based on electrical fittings

2.2 Illumination study and energy conservation option in lighting system

- Review of present lighting system, lighting inventories etc. Estimation of lighting load at various locations like different building floor, corridor, rooms etc. outside light and other important locations as mentioned by the management.
- Detail lux level study at various locations and comparison with acceptable standards.
- Study of present lighting system and recommendation for improvement.
- Exploring energy conservation options in lighting system.

2.3 Energy Conservation in Air-Conditioning and water pumping system

- Observation and energy conservation.
- Exploring Energy Conservation Option (ENCON) in system.

2.4 Diesel Generator (DG) Sets

- Review of DG set operation
- Performance assessment of DG sets in terms of Specific Fuel Consumption (SFC i.e. Lit/kWh).

3. METHODOLOGY ADOPTED FOR ENERGY AUDIT

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 project 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 are 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.

Step 6 - Identify/Evaluate Feasible ECMs

Based upon a final review of all information and data gathered about the facility, and based on the measurements final energy conservation measures is developed.

Step 7 - Prepare a Report Summarizing Audit Findings

The results of our findings and recommendations are summarized in this report. The report includes a description of the facilities and their operation, a discussion of all major energy consuming systems, a description of all recommended ECMs with their specific energy impact. The report incorporates a summary of all the activities and effort performed throughout the project with specific conclusions and recommendations and ECMs – Energy Conservation Measures

4. BUILDING DESCRIPTION

The Bikali College campus consisting of multiple buildings. The following Tables show the basic information about the building and the utilities.

Sl. No	Basic Building Data	Value
1	Connected Load/ Contract Demand For College Campus Consumer number: 38000012748 Consumer number: 38000012749 Consumer number: 38000012752 For Boy's Hostel Consumer number: 38000012750 For Girl's Hostel Consumer number: 38000012751	 8kW/8kVA 13kW/13 kVA 4kW/4kVA 2kW/2kVA 7kW/7 kVA
2	Installed capacity of DG set	20 kVA (1 No) Make: Kirloskar Oil Engine Limited
3	Electricity consumption (April' 2023 to March' 2024) For College Campus	

	Consumer number: 38000012748	19,716 kWh
	Consumer number: 38000012749	2,453 kWh
	Consumer number: 38000012752	3,564 kWh
	Total consumption (College campus)	**25,733 kWh**
	For Boy's Hostel	
	Consumer number: 38000012750	7,887 kWh
	For Girl's Hostel	
	Consumer number: 38000012751	14,693 kWh
4	Cost of electricity consumption (April' 2023 to March' 2024) For College Campus	
	Consumer number: 38000012748	₹ 1,80,609.00
	Consumer number: 38000012749	₹ 47,923.00
	Consumer number: 38000012752	₹ 38,590.00
	Total consumption (College campus)	**₹ 267,122.00**
	For Boy's Hostel	
	Consumer number: 38000012750	₹ 69,882.00
	For Girl's Hostel Consumer number: 38000012751	₹ 1,35,702.00
	Annual cost of electricity consumption through DG set. (April' 2023 to March' 2024)	₹ 36,000.00
	Total cost of electricity (Utility + DG set)	₹ 5,08,706.00
5	Total numbers of building covered	8 Nos
5.1	Working hours (Academic and Administration building)	8 Hrs (9 AM to 5PM)
5.2	Working hours (Hostel building)	24 Hr x7 days
5.3	Working Days/week	6 Days
6	Whether sub-metering of electricity consumption for each building	No

Table 1: Basic Building Description

5. PRESENT ENERGY SCENARIO

5.1 Review of analysis of electricity bill of Bikali College.

At present the overall energy consumption is catered by the electricity supply from Assam Power Distribution Company Limited and own DG sets. The entire load of the college and hostel buildings are connected through 5 different electrical connections from the APDCL. Out of these, 3 connections are for the college campus and remaining 2 for boy's and girl's hostels respectively (detail mentioned in table no 1). One 20 kVA DG set is used to supply power during load shading hours.

5.1.1. Energy Consumption.

The total energy consumption from April' 2023 to March' 2024 was 48,313.00 kWh and the total electricity bill paid to distribution company was ₹ 4,72,706.00. The total monthly electricity consumption and electricity bill paid from April' 2023 to March' 2024 has shown in fig.1 and fig. 2 respectively.

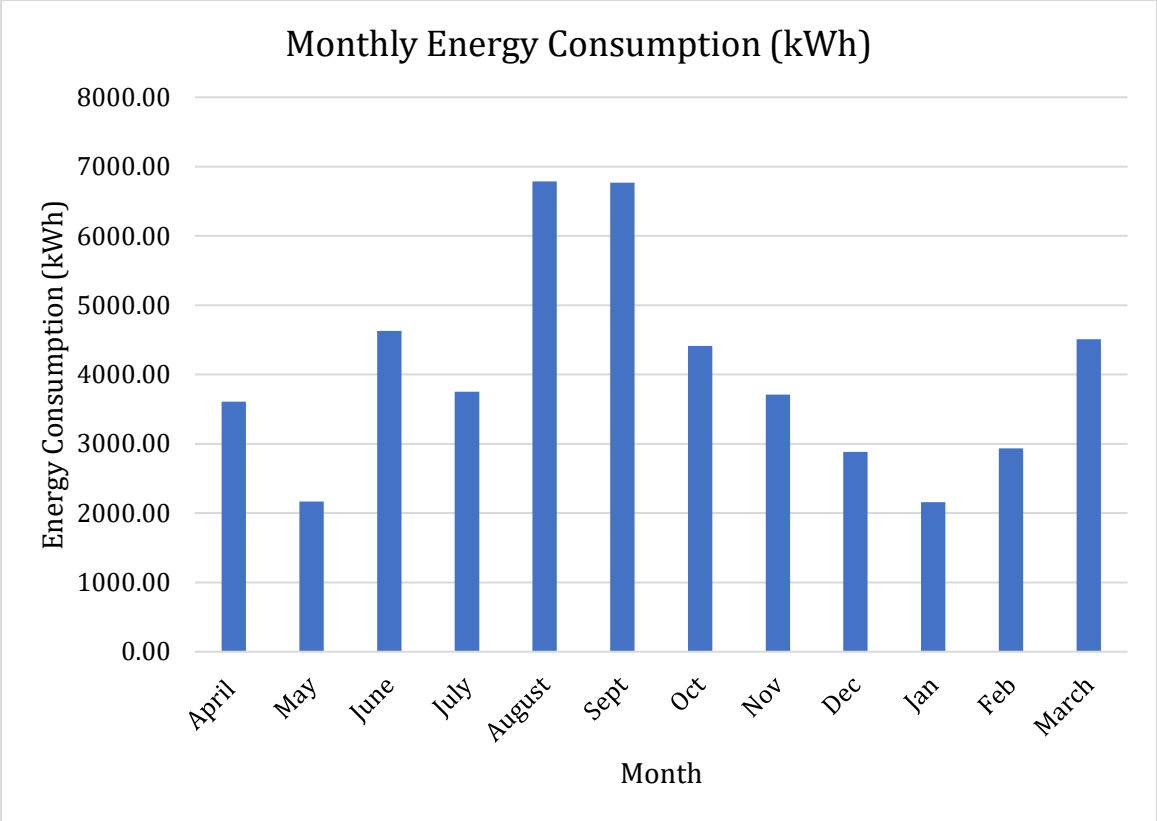

Figure 1: Monthly energy consumption from April' 2023 to March' 2024 (kWh)

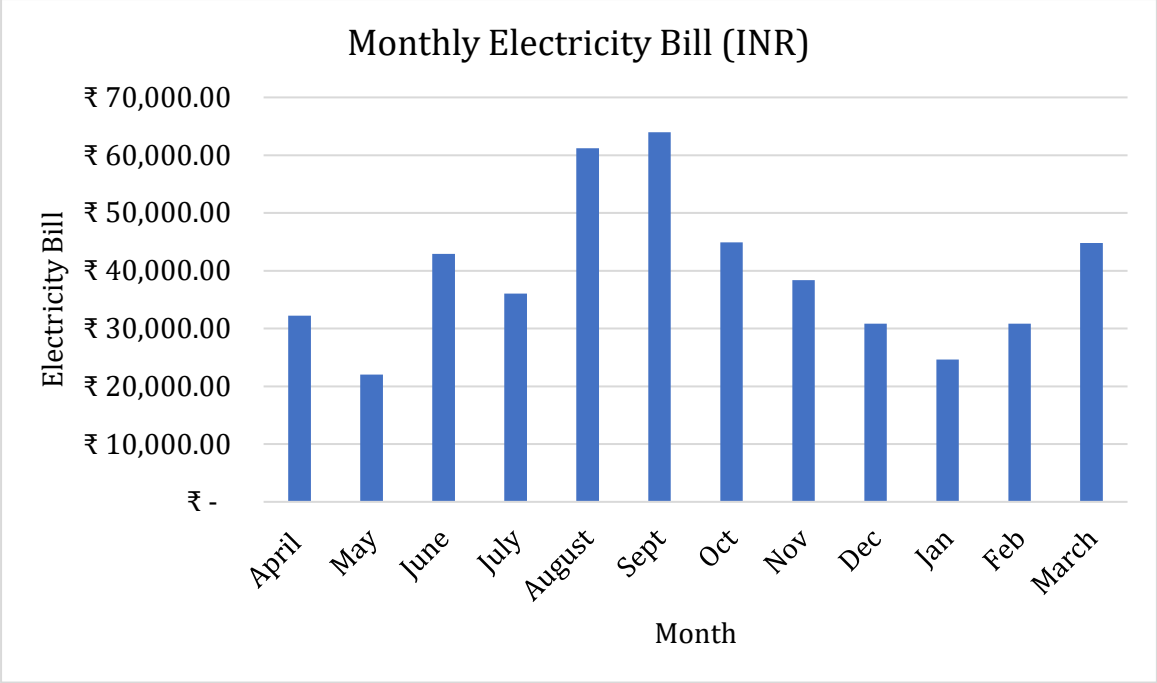

Figure 2: Monthly Electricity Bill from April' 2023 to March' 2024 (Rupees)

As the entire load of the campus is connected with 5 different electrical connections with different consumer numbers, therefore a consumer number wise monthly energy consumption and electricity bill paid from April' 2023 to March' 2024 has shown in fig.3 and fig. 4 respectively.

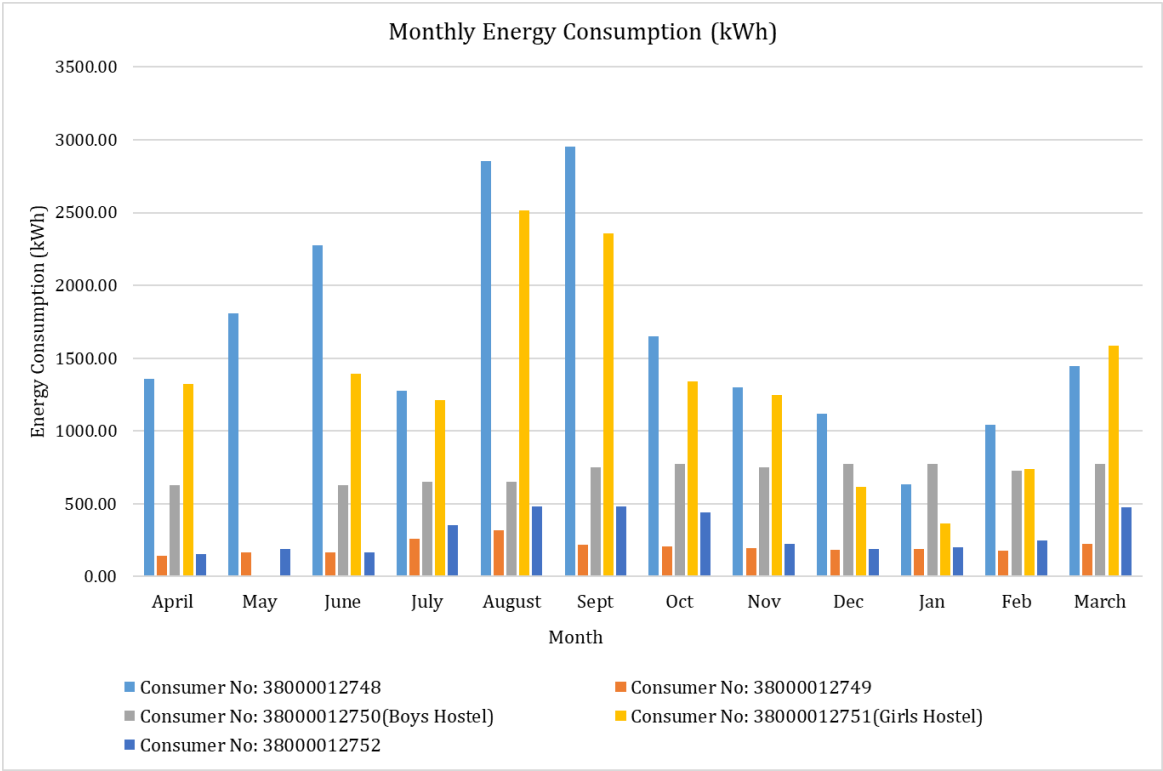

Figure 3: Monthly energy consumption from April' 2023 to March' 2024 (kWh)

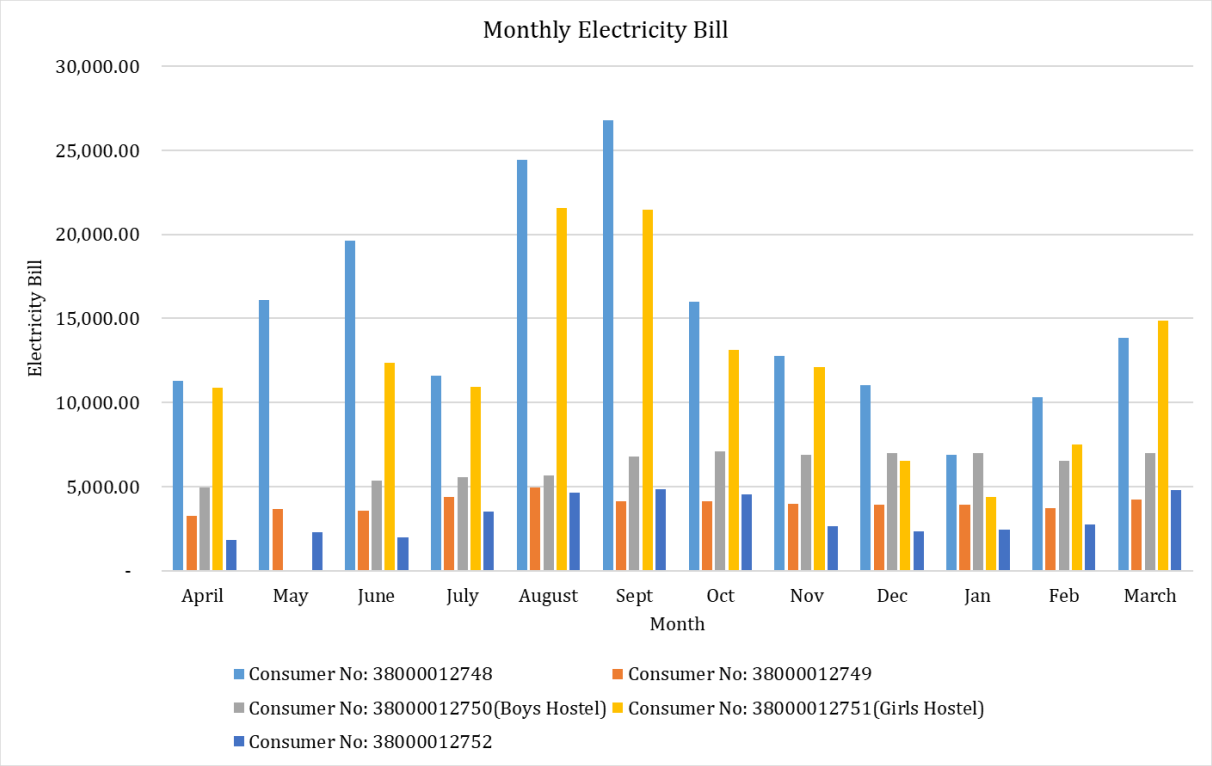

Figure 4: Monthly Electricity Bill from April' 2023 to March' 2024 (Rupees)

6. PERFORMANCE EVALUATION, OBSERVATION AND ANALYSIS

6.1 Assessment of Actual Operating Load and Scope for Optimizing

6.1.1 Energy Consumption in various Loads

The major energy consuming equipments/ utilities available in the building are-

- Lighting Load
- Cooling Load/ Fan & Air Conditioner
- Other Load (Computer/Laptop/projectors and digital classroom equipment)
- Water Pump

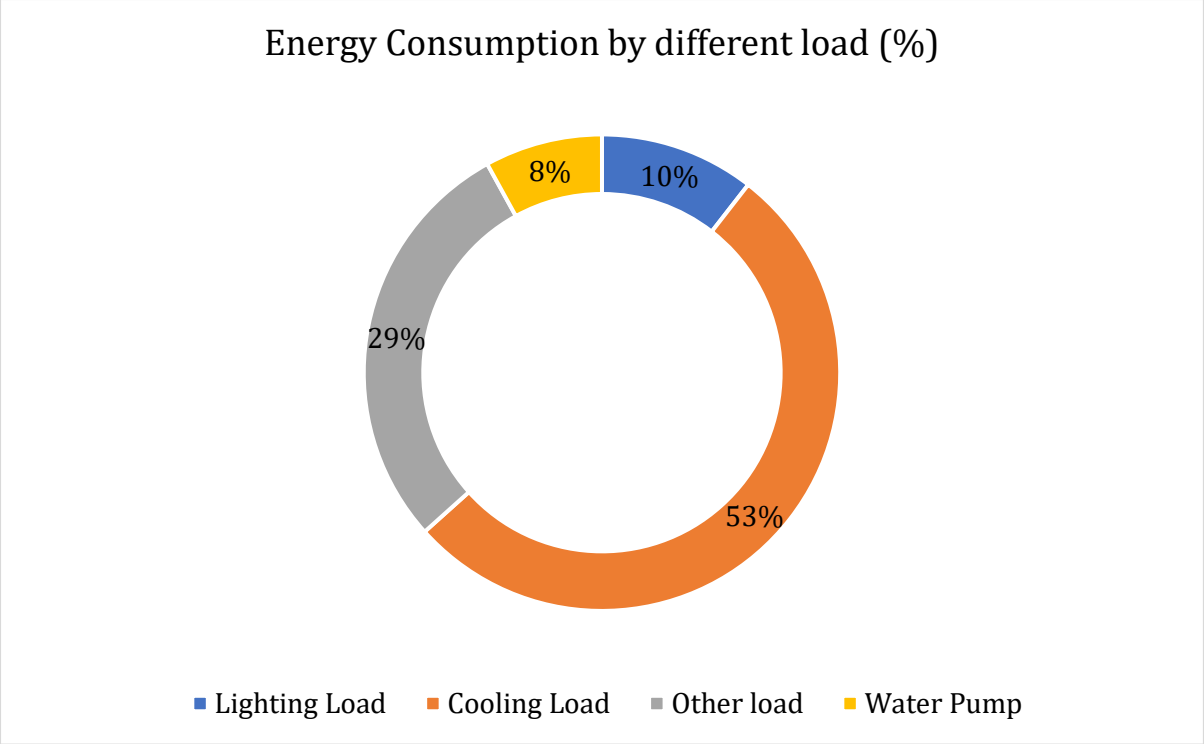

Figure 5: Energy consumption by different load

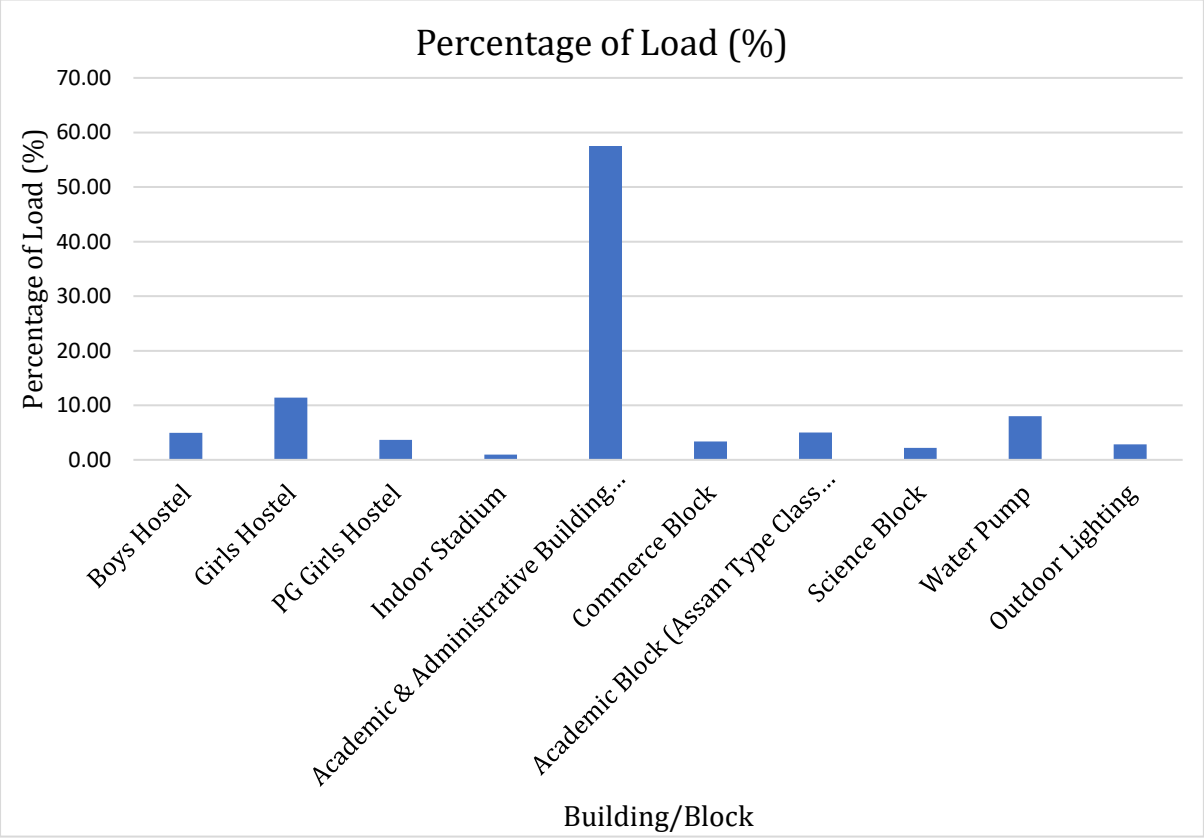

Figure 6: Building wise load profile

6.2 Observation and Recommendation

- It has been observed that the total installed load of the campus is on higher side than the total connected load.
- Cooling load dominates the 53% of the total load of the campus which leads major energy consumption during summer season. Energy conservation measures in air conditioner and fans will reduce the energy consumption.

Illumination Study and Energy Conservation in Lighting System:

6.2.1Review of Present Lighting Loads

Lighting contributes about 10 % of total load of the campus. The lighting load of the campus is consisting of 9-Watt LED bulb and 20 W LED tube light to illuminate the workplace.

6.2.2 Lux Level Survey

The building wise and floor wise lux level is measured by the portable lux meter (Make: Fluke, Model: Fluke 941). For building energy audit the parking area is normally excluded. Location/Floor/ Room/ area wise Lux level was measured and the details are as follows:

It has been observed that most of the area surveyed receives a good amount of day light if all windows and curtains are open, which implies lesser use of artificial lighting.

Major Working Area	Luminaries used	Wattage	Average lux level (Lux)
Class Room	LED Bulb/LED Tube	9W/20W	130
Library	LED Bulb/LED Tube	9W/20W	144
Office	LED Bulb/LED Tube	9W/20W	123
Conference hall	LED Bulb/LED Tube	9W/20W	88.5
IQAC	LED Bulb/LED Tube	9W/20W	291
Hostel	LED Bulb/LED Tube	9W/20W	285

Table 2: Illumination level of different working areas

OBSERVATIONS

- Since educational institutes are working mainly on day time, therefore illumination study was carried out during day time only and it is observed that if

all windows are open and curtains are kept open, the working area or the study area covers adequate illumination level.

- It is also observed that, some part of the study area in Library and class room there is not adequate day lighting which leads to dependence on artificial lighting. This will increase the use of energy and operating cost to meet up the standard illumination level.

RECOMMENDATION

- Inculcate discipline and sense of participation in the energy conservation movement, any unnecessary lighting during day period should be avoided through awareness programmes.
- Intensive monitoring/inspection in order to ensure the minimum use of artificial light.
- It is recommended that all luminaries should be converted to energy efficient LED as an energy conservation measures, if any.
- Area specific use of task lighting specifically where the back ground illumination is not required.
- Installation of master switch outside in each room which will help to switch off all electrical appliances during non-working hour.
- Installation of occupancy sensors so that the lighting systems are controlled by this smart occupancy sensor.
- Installation of motion sensors so that unnecessary energy consumption can be reduced.

Use of natural day light:

Priority should always be given to utilize maximum natural lighting for day-to-day activities.

Some of the methods to incorporate day lighting are-

- Innovative design of buildings to receive maximum day light keeping minimum heat generation inside the building.
- Natural light from windows should be used. However, it should be well designed to avoid glare.

- Use of atrium with FRP dome in in the basic architecture can eliminate the use of electric lights in passage
- Tubular daylight devices to maximize the use of daylight which will reduce the energy consumption.

It is recommended to use standard practice of illumination level as follows (As per IES standard)

Type of interior/activity	Standard illumination Level (Lux)
Libraries	
Shelves, book stacks	150
Reading table	300
Staff rooms, student rooms\students hostels etc	
Gymnasium	300
Assembly halls general	300
Teaching spaces general	300
INDOOR SPORTS AND RECREATIONAL BUILDING MULTIPURPOSE SPORTS HALLS	
Athletics, basketball, bowls, judo	300
Hockey	700
BADMINTON COURTS	300
PUBLIC AND EDUCATIONAL BUILDING ASSEMBLY AND CONCERT HALLS	
Theatre and concert halls	100
Multipurpose	500
FURTHER EDUCATION ESTABLISHMENT	
Lecture theatres general	500
Chalkboard	500
Demonstration benches	500
Examination halls, seminar rooms, teaching spaces	500
Laboratories	500

Table 3: Standard Illumination Level

REVIEW OF PRESENT COOLING LOADS

Ceiling fans as used as primary source of cooling in India. However, it is also one of the major energy consumers. In Bikali College 53% of total installed load is dominated by cooling load. Therefore, it is much essential to identify the energy conservation opportunities in cooling loads. These cooling load includes ceiling fans and Air Conditioners. Most of the ceiling fans installed are normal ceiling fans.

6.3.1 ENERGY CONSERVATION IN COOLING SYSTEM

Air Conditioning System

- Air conditioning system should be as per Bureau of Energy Efficiency (BEE) star rating guidelines. The star rating is related to Energy Efficiency Ratio (EER). Higher the star rating, higher is the EER and lower the power consumption.

- Thermostat temperature setting plays important role for efficient operation of air conditioning system. Thermostat controls the start and stop of compressor and condenser motors. Power consumption of air conditioning system depends on running period of these two motors. Higher the Run/Rest ratio of compressor, more is energy consumption. It is estimated that rising of temperature setting by 10C, results in reduction of about 2.5 % in energy consumption.

- Restrict the entry of heat from outside into the room. Air conditioning systems are used when outdoor is very hot. If this external heat enters the room, the machine has to draw out this additional heat to attain temperature as per setting which results in longer running of compressor consuming more energy.

- Door and window should remain closed when air conditioning system is running. Any vent or gap in door/window/partition should be sealed to avoid transfer of air. Door seal strip available in the market may be used to fix the gap between bottom of door and floor. Door closer may be installed to avoid instances of open door by mistake.

- Wasteful running of air conditioner in absence of occupant may be avoided by installing occupancy sensors.

- Periodic maintenance of air conditioning systems by cleaning air filters of internal unit.

- Checking and cleaning if any blockage, which may restrict air flow resulting in less heat transfer and lesser cooling and longer compressor operation.

- Regular checking of gas pressure, gas or any other leakages.

Ceiling Fans

- Proper monitoring to avoid any unnecessary running of ceiling fans.

- Wasteful running of fans in absence of occupant may be avoided by installing occupancy sensors.

- Install or replace the existing ceiling fans with energy efficient ceiling fans (example: BLDC fans) considering the replacement cost factor. The new energy efficient ceiling fans will reduce up to 50% of the total energy bill incurred by the cooling load.

Advantages of BLDC fans:

- Traditional or normal ceiling fans run on AC motors, on the other hand fans with BLDC technology use brushless DC engines that cut a significant amount of power consumption.
- Longer lifespan and do not get overheated.
- There is no hidden maintenance cost involved in the replacement of brushes carbon brushes are absent in BLDC fans.
- BLDC fans maintain high torque to secure high-quality performance.
- A BLDC fan has zero friction, hence creating minimal noise.

6.4 Diesel Generator (DG) Set

6.4.1 Review of present Diesel Generator (DG) Set:

A 20 kVA DG sets are installed in the college campus. The salient technical specifications are as follows:

Make	20 kVA Kirloskar Oil Engine Limited
Model No	KG1-20WS
Rated kVA	20
Rated kW	16
Voltage	230 V
Frequency	50 Hz

Table 4: Diesel Generator Set Technical Specification

6.4.2 Performance assessment of the Diesel Generator sets:

For the performance assessment of the DG sets its need to study specific fuel consumption [SFC= Total fuel consumed (litres)/ 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, therefore the performance assessment of DG sets is not able to conduct. Although the design value of fuel consumption/hr are Shown below-

Load Condition	Fuel Consumption(lit/hr)
At 100% Load	5.1
At 75% Load	3.8
At 50% Load	2.7

Table 5:Fuel Consumption of DG sets (Design Value)

Recommendation:

It is strongly recommended the data recording or data logging of monthly fuel consumption and monthly energy generation practices for the DG set. A typical data logging format is given as ANNEX 1.

6.5 Water Pumping System:

8% of the total load contributes by the water pumps. These water pumps are submersible and surface water pumps. Due to submersible in nature proper specification of the water pumps were not able to identify.

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

7. GOOD ENGINEERING PRACTICES

7.1 Guidelines for Energy Management in Buildings

7.1.1 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.

7.1.2 Use of Efficient Lighting Technology

The college campus has already took the initiative to convert all inefficient luminaries to energy efficient LED tube lights and LED bulbs.

7.1.3 Air-Conditioning System

The Bikali College campus has very less number of air conditioning units as cooling load. It is recommended to use 5 star rating air conditioning unit.

7.1.4 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.

7.1.5 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.

7.1.6 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.

8. INTEGRATION OF RENEWABLE ENERGY IN COLLEGE CAMPUS:

8.1 INITIATIVE ALREADY TAKEN

To minimize the dependency on electrical energy consumption from conventional energy sources, energy generation and utilization from the renewable energy sources has been adopted. Initially the college has installed one solar street light to replace the conventional street light in girls' hostel.

ANNEX 1

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

DATA LOGGING FORMAT FOR PERIODIC MAINTENANCE.

ANNEX 2

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