JUNE 19, 2023

A REPORT
ON
ENERGY AUDIT IN NAZIR AJMAL MEMORIAL COLLEGE OF EDUCATION

SUBMITTED TO
THE PRINCIPAL
NAZIR AJMAL MEMORIAL COLLEGE OF EDUCATION
JUGIJAN ROAD, BARPUKHURI, HOJAI, DIST.-HOJAI,
ASSAM, INDIA, PIN-782435

SUBMITTED BY
ADD SQUARE SOLUTIONS
VILL: DEURIPARA (BEHIND DEEO OFFICE, BONGAIGAON),
P. O+DIST: BONGAIGAON, ASSAM-783380
(ISO 9001:2015 CERTIFIED ORGANIZATION)

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We are sincerely thankful to the Nazir Ajmal Memorial College of Education management for giving us the opportunity to conduct energy audit.

We are also grateful to Dr. Ashis Saha, Principal, Nazir Ajmal Memorial College of Education, 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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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.

Nazir Ajmal Memorial College of Education, an educational institute of Ajmal Foundation in Hojai district of Assam taking initiative for reducing energy intensity in their college campus and entrusted Add Square Solutions for conducting Energy Audit. To conduct the energy audit, the audit team visited the campus on 13th May 2023 to collect data and to take necessary 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 campuses.
- Assessment of building wise/block wise electrical load base on electrical appliances.

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 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 BUILDING 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 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.

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 Nazir Ajmal Memorial College of Education consists of a multi stored building. The following Tables show the basic information about the building and the utilities.

Sl. No	Basic Building Data	Value
1	Consumer Number: 125010060408 A. Connected Load B. Contract Demand	 170 kW 80 kVA
2	Installed capacity of DG set	82.5 kVA (1 No) Make: Kirloskar Oil Engines Limited Model: KG1-82.5 WS1 62.5 kVA (1 No)

		Make: Kirloskar Oil Engines Limited Model: KG1-62.5 WS
3	Electricity consumption (April' 2022 to March'2023)	61,556.34 kWh
4	Cost of electricity consumption (April' 2022 to March' 2023) @ 7.60/unit	Rs. 6,99,906.00
4.1	Approximate cost of electricity consumption through DG set. (April' 2022 to March'2023) (Considering monthly average diesel consumption of 100 ltr. And Price of diesel as Rs. 89/ Ltr) *Note: Approximate value of diesel consumption derived from 4 months diesel consumption data.*	Rs. 1,06,800.00
4.2	Total cost of electricity (Utility + DG set)	Rs. 8,06,706.00
5	Total numbers of block covered	12 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 ANALYSIS OF ELECTRICITY BILL OF NAZIR AJMAL MEMORIAL COLLEGE OF EDUCATION.

At present the overall energy consumption is catered by the electricity supply from Assam Power Distribution Company Limited and own DG sets. The college has electrical connection having consumer number 125010060408 with connected load

170 kW. The college also has 2 numbers of DG sets with individual capacity of 82.5 kVA and 62.5 kVA to supply electricity during power cut.

5.1.1. ENERGY CONSUMPTION.

The total electricity consumption from April' 2022 to March'2023 was 61,556.34 kWh and the total bill paid to distribution companies was Rs. 6,99,906.00

Monthly electricity consumption(kWh) and electricity bill (Rs.) paid from April' 2022 to March'2023 has shown in figures below.

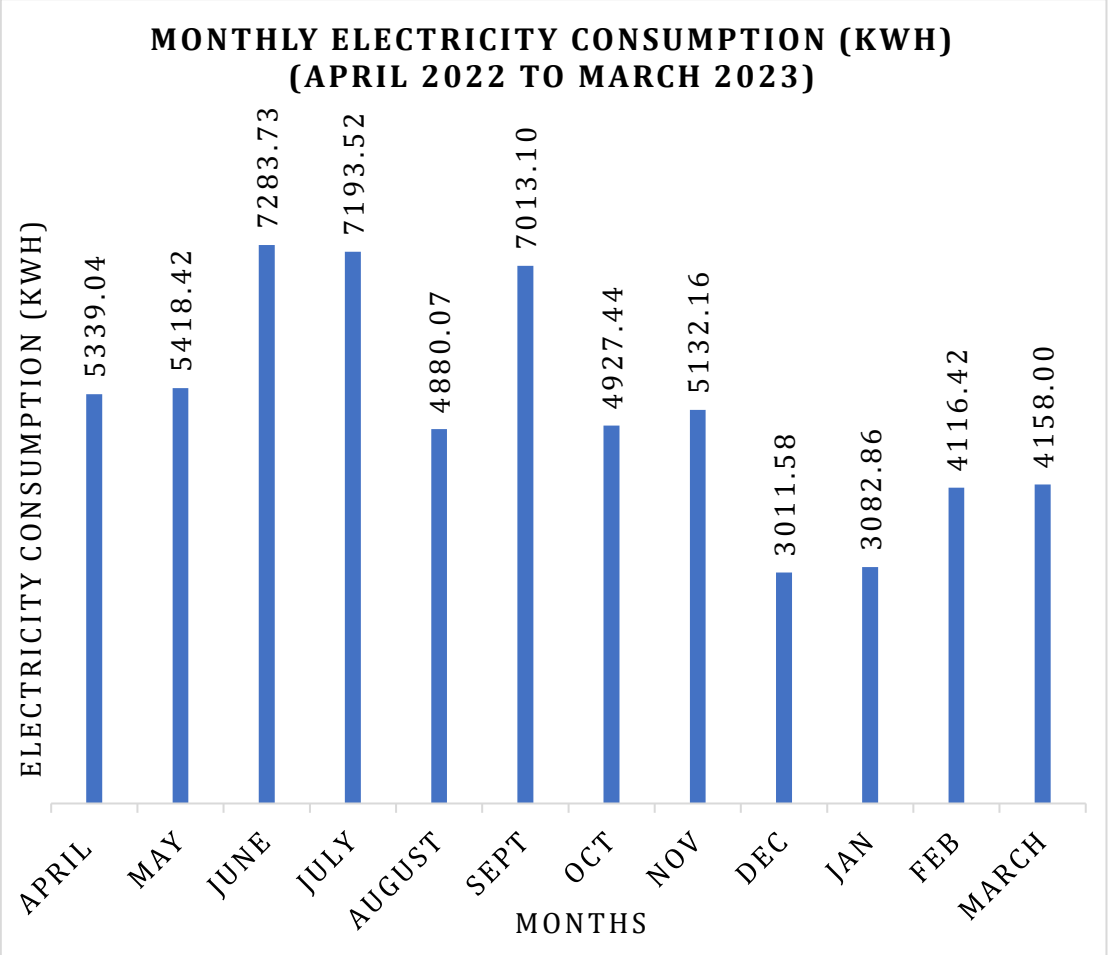

Figure 1: Monthly Electricity Consumption (Consumer Number: 125010060408)

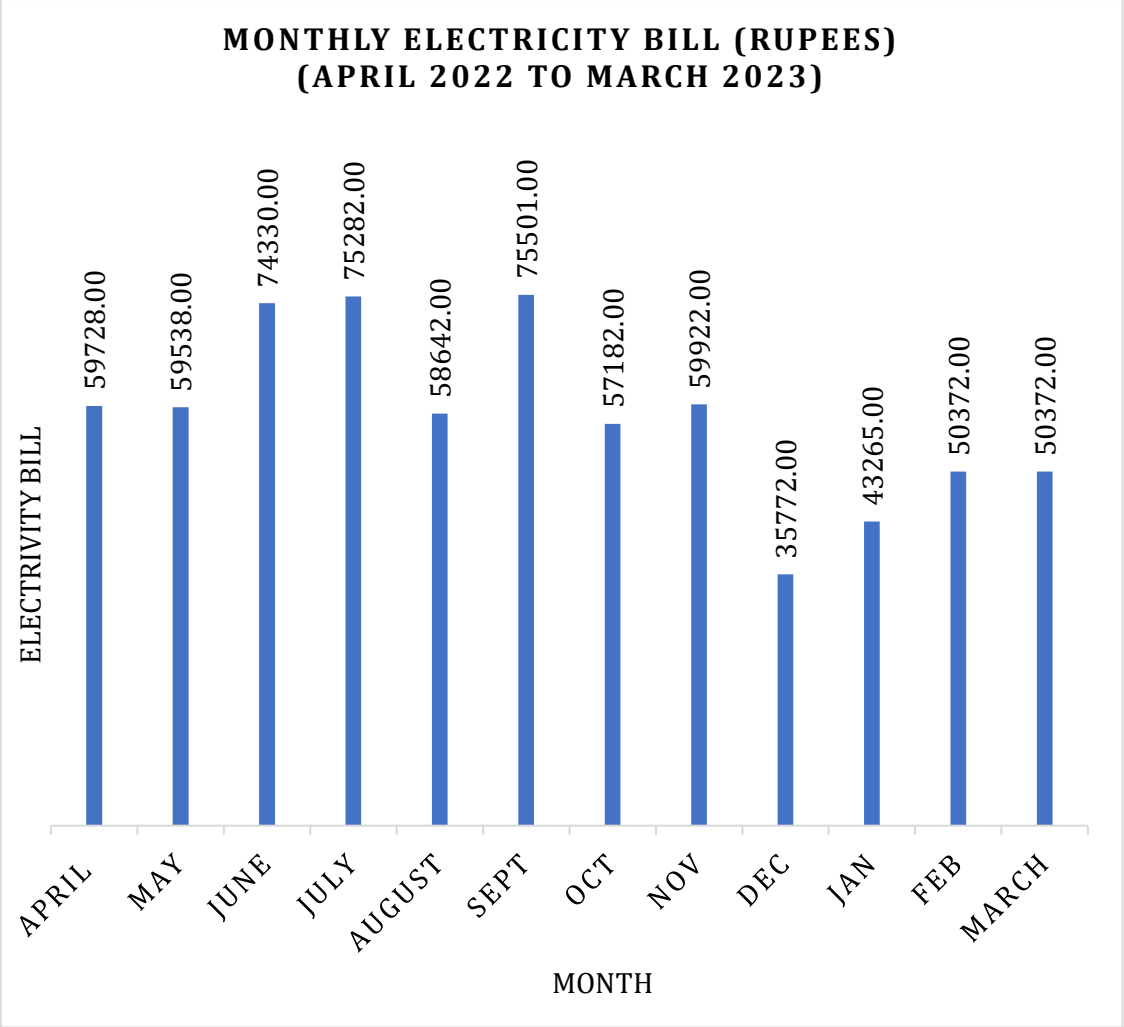

Figure 2:Monthly Electricity Bill (Consumer Number: 125010060408)

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 equipment/ utilities available in the building are-

- Lighting Load
- Cooling Load/ Fan
- Other Load (Computer/Laptop/Printer/Photostat machine)
- Water Pump

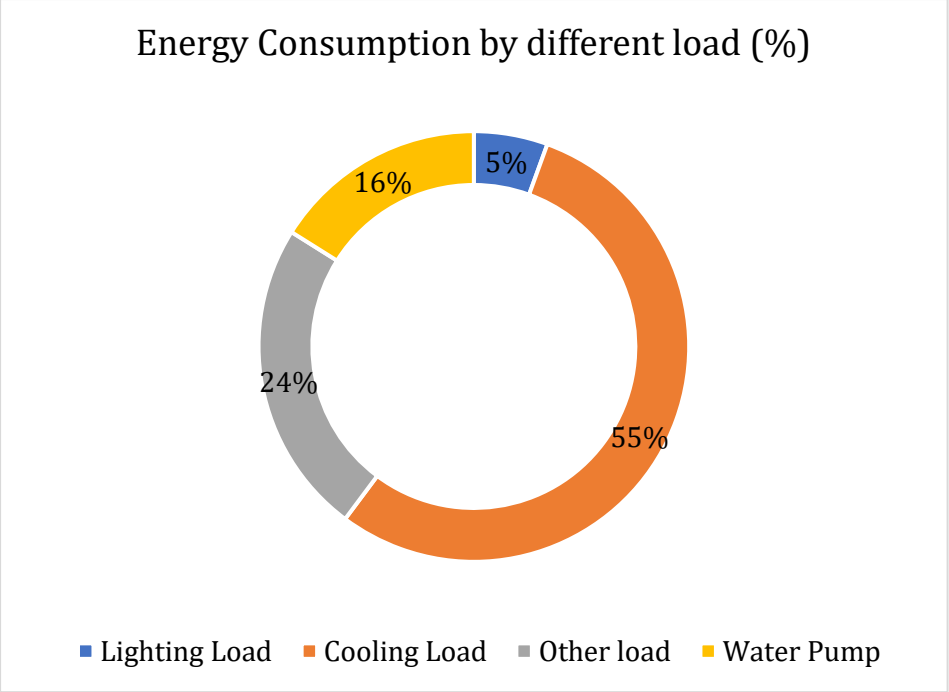

Figure 3: Energy consumption by different load

6.1.2 BUILDING WISE ESTIMATION OF LOAD:

Nazir Ajmal Memorial College of Education comprises various load. A detail assessment was carried out during audit period considering all the loads installed in the building. A building wise/block wise estimation (as shown in fig.4) has been made to understand the load profile which will further help to estimate the electrical energy requirement by the individual buildings/blocks in the campus.

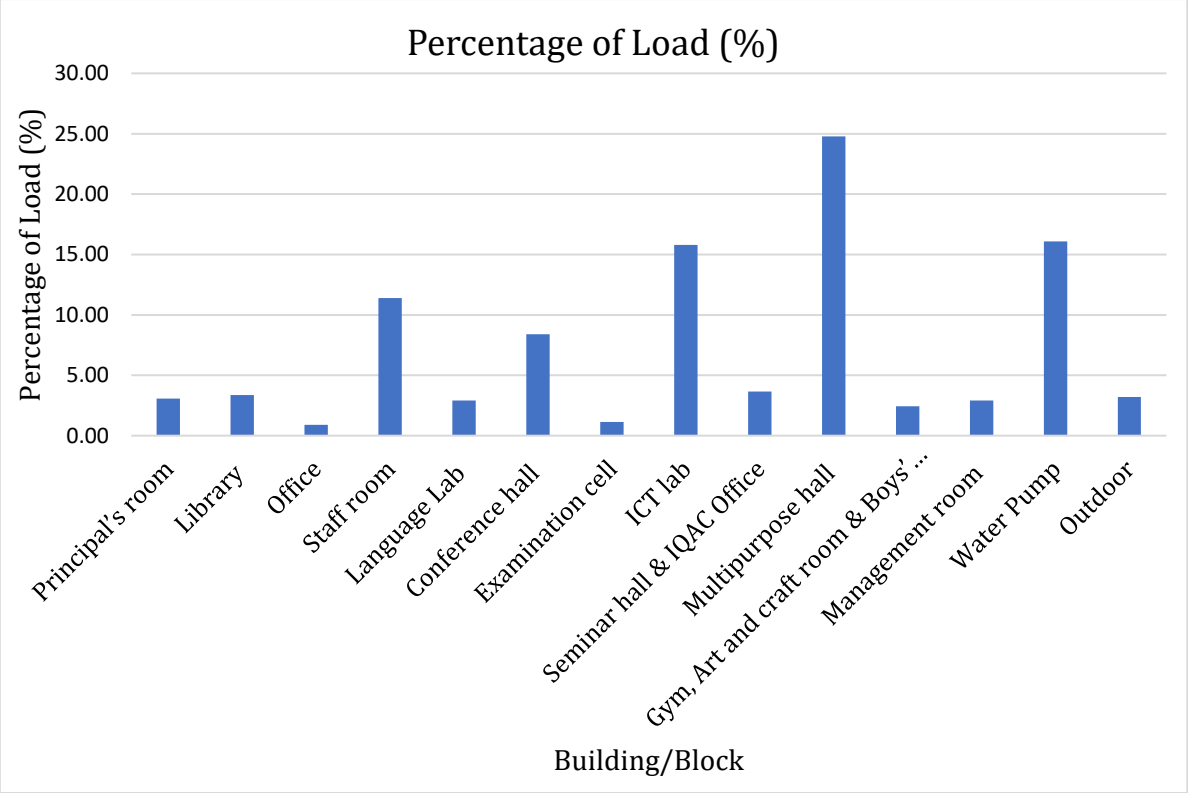

Figure 4: Building wise estimation of Load

6.2 OBSERVATION AND RECOMMENDATION

- At present the total installed load of the campus include lighting load, fan load, motor load etc. Out of these loads, most of the loads are used on occasional basis, except some areas where energy uses are in regular basis.
- There is no evidence of recording data of energy generation 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.

ILLUMINATION STUDY AND ENERGY CONSERVATION IN LIGHTING SYSTEM:

6.2.1REVIEW OF PRESENT LIGHTING LOADS

Lighting contributes about 5.55 % of total load in the campus. The lighting load of the campus is consisting of 12-Watt LED bulb and 20 W LED tubes. It has also been observed that, almost all the luminaries have already been converted to energy efficient LED lights. It is recommended to consider energy efficient luminaries if any changes or new installation required.

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)
Principal's room	LED Bulb/LED Tube	10W/20W	130
Library	LED Bulb/LED Tube	10W/20W	144
Office	LED Bulb/LED Tube	10W/20W	110
Staff room	LED Bulb/LED Tube	10W/20W	152
Language Lab	LED Bulb/LED Tube	10W/20W	131
Conference hall	LED Bulb/LED Tube	10W/20W	88.5
IQAC	LED Bulb/LED Tube	10W/20W	291
Class Room	LED Bulb/LED Tube	10W/20W	285
Seminar hall	LED Bulb/LED Tube	10W/20W	164.8
Multipurpose hall	LED Bulb/LED Tube	10W/20W	184
Art and craft room	LED Bulb/LED Tube	10W/20W	553
Management room	LED Bulb/LED Tube	10W/20W	210.5

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, laboratory 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\student's 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

6.3 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 Nazir Ajmal Memorial College of Education, 55% 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:

There are 2 (two) numbers of DG sets installed in the college campus which covers all the loads of the campus. Out of these two, one DG set runs at a time while the other is kept as stand by.

The salient technical specifications are as follows:

Technical Specification	DG 1	DG 2
Make	Kirloskar Oil Engines Limited	Kirloskar Oil Engines Limited
Model	KG1-62.5 WS	KG1-82.5 WS
Rated kVA	62.5	82.5
Rated kW	50	66
Voltage	230 (Single Phase) & 415 (Three Phase)	415 (Three Phase)
Frequency	50	50
Power Factor (Lagging)	0.8	0.8
Specific Fuel Consumption (SFC)	At 100% load-14.1 ltr/hr At 75% load-11.3 ltr/hr At 50% load- 7.5 ltr/hr	At 100% load-18.8 ltr/hr At 75% load-13.8 ltr/hr At 50% load- 9.9 ltr/hr

Table 4:Diesel Generator Set Technical Specification

6.4.2 PERFORMANCE ASSESSMENT OF THE DIESEL GENERATOR SETS:

It has been observed that, regular log sheet is maintaining by the operation and maintenance department, keeping record of fuel issued, fuel filled up and running hours.

For the performance assessment of the DG sets it needs to study specific fuel consumption (SFC). [SFC= Total fuel consumed (litres)/ total power generated (kWh)]. 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 record is not available, therefore the performance assessment of DG sets is not able to conduct. Although as per design value, the fuel consumption of installed DG sets is mentioned in the table no. 4.

Recommendation:

- It is strongly recommended to add the parameter of “fuel level before fuel input” in the existing log sheet or maintain the record of “closing fuel in” column in the existing log sheet.
- It is recommended to keep the record of energy generation data (monthly basis) from the energy meter (kWh meter) of the generator set (if available). If energy

meter (kWh meter) is not available, then it is suggested to make necessary arrangement to install the same after consultation and proper guideline from the manufacturer or supplier of the DG sets.

6.4.3 ENERGY CONSERVATION MEASURES FOR DG SETS

- Ensure steady load conditions on the DG set avoiding fluctuations, imbalance in phases, harmonic loads and provide cold, dust free air intake.
- Improve air filtration
- Ensure fuel oil storage, handling and preparation as per manufacturer's guideline.
- Consider fuel oil additives in case they benefits fuel oil properties for DG sets use.
- Ensure compliance with maintenance checklist.

6.5 WATER PUMPING SYSTEM:

Nazir Ajmal Memorial College of Education has total 4 numbers of water pumps. Out of which 2 numbers is surface water pump and 2 numbers are submersible water pump. All these water pumps are used in the water treatment plant to pump water from borewell up to the filtration unit and from filtration unit to the overhead storage tank. Detail of water pumps are given below-

Location	Water Treatment Plant
Number of Pumps	4 Nos
Type & Capacity	Submersible-5 HP-1No Submersible-2HP- 1 No Surface Jet Pump-5HP- 1 No Surface-1HP-1No

Table 5: Water Pump Detail of Nazir Ajmal Memorial College of Education

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 taken the initiative to convert all inefficient luminaries to energy efficient LED tube lights and LED bulbs.

7.1.3 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.

7.1.4 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.

7.1.5 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.

7.1.6 INTEGRATION OF RENEWABLE ENERGY IN THE CAMPUS

- Since the college campus has enough roof space available, therefore the college authority may install and generate solar energy which will reduce the annual energy cost incurred by the college.

8. ENERGY CONSERVATION INITIATIVES

The college authority has already taken an initiative for energy conservation practices within the campus through awareness drive.

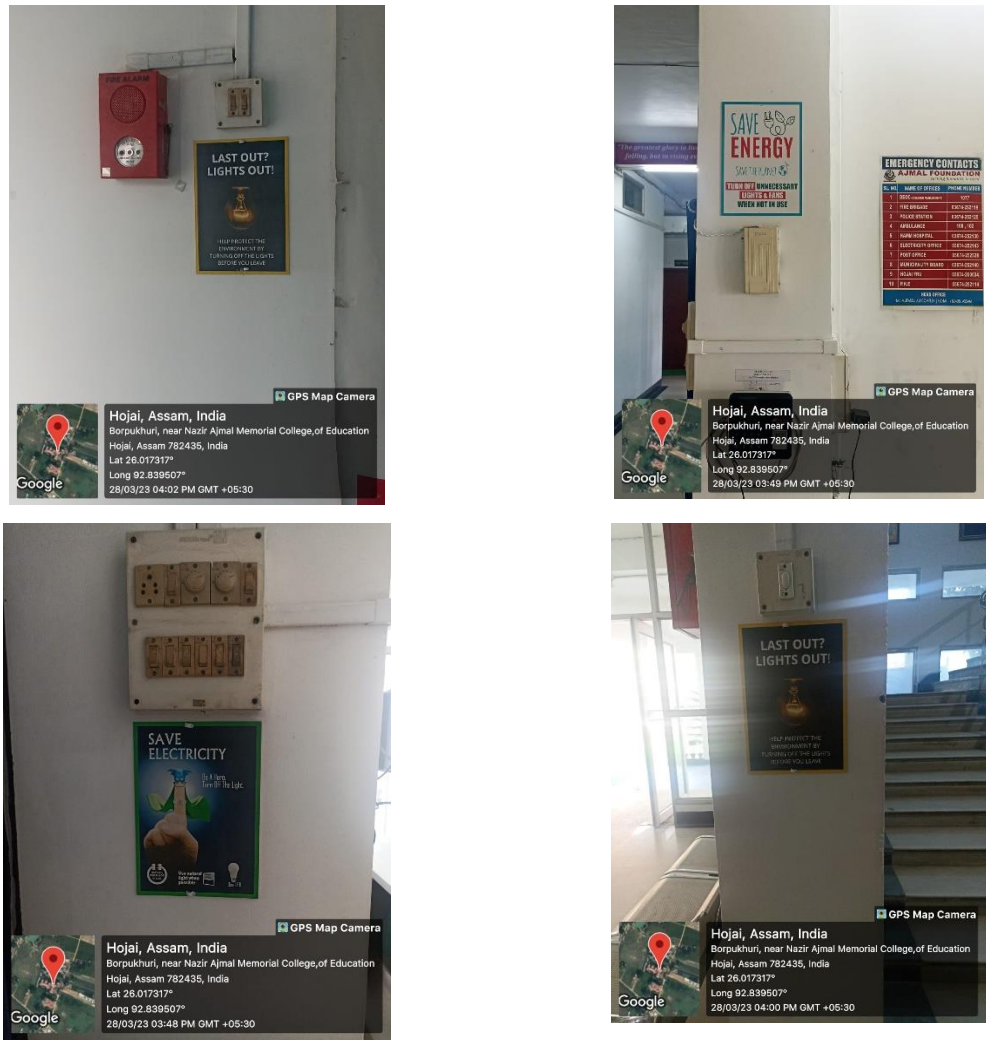

Figure 5: Posters installed at different locations