JULY 8TH, 2023

A REPORT ON ENERGY AUDIT IN PRAMATHESH BARUA COLLEGE

SUBMITTED TO
THE PRINCIPAL
PRAMATHESH BARUA COLLEGE, GAURIPUR,
DHUBRI (ASSAM)

SUBMITTED BY
ADD SQUARE SOLUTIONS
VILL: DEURIPARA (BEHIND DEEO OFFICE, BONGAIGAON),
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We are sincerely thankful to the Pramathesh Barua College management for giving us the opportunity to conduct energy audit.

We are also grateful to Dr. Kalyan Das, Principal, Pramathesh Barua College, Gauripur, 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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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. Pramathesh Barua College, an educational institute in Dhubri district of Assam taking initiative for reducing energy intensity intheircollege campusand entrusted Add Square Solutions for conducting Energy Audit. To conduct the energy audit, the audit team visited the campus on 4th July 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 inthe campus.
- Assessment of Building wise/Floor wise electrical load base 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 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, andbased 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 Pramathesh Barua College consists of four campuses- college campus, new girl's hostel campus, old girl's hostel campus, and boys hostel campus (Lalji campus). The college campus consists of numbers of buildings with Assam type buildings, and RCC buildings. The other campuses consist of RCC building. The following Tables show the basic information about the building and the utilities.

Sl. No	Basic Building Data	Value
1	Connected Load/Contract Demand	
	• College campus Consumer Number: 47000002912	6 kW
	• New girl's hostel campus Consumer Number: 47010105073	14 kW
	• Old girl's hostel campus	1 kW

	Consumer Number: 47000014080 • Boy's hostel campus Consumer Number: 47010116203	1 kW
2	Diesel Generator set availability	25 kVA (1 No) Make: Mahindra Powerol Model: 25 kVA 1PH 3385 TCI GM-C2 15 kVA (1 No) Make: Kirloskar Oil Engines Ltd. Model: KG-15AS1-C
3	Electricity consumption (June' 2022 to April' 2023) • College campus Consumer Number: 47000002912 • New girl's hostel campus Consumer Number: 47010105073 • Old girl's hostel campus Consumer Number: 47000014080 • Boy's hostel campus Consumer Number: 47010116203	14,911.00 kWh 4,571.00 kWh 2,074.00 kWh 835.00 kWh
4	Cost of electricity consumption (June' 2022 to April' 2023) • College campus Consumer Number: 47000002912 • New girl's hostel campus Consumer Number: 47010105073 • Old girl's hostel campus Consumer Number: 47000014080 • Boy's hostel campus Consumer Number: 47010116203	₹ 1,20,572.00 ₹ 56,346.00 ₹ 17,014.00 ₹ 7,542.00
4.1	Diesel consumed	399.53 Ltr

	Cost of electricity consumption through DG set.	₹ 35,500.00
4.2	Total cost of electricity (Utility+DG set)	Rs. 2,36,974.00
5	Total Numbers of building covered	10 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 PRAMATHESH BARUA COLLEGE.

At present the overall energy consumption is catered by the electricity supply from Assam Power Distribution Company Limited. The college has four numbers of electrical connections with consumer numbers and connected load mentioned in the table number 1.

5.1.1. ENERGY CONSUMPTION.

The total electricity consumption from June' 2022 to April' 2023 was 22,391.00 kWh and the total bill paid to distribution companies was ₹ 2,01,474.00

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

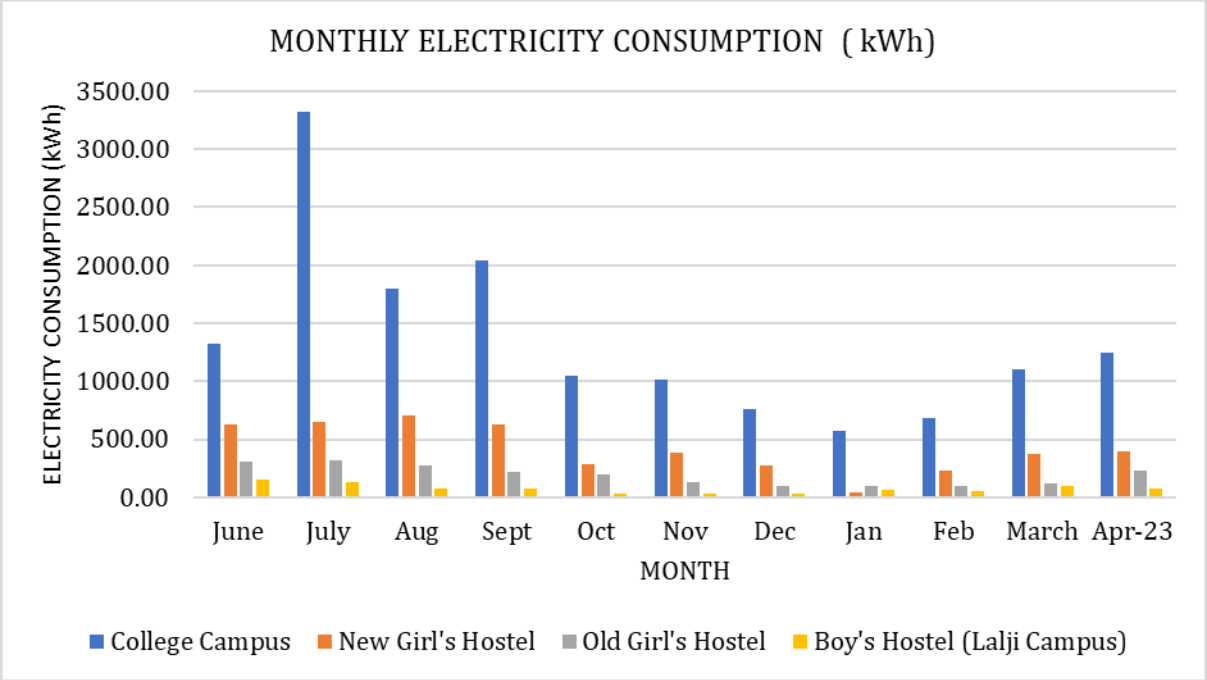

Figure 1: Monthly Electricity Consumption (June' 2022 to April 2023)

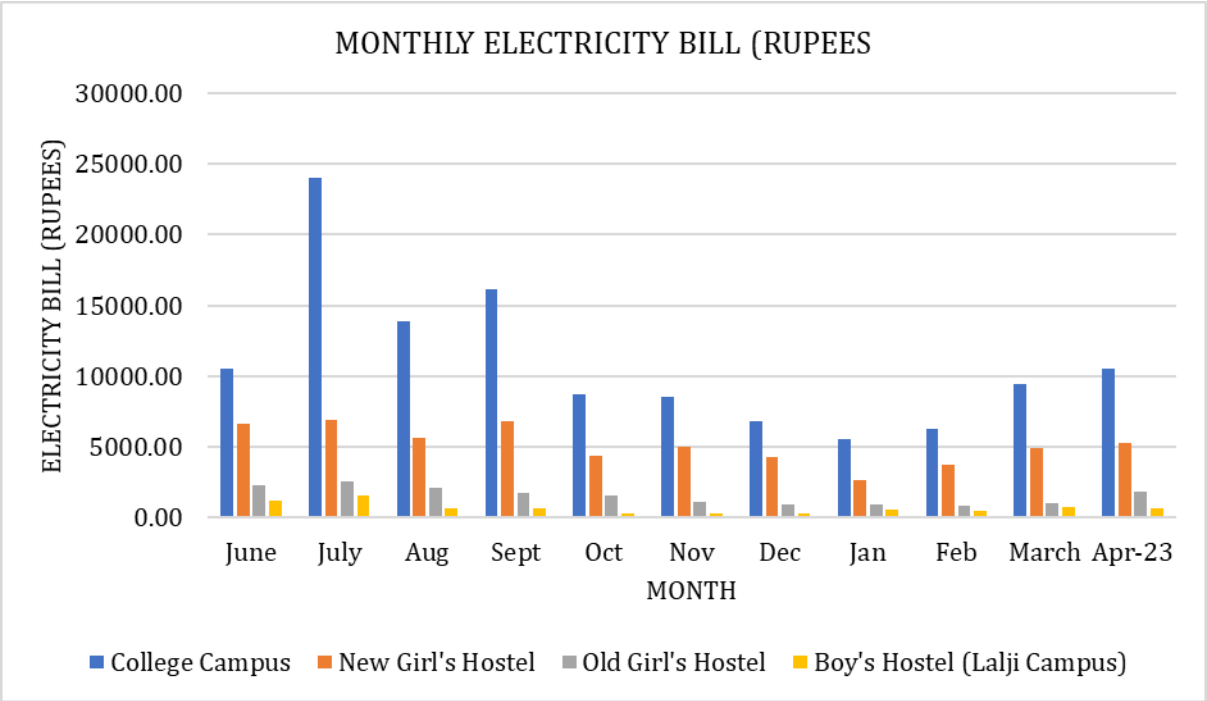

Figure 2:Monthly Electricity Bill (June 2022 to April 2023)

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)

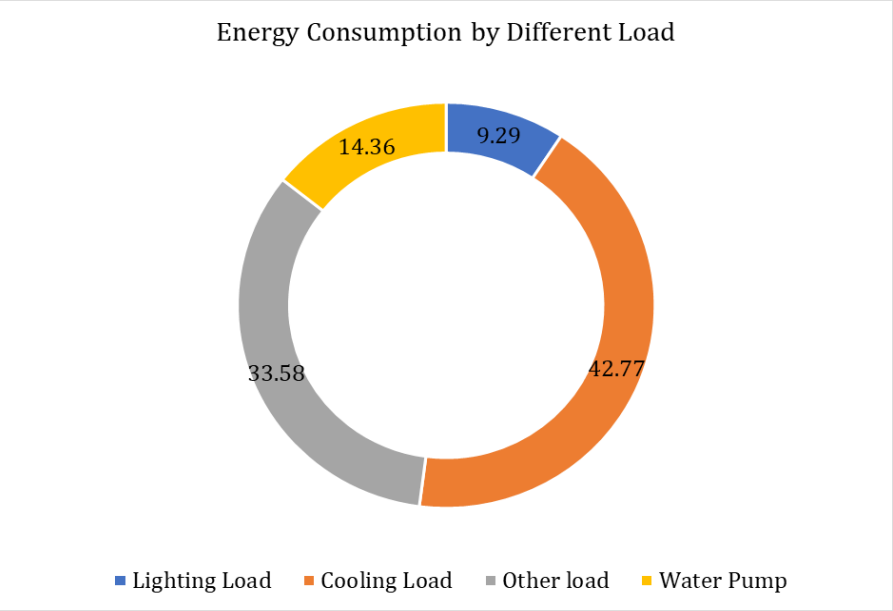

Figure 3: Energy consumption by different load

6.1.2 BUILDING WISE ESTIMATION OF LOAD:

Pramathesh Barua College consist of multiple buildings comprising various load. A detail assessment was carried out during audit period considering all the loads installed in the building. A building 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 in the campus.

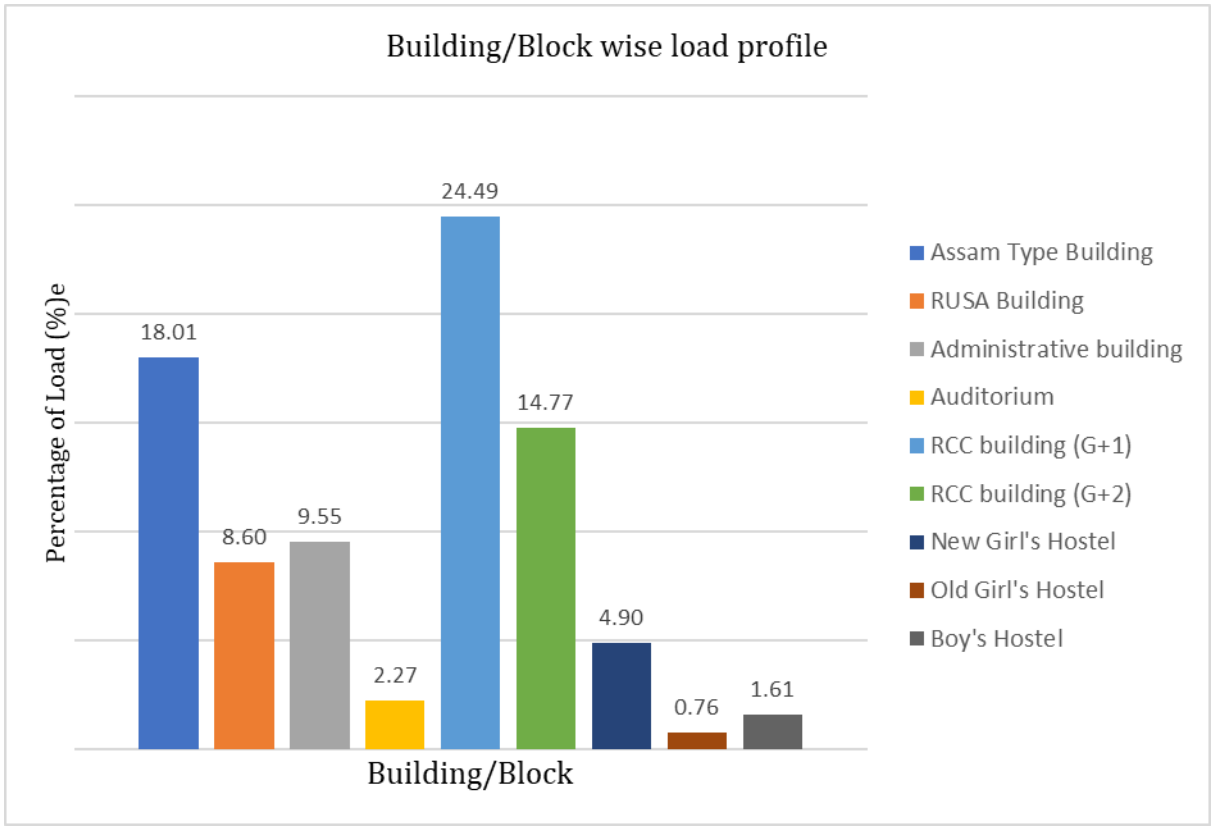

Figure 4: Building wise estimation of Load

6.1.3 OBSERVATION AND RECOMMENDATION

- Since the campus consist of multiple numbers of buildings with energy consuming equipment, therefore it is recommended to install separate sub meter for each building to identify the energy consumption of each building. This will help the management to take energy conservation measures as well as it will help to do the performance assessment of electrical uses.
- At present the total installed load of the campus include lighting load, cooling loadetc. Out of these, 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 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).

6.2 ENERGY CONSERVATION IN LIGHTING SYSTEM:

6.2.1REVIEW OF PRESENT LIGHTING LOADS

Lighting contributes about 9.21% of total load. The lighting load of the campus is consisting of 9-Watt LED bulb and20 W LED tubes. It has also been observed that, almost all the luminaries have already been converted to energy efficient LED lighting in all the campuses.

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.

Illumination Study

Major Working Area	Luminaries used	Wattage	Average lux level (Lux)
Assam Type Building	LED Bulb/LED Tube	9W/20W	231
RUSA Building	LED Bulb/LED Tube	9W/20W	211
Administrative building	LED Bulb/LED Tube	9W/20W	197
Auditorium	LED Bulb/LED Tube	9W/20W	187
RCC building (G+1)	LED Bulb/LED Tube	9W/20W	212
RCC building (G+2)	LED Bulb/LED Tube	9W/20W	189
New Girl's Hostel	LED Bulb/LED Tube	9W/20W	198
Old Girl's Hostel	LED Bulb/LED Tube	9W/20W	172

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.
- 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.
- Tubular daylight devices to maximize the use of daylight which will reduce the energy consumption.
- Installation of occupancy sensors so that the lighting systems are controlled by this smart occupancy sensor.

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 Pramathesh Barua College, 42.77% 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 WATER PUMPING SYSTEM:

A total 7 numbers of water pumps of are installed, out of which 4 numbers are 1.5 HP capacity remaining 3 numbers are 1 HP capacity.

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

6.5 DIESEL GENERATOR (DG) SET

6.5.1 REVIEW OF PRESENT DIESEL GENERATOR (DG) SET:

There are 2 (two) nos DG sets are installed in the college campus which covers all the loads of academic blocks, administrative building, library, canteen, auditorium and hostels.

Total diesel consumption by considering both the DG sets was 399.53 ltr and total costing of diesel consumption was ₹ 35,500.00 during the study period.

The salient technical specifications are as follows:

Technical Specification	DG 1	DG 2
Make	Mahindra Powerol	Kirloskar Oil Engines Ltd.
Model	25 kVA 1PH 3385 TCI GM-C2	KG-15AS1-C
Rated kVA	25	15
Rated kW	20	12
Voltage	230	230
Frequency	50	50

Power factor	0.8 lagging	0.8 lagging

Figure 5: Diesel Generator Sets Detail

6.5.2PERFORMANCE ASSESSMENT OF THE DIESEL GENERATOR SETS:

For the performance assessment of the DG sets it needs 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 as per design value, the fuel consumption of installed DG sets is mentioned in the table no. 4.

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.
- 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.

6.5.3 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.

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

Pramathesh Barua College has a potential to generate energy from renewable energy sources especially solar energy. Therefore, it is recommended to install solar power plant/ solar street lights to reduce the energy consumption from the grid.

ANNEX 1

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				

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