APRIL 9, 2022

A REPORT
ON
ENERGY AUDIT AT GOLAGHAT COMMERCE COLLEGE, GOLAGHAT

SUBMITTED TO
THE PRINCIPAL
GOLAGHAT COMMERCE COLLEGE
JYOTI NAGAR, GOLAGHAT - 785621 ASSAM (INDIA)

SUBMITTED BY
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Acknowledgement:

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

We are also grateful to Dr. Utpal Sarma, Principal, Golaghat Commerce 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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STUDY TEAM:

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1. BACKGROUND:

Consumption of energy 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. Golaghat Commerce College, an educational institute in Golaghat 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 25th of March 2022 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 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 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 Golaghat Commerce 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	120 kW
	Contract Demand	141.17kVA
2	Installed capacity of DG set	25kVA (1 Nos) Make: Jakson Limited Model: CJ 25D5 P
3	Annual electricity consumption (April'2021 to March'2022)	33,259.67 kWh
4	Annual cost of electricity consumption	Rs. 5,81,746.52
	Annual cost of electricity consumption through DG set. (Considering Rs. 6,000/ Month Diesel Charges)	Rs. 72,000.00
	Total cost of electricity (Utility + DG set)	Rs.6,53,746.52
5	Total Numbers of building covered	9 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: Building Details

5. PRESENT ENERGY SCENARIO

5.1 Review of analysis of electricity bill of Golaghat Commerce College.

At present the overall energy consumption is catered by the Electricity supply from Assam Power Distribution Company Limited (APDCL) and own DG set. Total Connected load of Golaghat Commerce College is 120 kW and Contracted Demand is 141.17 kVA. The campus has a dedicated transformer of 250 kVA.

5.1.1. Energy Consumption.

The total energy consumption in the financial year 2021-2022 was 33,259.67 kWh. The monthly energy consumption and electricity bill paid during the financial year 2021-2022 has shown in fig.1 and fig. 2 respectively.

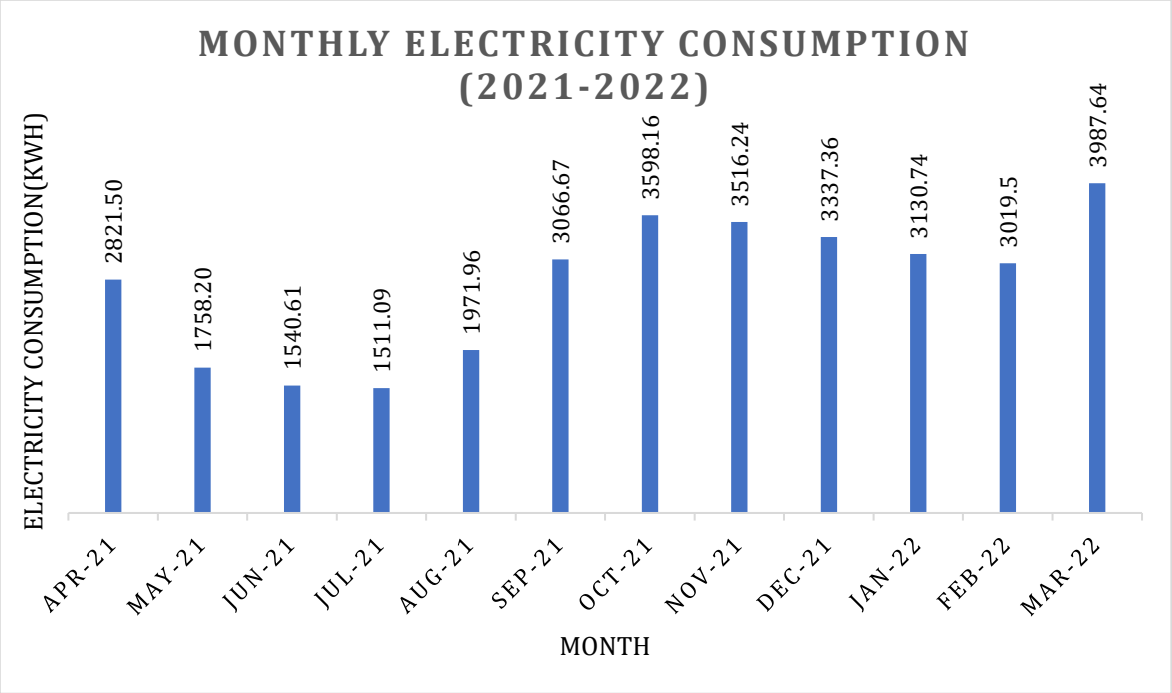

Figure 1: Monthly Electricity Consumption

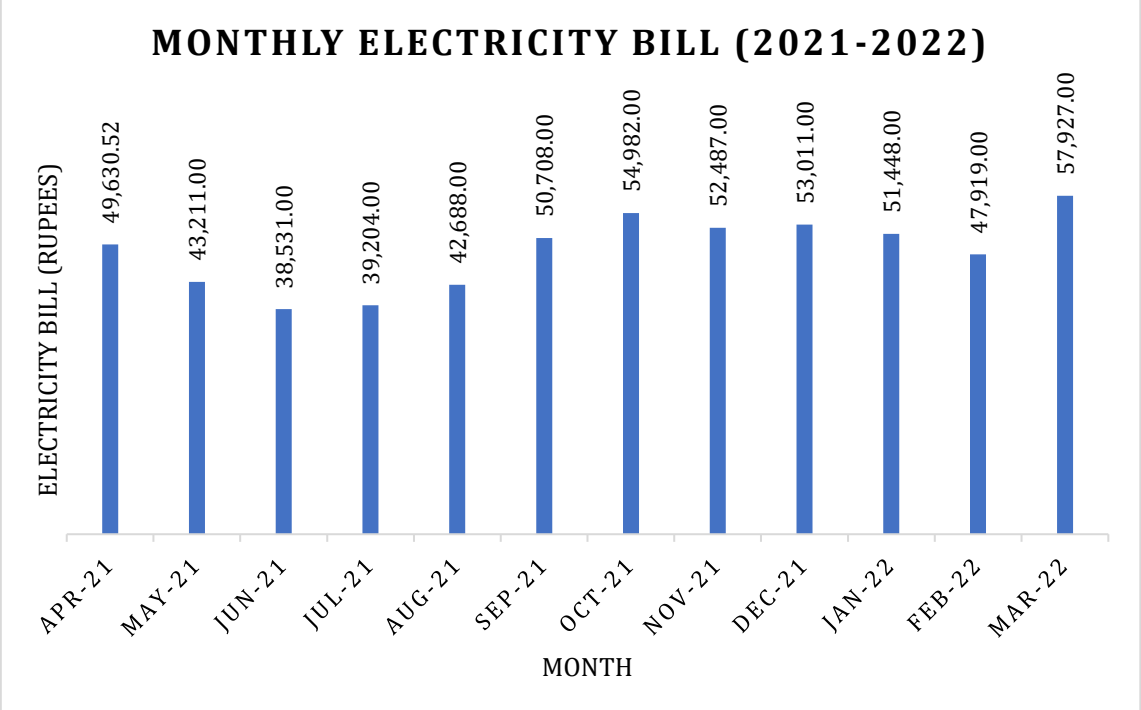

Figure 2: Monthly Electricity Bill

5.1.2 Fixed Charge

Fixed charge amount depends upon of contract demand (which is 141.17kVA) and the energy charge depends upon the energy used by the facility (kWh). It has been found that monthly fixed charge paid to APDCL was Rs. 25,866.74.

5.1.3 Power Factor

The power factor indicates how much power is actually being used to perform useful work by a load and how much power get wasted. This wastage typically leads to huge electricity bills for consumers as distribution companies calculate consumption in terms of apparent power, as such, they end up paying for power which was not used to achieve any "meaningful" work.

The power factor for each month of the financial year 2020-2021 and due to non-maintaining the power factor, penalty imposed by APDCL has shown in table 1.

Billing Month	Average Monthly P. F	PFP (Power Factor Penalty)/Rebate (kWh)
Apr-21	70.20%	346.50
May-21	40.80%	679.55
Jun-21	52.80%	442.00
Jul-21	56.20%	357.58
Aug-21	66.50%	300.81
Sep-21	81.90%	89.32
Oct-21	85.60%	-36.34
Nov-21	80.60%	135.24
Dec-21	76.30%	247.21
Jan-22	67.10%	452.89
Feb-22	75.00%	274.50
Mar-22	81.20%	116.14

Table 2: Monthly average Power Factor (PF)

Power Factor Penalty

It has been observed that the monthly average power factor during the year 2021-2022 was in the range of 40.80% to 85.60%. To avoid the penalty charge, the average power factor should not be less than 85%. From the table: 2 it is well understandable that except in the month of October 2021 the power factor (85.60%), all 11 (eleven) months the power factor was poor (less than 85%) which leads to penalty in the electricity bill. The total additional unit (kWh) due to poor power factor was 3,441.74 kWh which was equivalent to the amount of Rs. 24,780.00. Therefore, it is very essential to reduce the unnecessary losses by improving the power factor.

Recommendation:

- It is recommended that the cause of low power factor should be identified and rectified for energy conservation and to reduce the electricity bill. The primary reason of low power factor is due to inductive load. Therefore, it is recommended that the inductive load (if any) must be avoided.
- It is strongly recommended that the college authority should discuss with the distribution company (APDCL) for low power factor penalty issue and to

conduct a thorough assessment from their end to ensure that there is no system fault or fault in the line exist.

- Installation of capacitor bank is one of the most common method to improve the Power Factor (PF). The size of the capacitor bank can be estimated after knowing the inductive load capacity and estimating the total load.

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)

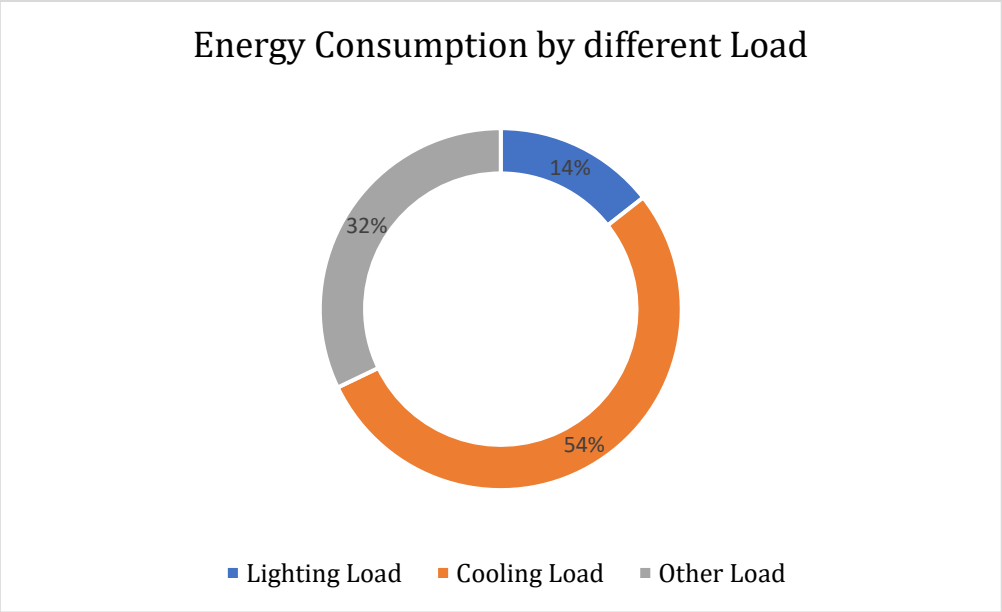

Figure 3: Energy consumption by different load

6.1.2 Building wise estimation of loads:

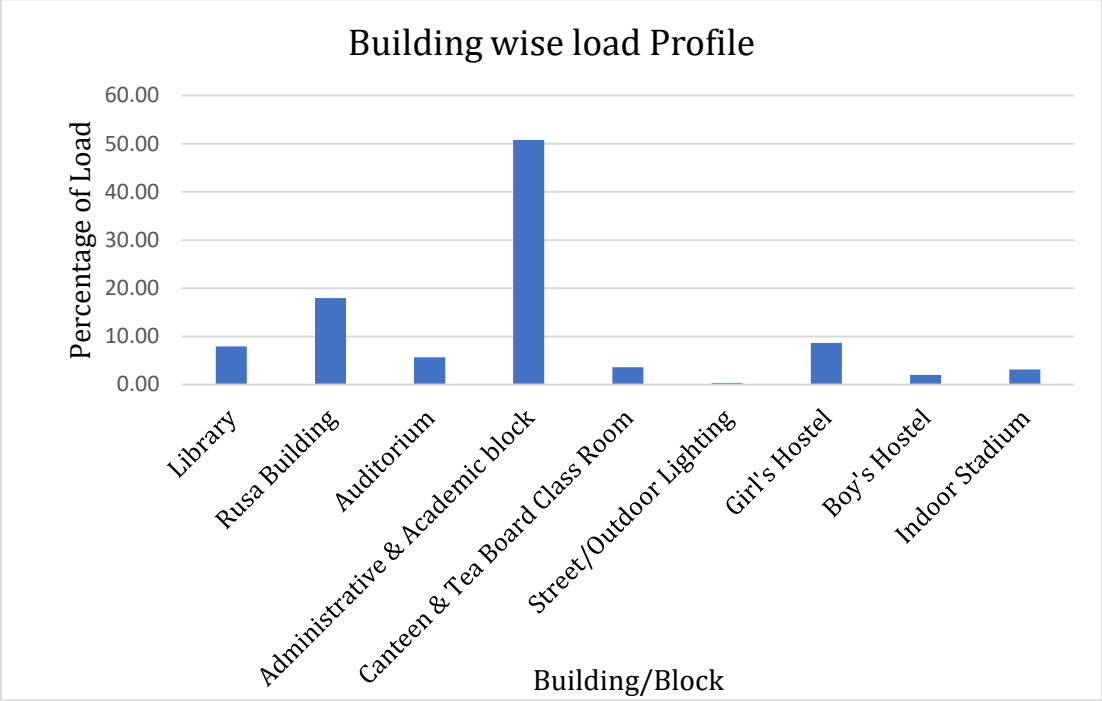

Figure 4: Building wise load profile of Golaghat Commerce College.

6.2 Observation and Recommendation

- It has been observed that the campus has one energy meter to measure the electrical energy consumption from the grid. Since the campus consist of multiple numbers of buildings with high energy consuming equipment, therefore it is recommended to install separate sub-meter for each building to identify and 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.
- Presently the total installed load of the campus is 75 KW (Approximate) Which include lighting load, Fan load, AC load, motor load etc. It seems that the actual load installed in the campus is much lower than the total connected load of the campus (120kW). The monthly maximum demand was in the range of 6.45 kVA to 25.65 kVA. Therefore, it is recommended that the college authority should discuss with APDCL if there is any provision of reducing the connected load which will reduce the fixed charge in the electricity bill.
- 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)

ILLUMINATION STUDY AND ENERGY CONSERVATION IN LIGHTING SYSTEM:

6.2.1Review of Present Lighting Loads

Lighting contributes about 14.43% 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 which implies lesser use of artificial lighting.

Administrative Building (Ground Floor):

Building/Block	Specific Area	Type of Luminaries used	Wattage	Average lux level (Lux)
Administrative /Academic Building				
	Class Room	LED TUBE	20W	265
	Teacher's Cabin	LED bulb/ LED TUBE	9W/20 W	278
	Office Room	LED Bulb	9W	265
Library				
	Boy's Reading Room	20 W	LED Tube	267

	Girl's Reading Room	20W	LED TUBE	271
	Teacher's Reading Room	9 W	LED Bulb	267
	Book Store	9 W	LED Bulb	120
	Computer Room	9 W	LED Bulb	256
	Front Desk	20 W	LED TUBE	232
RUSA Building				
	Computer Laboratory	9 W	LED Bulb	324
	Class Room	9 W	LED Bulb	424
Auditorium				
	Front Row of the seating arrangement	20 W	LED Tube	230
	Middle row of the seating arrangement	20 W	LED Tube	242
	Last row of the seating arrangement	20 W	LED Tube	232
Girl's Hostel				
	Hostel Room	20 W	LED Tube	245
Boy's Hostel				
	Hostel Room	9 W	LED Bulb	276
Indoor Stadium				
	Badminton Court	20 W	LED Tube	398

Table 3: 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 use maximum day light the working area or the study area covers adequate illumination level.
- It is also observed that, some part of the study area in Library, class room and teacher's cabin, there is not adequate day lighting which leads to depend on artificial lighting. This will increase the use of energy and operating cost to meet up the standard illumination level.
- As energy conservation measure, almost all the lights are converted to LED by the college authority.
- It has also been observed that the college authority has already install some motion sensor in some specific working areas as energy conservation strategies.

RECOMMENDATION

- Inculcate discipline and sense of participation in the energy conservation movement, any unnecessary lighting during day period should be avoided through awareness programmes.
- Area specific use of task lighting and reduction of back ground illumination.
- Installation of occupancy sensors in the faculty cabin 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\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 Hockey BADMINTON COURTS	 300 700 300
PUBLIC AND EDUCATIONAL BUILDING ASSEMBLY AND CONCERT HALLS Theatre and concert halls Multipurpose	 100 500
FURTHER EDUCATION ESTABLISHMENT Lecture theatres general Chalkboard Demonstration benches Examination halls, seminar rooms, teaching spaces Laboratories	 500 500 500 500 500

Table 4: Standard Illumination Level

6.3 DIESEL GENERATOR (DG) SET

6.3.1 Review of present Diesel Generator (DG) Set:

One DG sets with capacity of 25 kVA is dedicated to supply power to entire campus during load shading. The salient technical specifications are as follows:

DG set of 25 kVA:

Make:	Jakson Limited
Model No	CJ 25D5 P
Rated kVA	25 kVA
Rated kW	20 kW
Voltage	415 V
Full load current	35 (0.8PF) Amps
Frequency	50 Hz
Phase	3 Phase

Table 5: 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.

Recommendation:

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

6.4 WATER PUMPING SYSTEM:

The campus has total six (6) numbers of water pumps. Out of these five (5) are submersible and one (1) surface water pump. Detail specification of water pumps are given below-

Sl. No	Location	Capacity	Quantity	Type	Make
1	Boy's Hostel	1 HP	1	Submersible	-
2	Girl's Hostel	1 HP	1	Submersible	-
3	College Campus	1 HP	3	Submersible	-
4	Canteen	1 HP	1	Surface	-

Table 6: Detail of water pump location

OBSERVATION

The percentage of loading for the 1 HP motor is 85% which is acceptable as per the energy conservation measure.

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 Air-Conditioning System

The Golaghat Commerce College campus has very less number of air conditioning units as cooling load. It has been observed that the installed air conditioning units are 2 star and 3 star rating, therefore it is recommended to use 5 star rating air conditioning unit.

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.

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