JUNE 4, 2022

A REPORT
ON
ENERGY AUDIT IN NORTH LAKHIMPUR COLLEGE (AUTONOMOUS), LAKHIMPUR

SUBMITTED TO
THE PRINCIPAL
NORTH LAKHIMPUR COLLEGE (AUTONOMOUS)
P.O.: KHELMATI, DIST.: LAKHIMPUR (ASSAM),
PIN: 787031

SUBMITTED BY
ADD SQUARE SOLUTIONS
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Acknowledgement:

We are sincerely thankful to the North Lakhimpur College (Autonomous) management for giving us the opportunity to conduct energy audit.

We are also grateful to Dr. Biman Ch. Chetia, Principal, North Lakhimpur College (Autonomous), 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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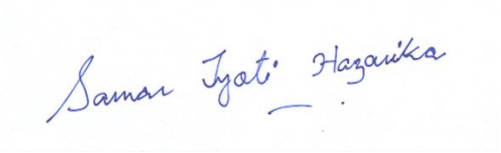

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1. BACKGROUND:

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. North Lakhimpur College (Autonomous), an educational institute in Lakhimpur 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 21st of May 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 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 North Lakhimpur College (Autonomous) campus consisting of multiple buildings (both RCC multi stored and Assam type building). The following Tables show the basic information about the building and the utilities.

Sl. No	Basic Building Data	Value
1	Connected Load	129 kW
	Contract Demand	152 kVA
2	Installed capacity of DG set	25 kVA (1 No) Make: Kirloskar Oil Engines Limited Model: KG25AS-C 40 kVA (1 No) Make: Kirloskar Oil Engines Limited Model: KG1-4043 40 kVA Make: Kirloskar Oil Engines Limited Model: KG1-40WS 30 kVA

		Make: Kirloskar Oil Engine Limited Model: KG1-30WS 15 kVA Make: Kirloskar Oil Engine Limited Model: KG15AS1-C 25 kVA Make: Kirloskar Oil Engine Limited Model: KG 25AS-C 35 kVA Make: Kirloskar Oil Engine Limited Model: KG 35AS 40 kVA Make: Kirloskar Oil Engine Limited Model: KG 1-40WS
3	Annual electricity consumption (April'2021 to March'2022)	94,550.78 kWh
4	Annual cost of electricity consumption @7.2/unit	Rs. 12,32,529.45
4.1	Annual cost of electricity consumption through DG set.	Rs. 1,01,500.00
4.2	Total cost of electricity (Utility + DG set)	Rs.13,34,029.00
5	Total Numbers of building covered	18 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 North Lakhimpur College (Autonomous).

At present the overall energy consumption is catered by the electricity supply from Assam Power Distribution Company Limited and own DG sets. Total Connected load of North Lakhimpur College (Autonomous) is 129 kW and Contracted Demand is 152 kVA. Total 8 numbers of DG sets (individual capacity of the DG sets are mentioned in the table no.1) are used to supply power during load shading hours. The campus has a dedicated transformer of 250 kVA which is installed behind the arts building.

5.1.1. Energy Consumption.

The total electricity consumption from April 2021 to March 2022 was 94,550.78 kWh and the total bill paid to distribution companies was Rs. 12,32,529.45.

Monthly electricity consumption(kWh) and electricity bill (Rs.) paid during the financial year 2021-2022 has shown in fig.1 and fig. 2 respectively.

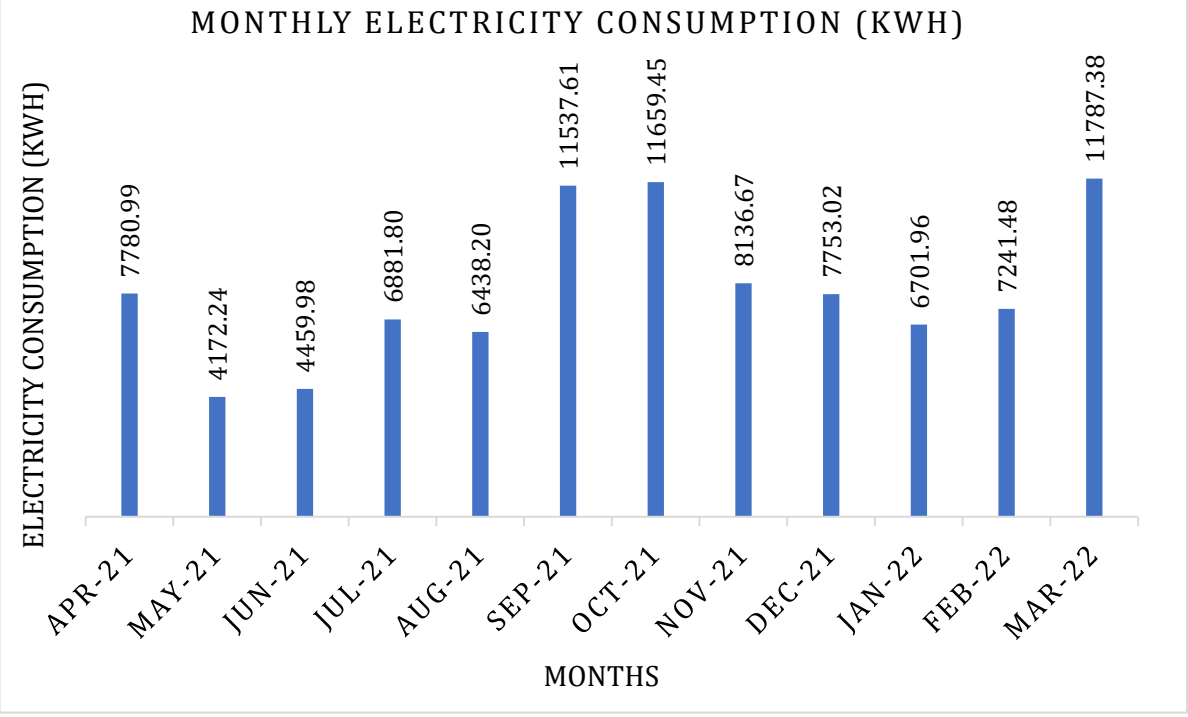

Figure 1: Monthly Electricity Consumption (April 2021- March-2022)

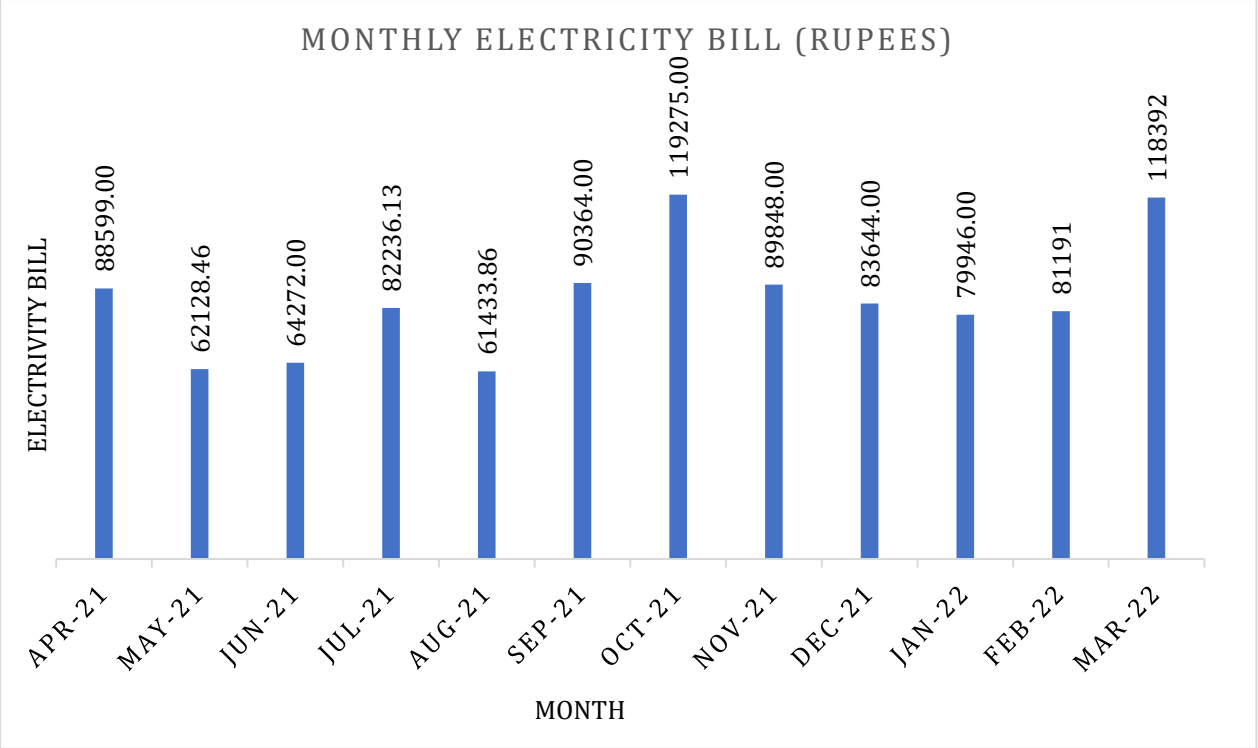

Figure 2:Monthly Electricity Bill (Rupees)

Annual diesel consumption by all the DG sets (cumulative) was 1,160.52 liter and total expenses incurred was Rs. 1,01,500.00.

Monthly expenses on diesel during the financial year 2021-2022 has shown in fig.3.

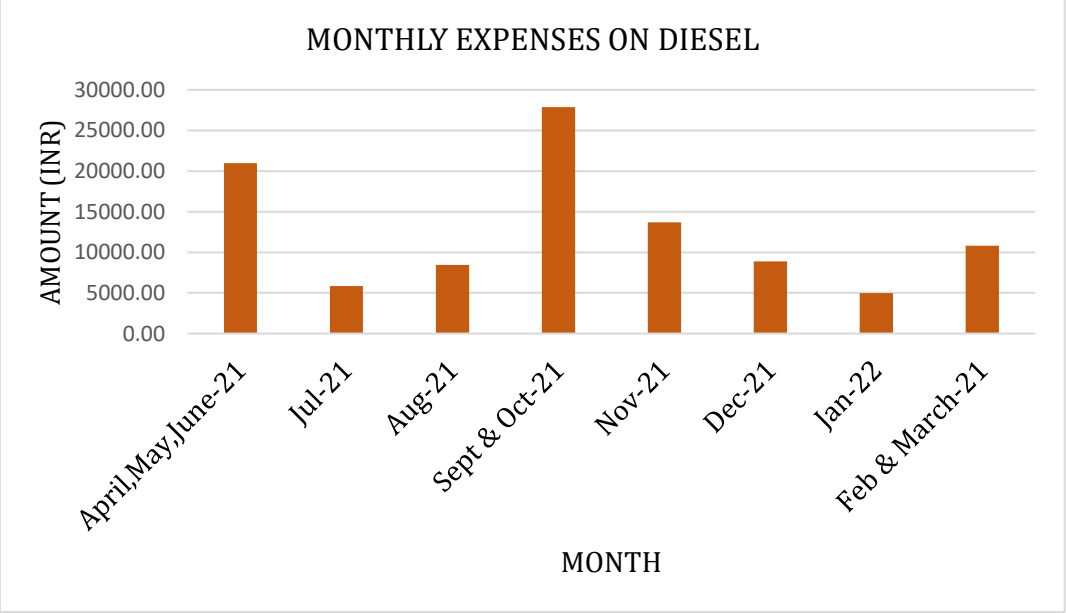

Figure 3: Monthly Expenses on Diesel (INR)

5.1.2 Fixed Charge

Fixed charge amount depends upon of contract demand (which is 152 kVA) and the energy charge depends upon the energy used by the facility (kWh). It has been found that the monthly fixed charge paid to APDCL is Rs. 27,884.710.

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 from April 2021 to March 2022 has shown in table 1. It has been observed that, the Power Factor (PF) is maintained in the range of 99.00% to 99.80% which is considered as well-maintained power factor and for which the consumer is rewarded as PF rebate in total energy consumption of the month.

Billing Month	Average Monthly Power Factor (%)
Apr-21	99.70%
May-21	99.60%
Jun-21	99.70%
Jul-21	99.80%
Aug-21	97.80%
Sep-21	99.10%
Oct-21	99.00%
Nov-21	97.90%
Dec-21	99.70%
Jan-22	99.70%
Feb-22	98.00%
Mar-22	99.10%

Table 2: Average monthly Power Factor (P.F)

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

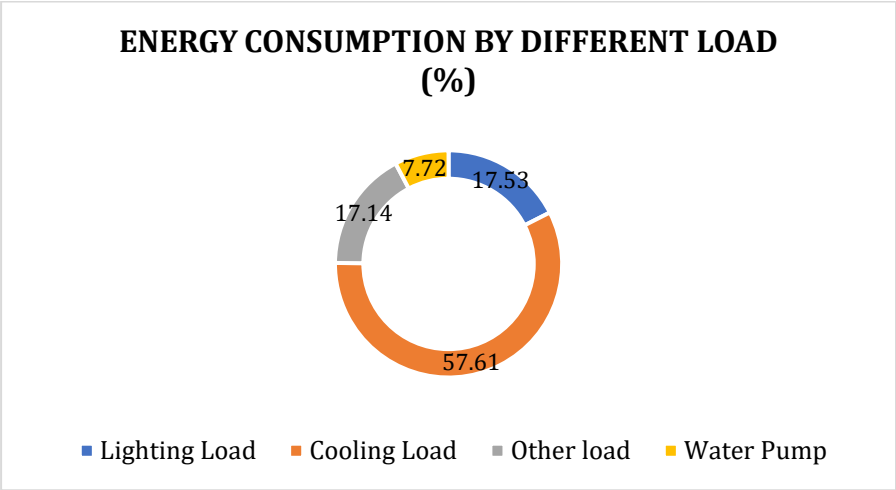

Figure 4: Energy consumption by different load

6.1.2 Building wise estimation of load:

North Lakhimpur College (Autonomous) 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.

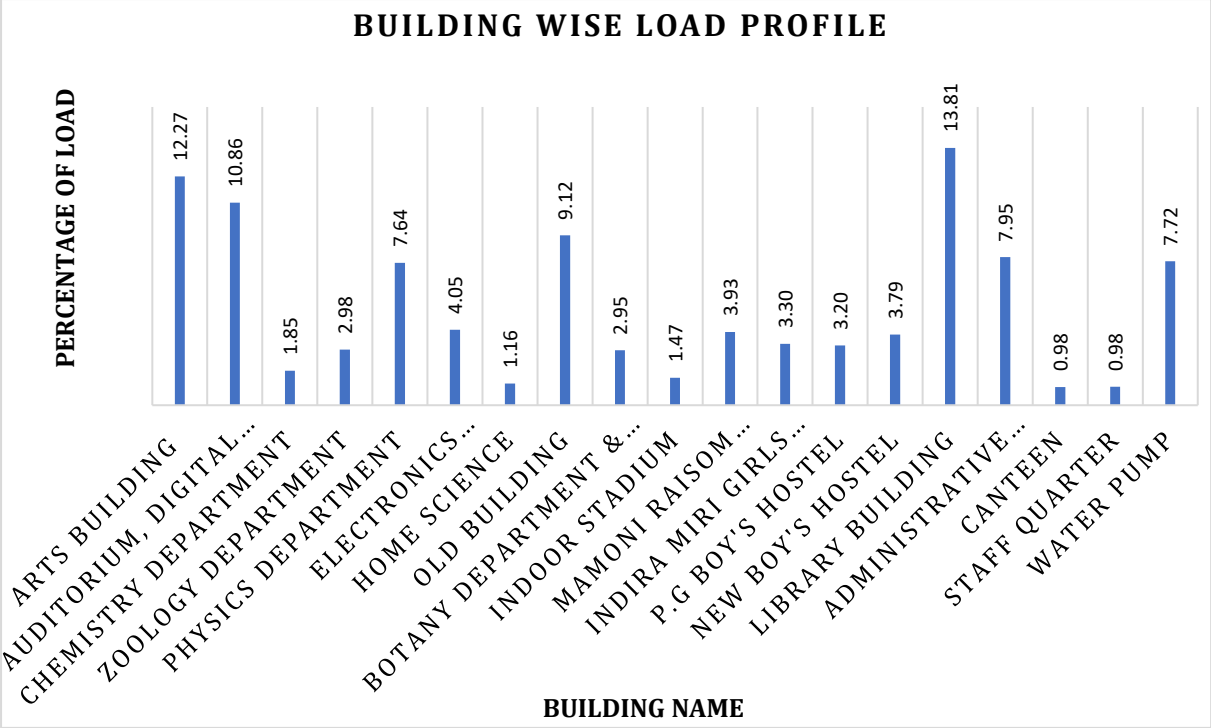

Figure 5: Building wise estimation of Load

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 submeter 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 116 KW (Approximate) Which include lighting load, Fan load, AC load, motor load etc. The monthly maximum demand in the range of 15.6 kVA to 54 kVA.
- 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 17.53 % of total load of the campus. The lighting load of the campus is consisting of 9-Watt LED bulb, 20 W LED tube light and 40-Watt Fluorescent Tube Light (FTL) to illuminate the workplace. It has also been observed that, 59.33% of the total lighting load has already been converted to energy efficient LED lighting. The College authority intend to comply energy efficient measures by converting remaining lighting systems to LED lighting.

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	Avg. lux level (Lux)
Arts Building	LED Bulb/LED Tube	9W/20W	230
Auditorium	LED Bulb/LED Tube	9W/20W	146
Chemistry Department	LED Bulb/LED Tube/ FTL	9W/20W/40W	228
Zoology Department	LED Tube/ FTL	20W/40W	302
Physics Department	LED Bulb/LED Tube/ FTL	9W/20W/40W	256
Electronics Department	LED Tube/ FTL	20W/40W	223
Home Science	LED Tube/ FTL	20W/40W	310
Old Building	LED Tube/ FTL	20W/40W	222
Botany Department & KKHSOU	LED Bulb/LED Tube/ FTL	20W/40W	210
Indoor Stadium	LED Tube	20W	-
Mamoni Raisom Goswami Girls Hostel	LED Tube	20W	227
Indira Miri Girls Hostel	LED Tube	20W	-
P.G Boy's Hostel	LED Tube	20W	198

New Boy's Hostel	LED Tube	20W	176
Library Building	LED Tube/ FTL	20W/40W	273
Administrative Building	LED Tube/ FTL	20W/40W	256
Canteen	LED Bulb	9W	269
Staff Quarter	LED Tube	20W	-

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 curtains are keep 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, class room and laboratories, 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 4: Standard Illumination Level

6.3 DIESEL GENERATOR (DG) SET

6.3.1 Review of present Diesel Generator (DG) Set:

Total 8 (Eight) numbers of DG sets are installed in the college campus. North Lakhimpur College (Autonomous) comprises total 4 numbers of hostel buildings covered by one 40 kVA DG set installed in Mamoni Raisom Goswami Girl's hostel, one

40 kVA DG set installed in Indira Miri Girl's Hostel and one 30 kVA DG set installed in New Boy's hostel. Other 5 numbers of DG sets are installed in different location within the college campus and covers all the academic blocks, administrative building, library, canteen and auditorium.

The salient technical specifications are as follows:

Sl. No	Make	Model	MFG Date /SR No	Rated kVA	Rated kW	Voltage (V)	Frequency (Hz)	Phase
1	Kirloskar Oil Engine Limited	KG25AS-C	16/08/2013/-197	25	20	415	50	3 ϕ
2	do	KG1-40WS	17/12/2015/-134	40	32	415	50	3 ϕ
3	do	KG1-40WS	31/12/2014/-156	40	32	415	50	3 ϕ
4	do	KG1-30WS	12/11/2014/-103	30	24	415	50	3 ϕ
5	do	KG15AS1-C	02/01/2014-003	15	12	415	50	3 ϕ
6	do	KG 25AS-C	-	25	20	415	50	3 ϕ
7	do	KG 35AS	27.04/2011-478	35	28	415	50	3 ϕ
8	do	KG1-40WS	-	40	32	415	50	3 ϕ

Table 5:Diesel Generator Set Technical Specification

Location of DG set and building wise load connected to each DG are mentioned in the table no. 6.

Sl. No	Make	Model	Rated kVA	Rated kW	DG location	Dedicated to Building Load
1	Kirloskar Oil Engine Limited	KG25AS-C	25	20	Near Botany Department Building	Botany Department, KKHSOU
2		KG1-40WS	40	32	Mamoni Raisom Goswami Girl's hostel	Hostel and Warden quarter

3		KG1-40WS	40	32	Indira Miri Girl's Hostel	Hostel
4		KG1-30WS	30	24	New Boy's hostel	New Boy's Hostel and P.G Hostel
5		KG15AS1-C	15	12	Near Physics and Electronics Department	Physics, Electronics Department, Home Science and Statistics Department
6		KG 25AS-C	25	20	Near Chemistry Department building	Chemistry, Zoology and Old academic Building
7		KG 35AS	35	28	Near Auditorium	Auditorium and Arts Building
8		KG1-40WS	40	32	Near Administrative Building	Administrative Building, Library Building and Canteen

Table 6: Building wise distribution of DG load

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(gm/Hp-hr)							
	25 kVA	40 kVA	40 kVA	30 kVA	15kVA	25kVA	35kVA	40kVA
At 100% Load	174	10.3	10.3	-	172	174	163	10.3
At 75% Load	170	8.7	8.7	-	168	170	159	8.7

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.

6.4 WATER PUMPING SYSTEM:

The campus has total 18 (Eighteen) numbers of water pumps. Detail specification along with installed location are given below-

Sl. No	Location	Capacity	Qty	Type	Make/Model
1	Mamoni Raisom Goswami Girl's hostel	1 HP	1	Submersible	Crompton Greeves
		0.5 HP	1	Submersible	Crompton Greeves
2	Indira Miri Girl's Hostel	1 HP	1	Submersible	Crompton Greeves
		0.5 HP	1	Submersible	Crompton Greeves
3	P.G Boy's Hostel	1 HP	2	Submersible	Crompton Greeves
4	New Boy's Hostel	1 HP	1	Submersible	Crompton Greeves
		0.5 HP	1	Submersible	Crompton Greeves
5	All other building within the campus	0.5HP	10	Submersible	Crompton Greeves

Table 7: Detail of water pump location

OBSERVATION

Out of 18 numbers of water pumps 5 numbers are 1 HP and 13 numbers are of 0.5 HP. 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 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 Air-Conditioning System

The North Lakhimpur College (Autonomous) campus has very a smaller number of air conditioning units as cooling load. It has been observed that some of the installed air conditioning units are 3 star rating, therefore 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.

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