APRIL 17, 2024

ENERGY AUDIT REPORT
DARRANG COLLEGE, TEZPUR, ASSAM

SUBMITTED TO
THE PRINCIPAL
DARRANG COLLEGE
SONITPUR, TEZPUR, ASSAM 784001

SUBMITTED BY
TRCATS LLP
REGISTERED OFFICE: BARUAH CHUBURI, MAZGAON,
SONITPUR, ASSAM, 784001

TRCATS Transitioning Research Consultancy and Training Services LLP
Transition Ideas to Business
An ISO 9001-2015 certified LLP established under the NISP initiative of Tezpur University
GSTIN: 18AAUFT1027A1ZB

Acknowledgement

We are sincerely thankful to the Management of Darrang College for giving us the opportunity to conduct Energy Audit of the Institute.

We are also grateful to Dr. Palash Moni Saikia, Principal, Darrang College, Assam whose valuable comments / feedback, during various reviews have helped us during the course of the Audit.

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

For TRCATS LLP

(Dr. Dipal Baruah)
Director (R&D and Innovation)
TRCATS LLP

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Ref. No. Cert./2024/002 **Date: 17/04/2024**

TO WHOM IT MAY CONCERN

This is to certify that TRCATS LLP, having registered office at Baruah Chuburi, Mazgaon, Tezpur, Sonitpur, Assam -784001, has successfully conducted the Energy Audit of DARRANG COLLEGE, TEZPUR, SONITPUR, ASSAM 784001.

The college has provided the necessary data and credentials for scrutiny. The activities and measures undertaken by the college have been verified. After collecting and analyzing the required data, the Energy Audit report has been prepared and submitted. The efforts taken by the college towards energy conservation are appreciated.

(Dr. Dipal Baruah)
Director (R&D and Innovation)
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Ref. No. Cert./2024/003 **Date: 17/04/2024**

Certificate

This is to certify that Energy Audit was conducted at Darrang College, Tezpur, Assam - 784001 on 29th of February, 2024. The summary of the energy audit report is listed below.

Location of the College

DARRANG COLLEGE
SONITPUR, TEZPUR
ASSAM - 784001
Latitude : 26º38'05" N to 26º38'20"N
Longitude : 92º47'45" E to 92º47'55" E

Sl. No	Description of the Building	Units/ parameter	Values
1	Connected Load	kW	210
2	Contracted Demands	kVA	247
3	Installed capacity of DG set	kVA	275
4	Annual electricity consumption (APRIL 2023 - FEBRUARY 2023)	kWh	1,06,111.30
	Annual cost of electricity consumption @ ₹ 7.15/ unit	₹	7,58,695.80
	Fixed charges, surcharge, late fee etc. (As per bill details)	₹	5,75,911.20
	Total cost of electricity (as per bill) including all the component	₹	13,34,607.00
	Annual cost of electricity consumption through DG set	₹	1,89,000.00
	Total cost of electricity (Utility+DG set)	₹	15,23,607.00
5	Number of building	No.	22
6	Working hours (Academic and Administration building)	Hrs	8 Hrs (9AM to 5PM)
7	Working hours (Hostel building)	Hrs	24x7
8	Working Days/week of the College	Days	6 days
9	Whether sub-metering of electricity consumption for each building	No.	No sub-meter

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The monthly energy consumption and energy bill of Darrang College is as follows.

Sl. No	Description of the Building	Units/parameter	Values
1	Monthly Average consumption	kWh/month	9646.48
2	Monthly average energy consumption cost @ ₹7.15 per unit and including fixed charges as applicable	₹/month	68,972.35
3	Annual energy consumption	kWh/annum	1,15,757.76
4	Annual energy consumption cost	₹/annum	14,55,934.91
5	Connected load	kW	210
6	Average P.F maintained		92.53

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1. INTRODUCTION

The use of energy in various forms has been steadily increasing across almost all industries, including those in agriculture, manufacturing, transportation, business, home, and educational institutions. Consuming more energy makes us more dependent on power generated from fossil fuels. Improvements in energy efficiency and potential energy saving are now critical goals for energy users. The Energy Conservation Act 2001 was passed by the Indian government in October 2001. The Energy Conservation Act of 2001 went into force in March, 2002 providing a framework for institutionalizing and improving the delivery mechanisms for energy efficiency programmes throughout the nation.

Darrang College, an educational institute in the Sonitpur district of Assam, taking the initiative to reduce energy intensity in the college campus, entrusted TRCATS LLP with the responsibility for conducting an Energy Audit of the College. The audit team visited the campus on February 29, 2024, to gather information and take measurements to evaluate various energy-consuming components.

2. SCOPE OF WORK

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.

Diesel generator (DG) sets

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

Water pumping systems

- Review of status of water pump set operation

Battery backup systems

- Review of status of battery backup systems

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.

3. BENEFITS OF ENERGY AUDIT

An energy audit has multi-faceted benefits in terms of reinforcing the contribution of an institute towards environmental sustainability through responsible use of energy. Some key points are summarized below.

- Better energy conservation practices of the institute.
- More efficient resource management.
- Benchmarking for energy conservation initiatives.
- Enhance the awareness for energy conservation guidelines and duties.
- Cost saving methods through better resource management.
- Developing energy ethics and value systems among the students and other stakeholders.
- Develop a valuable tool to monitor the energy and sustainable development of the college.
- Improvement of overall college profile.

4. 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 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

5. DESCRIPTION OF THE COLLEGE CAMPUS

Established in 1945, Darrang College finds its home on the northern bank of the Brahmaputra River in Tezpur (Sonitpur District). Flanked by the collegiate field and Marabhairab market to the north/northeast, and the Marabhairab temple to the south, its geographical coordinates span from 26º38'05" N to 26º38'20"N and 92º47'45" E to 92º47'55" E, covering approximately 70,518.67 square meters (Fig. 1). The climate in this region is characterized by high humidity and moderate temperatures. It falls within the subtropical zone, experiencing warm, dry winters from November to February, followed by a lengthy, hot, and rainy period from April to mid-October. The monsoon typically lasts from June to early or mid-October, with occasional showers from March to May and sometimes even in February, gradually increasing in intensity and frequency.

Fig. 1 Google Earth Map of Darrang College

The total area of Darrang College encompasses 70,518.67 square meters, with specific allocations for various purposes: 452.98 square meters for hollows (trench-like areas), 18,162.42 square meters for the playground, 20,782.53 square meters for built-up areas, and 31,120.74 square meters for open space and plantation. The college campus comprises a variety of buildings, ranging from single-story Assam type structures to multi-story RCC buildings, interspersed with green vegetation and trees. It is encircled by roads on the southern and western sides, with residential areas bordering the northern and western perimeters.

Currently, the college hosts 27 departments, including 16 arts departments, 8 science departments, 1 commerce department, 1 environmental science department, and 1 home

science department, housed across different buildings. These buildings accommodate classrooms, laboratories, a library, an auditorium, offices, storage facilities, and bathrooms. Additionally, the college features amenities such as a canteen, playground, hostels, and expansive green spaces adorned with vegetation and trees (Fig. 2).

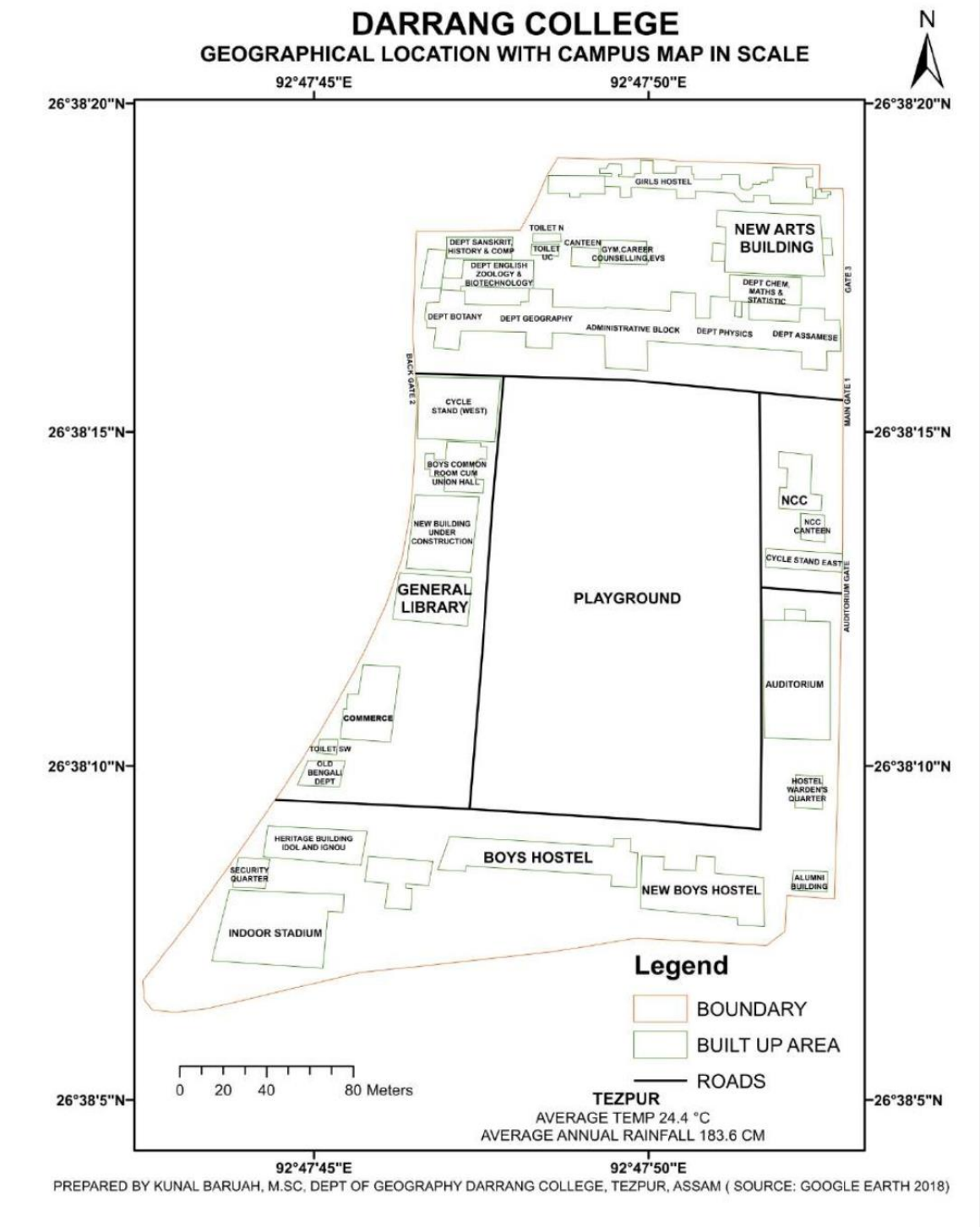

Fig. 2 Layout of Darrang College

The total built-up area of the campus is occupied by number of buildings and are listed in Annexure I.

6. PRESENT ENERGY CONSUMPTION SCENARIO

Assessment of actual operating load and scope for optimizing the same

At present the overall energy consumption of the College is catered by the electricity supply from Assam Power Distribution Company Limited and own DG sets. The College has electrical connection having consumer number 099000001429 with connected load/Contract demand as 210kW. The college also has DG sets with individual capacities of 110 kW and 112 kW to supply electricity during power cut. Apart from the electricity consumption, the College consumes 29 LPG cylinders per annum for laboratory use.

The total electricity consumption from April' 2023 to February'2024 was 1,06,111.30 kWh and the total bill paid to distribution companies was ₹13,34,607.00. Monthly electricity consumption(kWh) from April' 2022 to March'2023 is shown in Fig. 3.

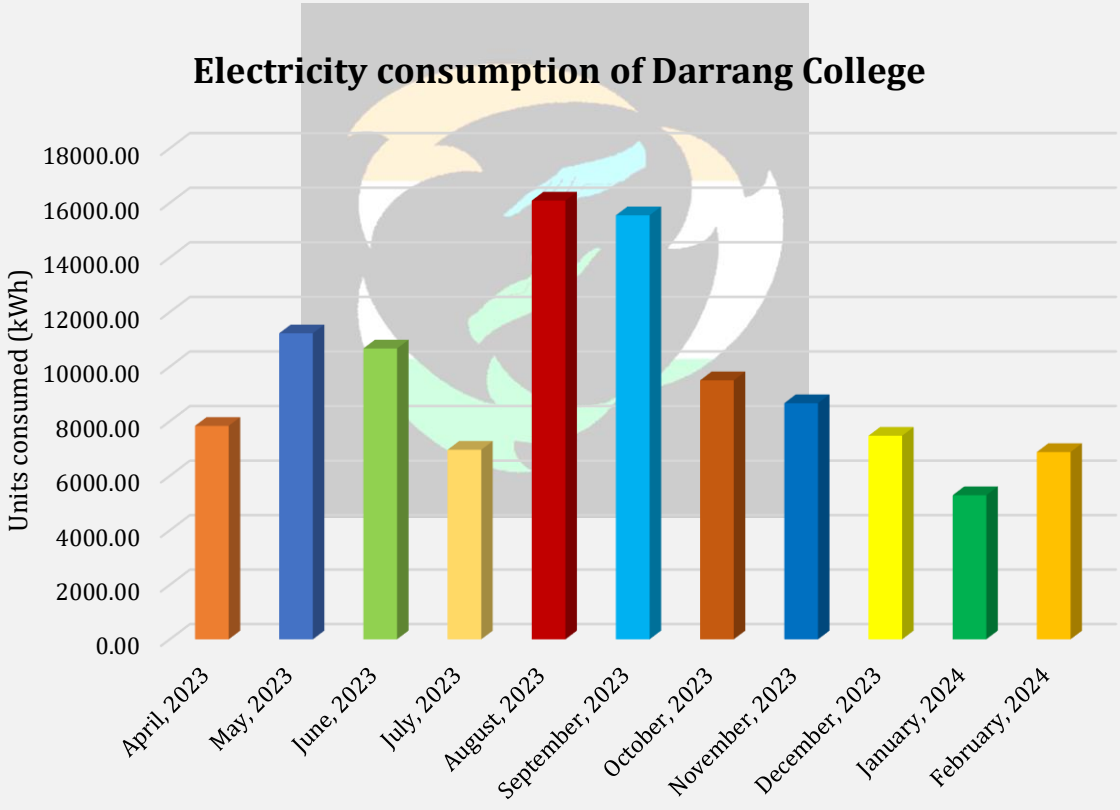

Fig. 3 Electricity consumption of Darrang College

The energy consumption of the College may be categorized under the major heads of lighting load, cooling load, water pumping load and other load (Computer/Laptop/Printer/Photostat machine/CCTV/Laboratory equipment). The distribution of the load of the College is summarized in Fig. 4. It is observed that other load contributes a major fraction of the total load (41%). However, consumption under

other load category is intermittent. Lighting is a constant source of load (11%) in the campus along with cooling load (40%) which is maximum in the summer season.

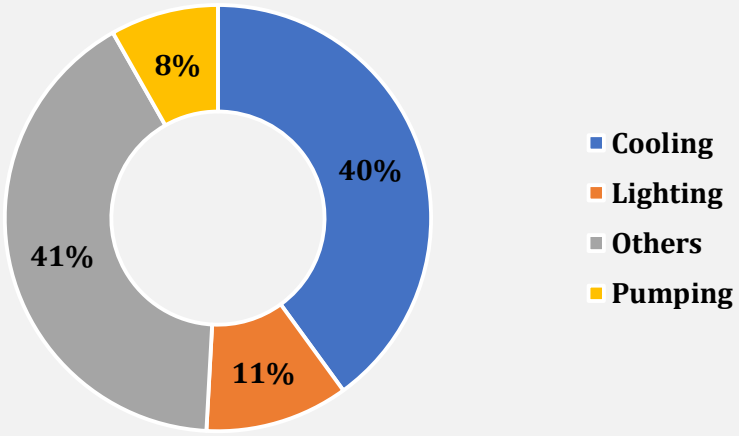

Fig. 4 Load distribution of Darrang College

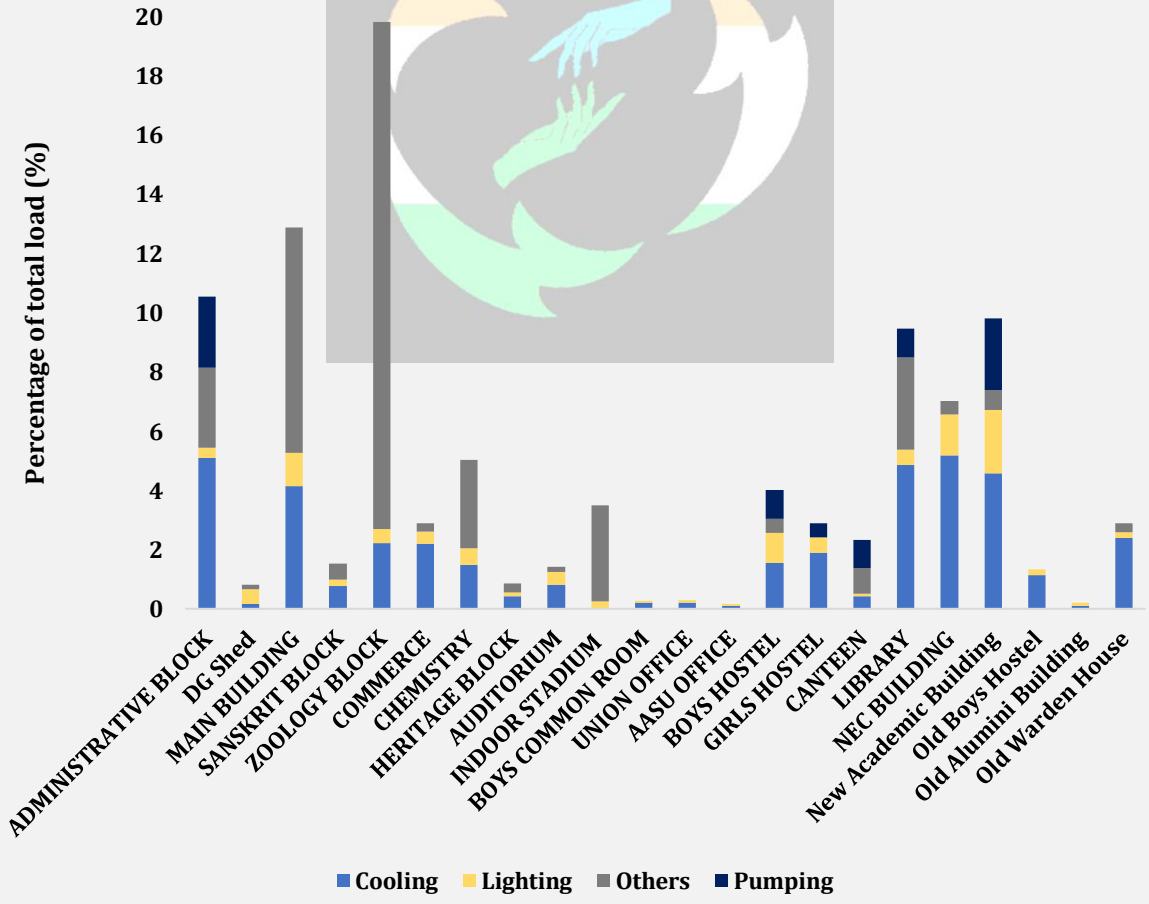

Fig. 5 Load profile of different buildings of Darrang College

Darrang College consist of multiple buildings having various load. A detailed assessment was carried out during the audit period, considering all the loads installed in the different buildings. A building wise/block wise estimation has been made to understand the load profile which is expected to provide an understanding of the electrical energy requirement by the individual buildings/blocks in the campus (Fig. 5). Details of the electrical appliances available at Darrang College is given in Annexure II.

Zoology block housing most of the laboratory equipment is expected to consume the most electricity (19%) at peak load (all equipment running, unlikely scenario). Administrative block, Main Building, New Academic Building, NEC building and Library are the other major energy consuming buildings of the college.

Diesel generator (DG) sets

There are two DG sets installed in the college campus that covers the loads of academic blocks, administrative building, library, canteen and auditorium. There is one DG set each in the Girls and Boys Hostel. The specifications of the DG sets are shown in Table 1.

Table 1: Diesel Generator Set Specification

	College Campus		Boys Hostel	Girls Hostel
Make	Kirloskar Oil Engines Ltd.	Kirloskar Electric Co. Ltd.	Kirloskar	Kohler Power India Pvt. Ltd.
Model	KG 254 S0	4AB225S1	NA	KES 15II
Rated kVA	140	100	20	15
Rated kW	112	85	16	12
Voltage	415	415	415	230
Frequency	50	50	50	50
Specific Fuel Consumption (SFC)	At 100% load-37.1 ltr/hr	At 100% load-28.0 ltr/hr	At 100% load-6.0 ltr/hr	At 100% load-4.0 ltr/hr
	At 75% load-28.8 ltr/hr	At 75% load-21.9 ltr/hr	At 75% load-4.9 ltr/hr	At 75% load-3.0 ltr/hr
	At 50% load- 20.4 ltr/hr	At 50% load- 15.5 ltr/hr	At 50% load- 3.4 ltr/hr	At 50% load- 2.2 ltr/hr
Photograph				

The performance assessment of the DG set is done by evaluating the specific fuel consumption [SFC= Total fuel consumed (litres)/ total power generated (kW)]. The performance assessment is based on the monthly fuel consumption data. It was however observed that the record keeping of the fuel consumption and operating hours of the DG sets was not proper. In absence of the proper records a proper performance assessment

of the DG set could not be conducted. However, as per design value the fuel consumption of installed DG set under different load conditions is shown in Table 1. It is recommended that performance analysis of the DG be carried out to ensure its efficient functioning for ensuring energy conservation. Regular maintenance of the system is also recommended.

The data recording system for energy generation and fuel consumption by DG sets is not proper. The current practice involves noting fuel purchased and duration of operation of only some of the DG sets in a notebook. It is strongly recommended to implement data recording or data logging of monthly fuel consumption and monthly energy generation practices for the DG set. A typical data logging and periodic maintenance format is given below.

Month/Year:...../.....					Generator Operator Name:.....				
Date	Generator Name	Capacity/ location	Time		Meter Reading		Fuel Addition	Total Running Hrs	Total meter reading	Signature of operator
			Start	End	Start	End				

Data Logging format for periodic maintenance:

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

Water pumping systems

Darrang college has a total of 5 numbers of water pumps of different capacities. Some of these water pumps are used to pump water from borewell up to the filtration unit and some are used to pump the water from filtration unit to the overhead storage tank. All pumps are not operated in parallel. Regular maintenance of these pumps is required for efficient functioning. Also, if any changes and new installation is required to be done, management may take initiative to purchase energy efficient motor (EEM) only.

Battery backup systems

There are a number of battery backup system in the college providing backup for computers in the administrative building, computer labs and library. It was observed that some of these batteries are at their end of useful life consuming higher electricity due to reduction in the charging-discharging cycle. It is recommended to replace such batteries which are at the end of their useful life.

7. ILLUMINATION STUDY AND ENERGY CONSERVATION IN LIGHTING SYSTEM

Lighting contributes about 11 % of total load in the campus. The lighting load of the campus is consisting of LED bulb and LED tubes. It has also been observed that almost all the luminaries have already been converted to energy efficient LED lighting except few CFL lamps in some locations. The College authority intend to comply with energy efficient measures by converting remaining lighting systems to LED lighting.

The building wise and floor wise lux level is measured by the portable lux meter (Make: Benetech, Model: GM1351). Location/Floor/ Room/ area wise Lux level was measured and the details are summarized in Table 2.

Table 2: Lux level in different buildings

Sl. No.	Name of building	Luminaries used	Average Lux level (Lux)
1	**Administrative Block**	LED Bulb (9W)/ LED Tube (20W)/ CFL Light (20W)	125
2	**Main Building**		162
3	**Sanskrit Block**		87
4	**Zoology Block**		75
5	**Commerce**		226
6	**Chemistry**		98
7	**Heritage Block**		137
8	**Auditorium**		146
9	**Indoor Stadium**		338
10	**Boys Common Room**		156
11	**Union Office**		133
12	**Aasu Office**		146
13	**Boys Hostel**		186
14	**Girls Hostel**		193
15	**Canteen**		147
16	**Library**		96
17	**Nec Building**		113
18	**New Academic Building**		112
19	**Old Boys Hostel**		82
20	**Old Alumini Building**		90

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. Some classrooms receive very less natural light due to their orientation. It is observed that there is scope for retrofitting of transparent roof in the Assam Type buildings as and when the roof are replaced, to increase natural lighting in the rooms.

8. OBSERVATIONS AND RECOMMENDATIONS

The following point were observed while analyzing the energy use pattern of the college.

- Absence of sub-meters in different buildings makes it difficult to evaluate the energy consumption pattern of each building separately. It is advised to install a separate sub-meter for each building to track its own energy consumption because the campus is made up of several buildings with energy-consuming machinery. Both the performance evaluation of electrical uses and the implementation of energy conservation measures will benefit from this.
- At the moment, the campus's total installed load includes loads for fans, motors, and lights. With the exception of a few places where energy is utilized on a daily basis, the majority of these loads are only used occasionally. The highest monthly demand is between 5290 kWh to 16086 kWh.
- 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.
- Data of energy generation and consumption by DG set is not maintained properly. It is recommended to have a log book recording the fuel consumption, duration of operation, etc. which will help in future performance assessment of energy profile of the systems as well as preventive and regular maintenance work.
- 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 at most of the locations.

- It is also observed that in some parts of the study area in library, laboratory and class room there is inadequate 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.

Recommendations for energy management in buildings

Illumination:

As much as feasible, natural light should be employed to provide the necessary level of lighting. Particularly during the day, less artificial light is needed. Care should be made while employing artificial lighting so that each area's lights may be partially turned off when not in use. For instance, 110 lux is acceptable while the space is not being utilized for work, but 150–300 lux is needed when working on a computer. This may be done by turning off a few of the lights. Additionally, properly labelling or numbering of the switches will make it easier for occupants or staff to utilize them. It is recommended to maintain standard illumination levels (As per IES standard) as shown in Table 3.

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.

Table 3: Standard illumination levels

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

Preventive maintenance

Verify and keep an eye on equipment performance. Keep a regular record of all important equipment's operations and maintenance. Prior to the need for big repairs, resolve small issues. Regular equipment inspections by competent personnel are required for this. At least once every six months, a maintenance shutdown should be performed. Contacts and other components should be carefully scrutinized for self-heating, loose connections, and voltage imbalance during this wiring. Before making any substantial repairs, consider the financial advantages of replacing the outdated equipment with more compact and efficient equipment. Such research should be completed far in advance to allow for speedy decision-making in the event of a breakdown. To keep all equipment on only when necessary, adjust schedules. Adjust temperature & humidity set points for AC within comfort zones seasonally.

Training & awareness

The operational and maintenance employees should get training and information on energy management concerns and practices. The operational personnel must get thorough training on each kind of equipment, system basics, the usage of reference materials and manuals, maintenance methods, service instructions, and warranty information before implementing an efficient preventive maintenance programme. They might be given appropriate maintenance schedules for certain pieces of equipment.

Other savings

There are built-in power-saving modes on new computers that are now on the market. These displays are referred to as Energy Star compatible displays. The majority of users, it was discovered, are unaware of this function. As a result, measures should be done to educate everyone of this and any similar possibilities in the future. In order for employees to turn off their terminals while not in use, switches for computers should be made more accessible.

Integration of renewable energy in the campus

The college authorities may install and generate solar energy because the college campus consists of several buildings with sufficient roof space accessible, which will lower the institution's yearly energy costs. There is however scope installing rooftop systems in the Assam Type Buildings, most of which are oriented towards the South.

Other measures

- 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.
- 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.
- Management may take an initiative to make an emergency assembly point to take measure in case of any disaster like fire, earthquake etc. and may conduct emergency mock drill including student participation in the campus.
- In case of any changes required in the luminaries, management may take initiative to change the luminaries in phase manner instead of changing all the luminaries. For cost benefit analysis of such replacement please refer to Annexure III.
- Assessment may be done in the campus to install roof top solar panel to get solar power for utilization in some of the buildings.

Annexure I: Building details of Darrang College

Sl. No.	Room No.	Area (Sq. ft)
1	Teachers Common Room	870.25
2	R – 24 (Geography)	722.75
3	R – 23 (Geography)	855.5
4	R – 25 (Geography)	594.5
5	R – 6 (Geography)	457.25
6	R – 7 (Geography)	464
7	R – 8	464
8	R – 9 (Botany)	437.9
9	Botany (Teachers Common Room)	495
10	Botany General Lab.	1017.75
11	Botany Lab.	826
12	Botany Kitchen (R – 11)	219.45
13	Botany Toilet	32.39
14	Chemical and glassware (Botany)	158.25
15	G. Lab -3 (Botany)	781.75
16	Multimedia Class room (Geo)	745.47
17	Staff common room (Geo)	386.1
18	Dept. Bathroom (Geo)	86.1
19	Kitchen (Zoo)	145.5
20	Teachers Common Room (Zoo)	715.77
21	Museum (Zoo)	750.96
22	Adv. Microscopy room (Zoo)	79.8
23	Bioinformatics Lab.	149.72
24	Lab (Zoo)	1101.87
25	Toilet (Zoo)	29.592
26	Mice Room (Zoo)	84
27	R – 5	950.62
28	Teachers Common Room (Eng)	536.679
29	G – III	1105.58
30	Plant Physiology adv. Molecular Biology Lab	315
31	P.G. class room (R – 12)	739.04
32	Plant Pathology and micro biology Lab.	329.84
33	R – 13	486.08
34	Teachers Common Room (Hindi)	302.56
35	R – 14	369.52
36	Teachers Common Room (Bengali)	292.64
37	Toilet (Bengali)	50.4
38	Toilet (Sanskrit)	23

Annexure I: Building details of Darrang College

Sl. No.	Room No.	Area (Sq. ft)
39	Teachers Common Room (Sanskrit)	346.71
40	R – 15	466.83
41	R – 16	606.06
42	R – 17	813.54
43	R – 56	559.54
44	Computer Dept. (Old)	807.12
45	R – 53	198.56
46	NSS Room	329.63
47	R – 54	234.36
48	Teachers Common Room (Nepali)	180.7
49	Toilet (Nepali)	30
50	Teachers Common Room (Boro)	151.51
51	Common Toilet (New)	471.6
52	Girls common room	1410.1
53	Lab – 5 (Physics)	728.16
54	Lab – 3 (Physics)	861.36
55	Dark Room (Physics)	441.04
56	Lab Staff Room (Physics)	328.56
57	Lab – 4 (Physics)	703.66
58	R – 27 (Physics)	483.2
59	R – 26 (Physics)	248.05
60	Lab – 1 (Physics)	882.08
61	Lab – 2 (Physics)	739.04
62	Teachers Common Room (Physics)	774.8
63	Kitchen Room (Physics)	104.146
64	Toilet Room (Physics)	62.72
65	G – II / R – 21	1179.09
66	G – I / R – 20	1473.12
67	R – 1	787.36
68	R – 2	876.16
69	R – 3	1024.16
70	Teachers Common Room (Assamese)	674.1
71	Library (Assamese)	433.62
72	Office Toilet (Ground)	104.04
73	Exam Branch	1711.12
74	Medical Room Office	221.48
75	Meeting Room Office	457.47
76	General Branch	426.075
77	Vice Principal Room	189.1

Annexure I: Building details of Darrang College

Sl. No.	Room No.	Area (Sq. ft)
78	Toilet Room (Vice Principal)	63.44
79	Blank Khata Store Room (Vice Principal)	103.85
80	Academic Vice Principal Room	140.39
81	Accounts Branch	154.85
82	Bearers Room (Chem)	175.72
83	Balance Room (Chem)	91.08
84	Staff Urinal (Chem)	25
85	TDC Gen. Lab – 2 (Chem)	1056.811
86	TDC Gen . Lab – 1 (Chem)	873
87	Store Gen (Chem)	424.41
88	Physics Lab (Chem)	185.367
89	HoD Room (Chem)	96.03
90	I and II sem Major Lab (Chem)	896.98
91	Teachers Common Room (Chem)	427.42
92	Digital Class Room (Chem)	352.17
93	R – 30 (Chem)	722.4
94	Toilet (Chem) 1st floor	28.56
95	Library (Chem)	241.67
96	R – 31, 33	564
97	R – 32	284.82
98	Old Boro Dept. (Chem Building)	288.86
99	R – 34 (Chem)	521.7
100	New Physical Lab (Chem)	349.28
101	Old TTM Dept. (Chem Building)	298.96
102	Staff Urinal (chem.) 2nd floor)	45.9
103	Principal Room)	319.14
104	Principal Toilet	27.84
105	Principal Kitchen with toilet	247
106	IQAC room (Office)	275.9
107	PM USHA Office	269.5
108	General Kitchen (Office)	272.8
109	Store Room (Office) – I	325.44
110	Store Room (Office) – II	223.74
111	General Toilet (1st Floor)	89.9
112	Exam control room (Old Library)	2596.88
113	Academic vice principal room	130.68
114	R – 44 (Commerce)	896.94
115	R – 45 (Commerce)	902.98

Annexure I: Building details of Darrang College

Sl. No.	Room No.	Area (Sq. ft)
116	Teacher common room (Com.)	599.278
117	Teacher Common Room Toilet (Com)	102.111
118	Computer Cabin (Commerce)	235.32
119	Girls Common Room With Toilet	578.38
120	Room No – 51 (Commerce)	585.111
121	DCCS Library (Commerce)	344.339
122	DCCS Library Store Room (Com)	72.179
123	DCCS Office (Commerce) / R	103.02
124	Room No – 47 (Commerce)	878.82
125	Room No – 48 (Commerce)	878.82
126	Rom No – 49 (commerce)	100.44
127	Room No – (New Com)	873.3
128	Room No – 46 (Com)	873.3
129	Room No – (Com – 4)	1144.023
130	New Alumni Hall	2921.62
131	Assignment Submission Room Unit	721.59
132	Office Room (Co-ordination)	239.19
133	Office Room – 2 (IGNOU)	223.11
134	Office (KKHSOU)	223.11
135	IDOL Class Room - 1	319.59
136	IDOL Office Room	402
137	Indoor Stadium	6545.22
138	Office Room (Indoor Stadium)	181.44
139	Boy's Toilet (Indoor Stadium)	208.74
140	Girl's Toilet (Indoor Stadium)	178.017
141	Change Room (Indoor Stadium)	80.23
142	OBH (Room No-1)	852
143	OBH (Room No-2)	721.14
144	OBH (Room No-3)	709.02
145	OBH (Room No-4)	721.14
146	OBH (Room No-5)	743.36
147	OBH (Room No-6)	719.12
148	Alumni Association Office Room	749.84
149	Auditorium General Toilet	228.26
150	Auditorium	10596.8
151	Boy's Common Room	618.89
152	Central Library (AASU Office)	632.82
153	Boy's Common Room Toilet	50.96
154	Union Hall	611.52

Annexure I: Building details of Darrang College

Sl. No.	Room No.	Area (Sq. ft)
155	Processing Room (Library)	276.52
156	Property Counter (Library)	138.75
157	Assistant Librarian Room	142.74
158	Xerox Room	78.2
159	News Paper Store Room (Library)	89.76
160	Staff Room (Library)	100.74
161	Kitchen Room (Library)	74
162	Server Room (Library)	31.171
163	Journal Section Room (Library)	275.94
164	E- Library (Library)	238.602
165	Reading Room (Arts Section)	1937.52
166	Arts Reference Room	454.31
167	Guest Toilet (Library)	119.88
168	Ladies Toilet (Library)	115.43
169	Librarian Room	205.38
170	Computer Section Room	390.42
171	Reading Room (Science Section)	2835.75
172	Reference Room (Science Section)	418.27
173	Teacher's Reading Room (Science Section)	298.2
174	Old Store Room (Library)	304.56
175	1st Flore Corridor	265
176	Conference Hall	755.04
177	Meeting Tea Room	102.258
178	Bound Volume Section (Library)	399.52
179	Reading Room (Commerce Section)	2018.18
180	Counter (Library)	423.8
181	Dept. of History (NAB)	330.99
182	History - 2	380.16
183	Tissue Culture Bab. (Biotech)	466.56
184	Bioinformatics Facility	267.27
185	BBT – Institutional Biotech Hub	382.32
186	Molecular Biology Lab	378.78
187	Toilet (Biotech)	264.6
188	Dept. of Biotech	384.09
189	Biotech - 1	382.32
190	Female Wash Room (General)	290.28
191	Biotech - 02	412.55
192	Biotech Class room -1 (Assamese PG NAB)	412.55
193	Home Science (Class Room – 2)	387.63

Annexure I: Building details of Darrang College

Sl. No.	Room No.	Area (Sq. ft)
194	Dept. of Home Science	382.32
195	Class Room – 3 (Home Science)	234.08
196	Home Science Laboratory	235.41
197	Library (Home Science)	160.336
198	Biotech Class Room – 2 (Assamese PG NAB)	371.7
199	Male Wash Room (Ground Floor)	267.447
200	Education - 1	382.32
201	Dept. of Education	375.84
202	Education - 2	382.32
203	Education Lab (Lab 1)	382.32
204	Education Lab -2	244.08
205	Library(Education)	257.04
206	History - 1	380.16
207	Dept. of Economics	330.99
208	NAB - 10	382.32
209	NAB - 8	378.78
210	NAB - 9	284.97
211	NAB - 4	633.68
212	NAB - 7	382.32
213	Ladies Toilet (1st Flore)	290.28
214	NAB - 6	382.32
215	NAB - 5	382.32
216	Dept. of Computer Science	237.6
217	Computer Lab	1036.8
218	NAB - 2	1147.52
219	NAB - 3	1060.23
220	Gents Toilet (1st Flore)	288.64
221	Library of Philosophy	244.26
222	NAB – 11(Philosophy)	548.64
223	Dept. of Philosophy	518.61
224	NAB - 1	1131.84
225	Small Room (NCAR Nab – 1)	155.52
226	Dept. of Pol. Science	457.38
227	Dept. Library (pol. Science)	332.86
228	Psychology - 1	386.26
229	Dept. of Psychology	251.72
230	Counseling Centre (PSY)	260.4

Annexure I: Building details of Darrang College

Sl. No.	Room No.	Area (Sq. ft)
231	Psychology - 3	371.07
232	Statistics - 1	382.32
233	Dept. of Statistics	346.38
234	Statistics - 2	269.04
235	Statistics – 6 (Bearers Room)	260.19
236	Statistics - 3	242.49
237	Library Cum Computer Room	242.49
238	Wash room (Men) 2nd Flore	288.64
239	Statistics - **4**	285.147
240	Dept. of TTM	233.64
241	Sociology - 3	269.04
242	Sociology - 4	233.64
243	Dept. of Sociology	244.64
244	Sociology - 2	568.7
245	Sociology - 1	933.1
246	Dept. Library (Mathematics)	378.78
247	Dept. of Mathematics	378.78
248	Math. Computer Room cum Lab	631.89
249	Wash Room (General) 2nd Flore	284.97
250	Pol. Science - 2	380.55
251	Pol. Science - 1	380.55
252	Math. Room - 1	380.16
253	Math. Room - 2	380.55
254	Pol. Science - 3	284.97
255	CSSC, Office	382.32
256	Reading Room, CSSC	383.06
257	Gents Toilet (3rd Flore)	270.469
258	Ladies Toilet (3rd Flore)	210.6
259	Laboratory – Psychology (3rd Flore)	461.55
260	Conference Hall (3rd Flore NAB)	909.06
261	Gymnasium	1827.8
262	Change Room (Gymnasium)	38.95
263	Toilet (Gymnasium)	29.45
264	NCC Office Toilet (73 Girls)	42.24
265	NCC Office (Room No – 1)	106.56
266	NCC Office(Room No -2)	184.47
267	NSS Office	372.11
268	Fishery Lab (zoo)	350.46

Annexure I: Building details of Darrang College

Sl. No.	Room No.	Area (Sq. ft)
269	Room No - 19	488.96
270	General Store (zoo)	188.68
271	Library (zoo)	213.061
272	MSC Class Room – 1 (zoo)	324.53
273	MSC Class Room – 2 (zoo)	292.23
274	Microtome Room (zoo)	293.76
275	Room No – 18	491.52
276	Boys General Toilet (Commerce Outside)	162
277	Mushroom Cultivation Room	1391.04
278	Mushroom Cultivation Store room	236.22

Annexure II: Details of Appliances available at Darrang College

Appliance/Equipment	Wattage	Type	Total Number
FAN	70	Cooling	845
TUBELIGHT	20	Lighting	926
LED BULB	9	Lighting	362
AC	1100	Cooling	17
COMPUTER	100	Others	75
PRINTER	200	Others	25
Projector	200	Others	16
Air Cooler	150	Cooling	4
Aquaguard	20	Others	13
Autoclave	3000	Others	3
Barcode scanner	15	Others	4
BOD Incubator	700	Others	2
CCTV	30	Others	32
CCTV DVR	30	Others	2
CCTV Monitor	60	Others	3
Centrifuge	600	Others	5
COFFEE MAKER	1000	Others	1
Calorimeter	500	Others	4
Conductivity Meter	15	Others	1
Deep Freezer	500	Cooling	0
DegitalServer	300	Others	1
Digital pH Metter	15	Others	6
Digital Balance	25	Others	1
Digital Board	300	Others	0
Digital Scanner	150	Others	1
Digital TV	300	Others	2
Electrical Balance	30	Others	1
Electrical Compound Microscope	150	Others	2
Electronic Balance	30	Others	4
Electronic Stirrer	20	Others	1
Exhaust Fan	60	Others	19
Flame Photometer	350	Others	1
FRIDGE	500	Cooling	1
Gas analyser	300	Others	0
Halogen Light	250	Lighting	3
Heating Mantle	300	Others	1
Incubator	300	Others	2
Knife Sharpner	150	Others	1
Laminar Air Flow	300	Others	4
Magnatic Stirrer	60	Others	1
Melting point Apparatus	200	Others	1
Metal Halide Light	600	Others	10
Mixer Grinder	750	Others	2
Online UPS	300	Others	1
OTG Oven	1500	Others	0

Annexure II: Details of Appliances available at Darrang College

Appliance/Equipment	Wattage	Type	Total Number
Oven	3000	Others	9
PCR Machine	1000	Others	1
Podium With Speaker	300	Others	1
Polari Meter	300	Others	1
Projector Display Monitor	300	Others	1
Refrigerator	400	Cooling	9
Smart TV	250	Others	4
Soul Server	100	Others	1
Spectro photometer	300	Others	2
Speaker	30	Others	2
Stabilizer	500	Others	1
Stand Fan	100	Others	2
Suction Pump	1000	Others	1
Sysmograph	200	Others	1
Table Fan	60	Cooling	5
pH Meter	30	Others	1
TV	300	Others	5
UV Spectrophotometer	300	Others	0
UV Projector	300	Others	1
Wall Fan	60	Others	5
WATER PUMP	1000	Pumping	1
	2000	Pumping	3
	5000	Pumping	2
Wifi Router	10	Others	4
Xerox Machine	1000	Others	3

Annexure III

Cost benefit analysis

Example: Replacing existing 40-Watt TL with 10 Watt LED.

Cost Benefit Analysis*

Parameter	40 TL	9 W LED	Savings
Cost in ₹	50	100	-
Wattage (W)	40	9	31
Average Life(hours)	8,000	40,000	-
Annual consumption (kWh) (Annual 8 hr/day and 300 working days)	96	21.6	74.4
Annual running cost at ₹ 6.45 per kWh (₹)	620	140	480
Simple payback period		2.5 months	
Considering single lamp replacement			

The example is taken only for the light with installed capacity of 40 W × 1 no. = 40 Watt, which can be replaced by 9 Watt lamp in the existing frame. We can have maximum saving of 31 Watt directly in single frame.

Standard light output for LEDs and CFLs with wattages of power consumption are shown below.

Light Output (Lumens)	LEDs (W)	CFLs (W)
450	**4 - 5**	**8 - 12**
300 - 900	**6 - 8**	**13 - 18**
1100 - 1300	**9 - 13**	**18 - 22**
1600 - 1800	**16 - 20**	**23 - 30**
2600 - 2800	**25 - 28**	**30 - 55**