ENERGY AUDIT

Principal/DDO
Goalpara College, Goalpara

Acknowledgement:

We are sincerely thankful to the Goalpara College management for giving us the opportunity to conduct energy audit in Goalpara College campus.

We are also grateful to Dr. Subhash Barman, Principal, Goalpara 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

Mr. Deepjyoti Barman, B.E (Mech), M.Tech (Energy Technology)
(Proprietor)

Principal/DDO
Goalpara College, Goalpara

STUDY TEAM:

1. Mr. Deepjyoti Barman, B.E (Mechanical), M. Tech (Energy Technology),
   ADD SQUARE SOLUTIONS
   House No: 298(A), Ward No:04, M.G Road, Abhayapuri, Dist: Bongaigaon, Assam 783384

2. Mr. Homen Chandra Ray
   (Technical Assistant)
   ADD SQUARE SOLUTIONS
   House No: 298(A), Ward No:04, M.G Road, Abhayapuri, Dist: Bongaigaon, Assam 783384

RESOURCE PERSON AND ENERGY AUDITOR

Mr. Samar Jyoti Hazarika, B.E (Mechanical), M. Tech (Energy Technology), Assistant Professor, Department of Energy Engineering, North Eastern Hill University, Shillong, Meghalaya

B.E.E Certified energy auditor (EA15266)

Deepjyoti Barman
Proprietor
Add Square Solution

Mr. Samar Jyoti Hazarika
B.E. E Certified energy auditor (EA15266)

Goalpara College, Goalpara

1. Background:

Energy is one of the basic driving parameters for the development of any country. Since the reserves of fossil fuels are limited and depleting fast due to abundant use by mankind, therefore an integrated approach is necessary to meet up the country's development by utilizing energy generated from fossil fuel in effective way. 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. Goalpara College, Goalpara an educational institute in Goalpara district of Assam taking voluntary objective of reducing energy intensity in the College Campus entrusted Add Square Solutions conducting Energy Audit. To conduct the energy audit, the audit team visited the campus on 21st of February 2022 to collect data and to take some measurement for assessment of different energy consuming components.

2. SCOPE OF WORK

The entire energy audit is focused on assessment of actual operating load, uses pattern of electrical appliances and scope of energy conservation options.

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 based 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.

Principal/HOD
Goalpara College, Goalpara

2.3 Energy Conservation in Air-Conditioning and water pumping system

- Study on present energy consumption pattern by air- conditioning and water pumping systems.
- Exploring Energy Conservation Option (ENCON) in system.

2.4 Diesel Generator (DG) Sets

- Review of DG set operation.
- Total number of DG sets with their operation details.
- Fuel cost involved to run the DG sets.
- Performance assessment of DG sets in terms of Specific Fuel Consumption (SFC i.e. Lit/kWh).

3. METHODOLOGY ADOPTED FOR ENERGY AUDIT

Step 1 - Meeting 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

Principal/DDO
Goalpara College, Goalpara

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, implementation costs, benefits and payback. 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 Goalpara 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	78 kW
	Contract Demand	92 kVA
2	Installed capacity of DG set	25kVA (1 Nos) 20kVA (1 Nos) 15kVA (1 Nos)
3	Annual electricity consumption (January'2020 to December'2020)	48,061.86 kWh
4	Annual electricity bill	Rs. 4,94,420.45

Principal/DDO
Goalpara College, Goalpara

	Annual cost of electricity consumption through DG set. (Considering Rs. 4,000/ Month Diesel Charges)	Rs. 48,000.00
	Total cost of electricity (Utility + DG set)	Rs. 5,42,420.45
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: Detail electrical utility of Goalpara College

5. PRESENT ENERGY SCENARIO

5.1 Review of Present Energy Consumption in various Load

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 Goalpara College is 78 kW and Contracted Demand is 92 kVA. The campus has a dedicated transformer of 100 kVA.

5.1.1 Electrical Energy Consumption

12 months (January'2020 to December'2020) electrical energy consumption data from distribution company (APDCL) has been collected from the college authority and a detail analysis has been carried out to understand the energy uses pattern of the college. Graphical representation of monthly electricity consumption has shown below-

Principal/DDO
Goalpara College, Goalpara

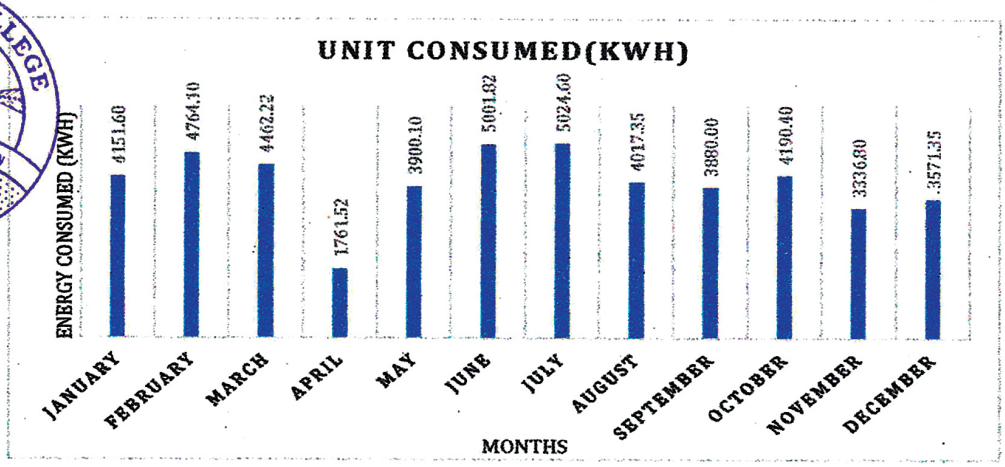


Figure 1: Monthly Energy Consumption (January-December 2020)

It has been observed from electricity bills that the monthly average maximum demand for the duration of January 2020 to December 2020 was 24.07 kVA and average power factor was maintained as 0.98.

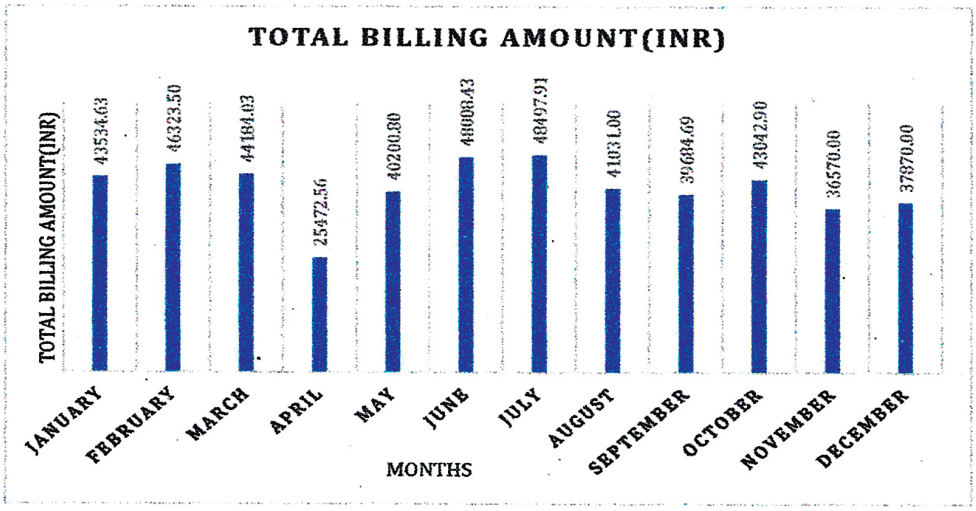


Figure 2: Monthly Energy Bill (January-December 2020)

Total electricity bill of Goalpara College for the year 2020 was Rs. 4,94,420.45. The maximum electricity bill paid to APDCL in the month of July 2020 where the maximum demand was recorded as 49.80 kVA and the PF was maintained as 0.99.

Principal/DDO
Goalpara College, Goalpara

5.1.2 Fuel Oil Consumption for Electricity Generation

To meet the electrical requirement during load shading or any interruption by the gird power, the campus is also generating their own electricity by using 3 numbers of Diesel Generator (DG) Sets with a rated capacity of 25 kVA, 20 kVA and 15 kVA. Monthly cost of fuel consumption by all the DG sets is estimated as Rs. 4,000.00.

5.2 Transformer Detail:

The campus has a dedicated transformer of 100 kVA. Detail technical specification of the transformer is shown in the table below-

Name of Manufacturer	M/s POWER MAKER(UNIT-II)
Model/Serial Number	PMU/100/101
Transformer Capacity (kVA)	100
Voltage	Upto 11kV
Year of manufacturing	2017
Total losses at 50% loading - Watts	475
Total losses at 100% loading - Watts	1650

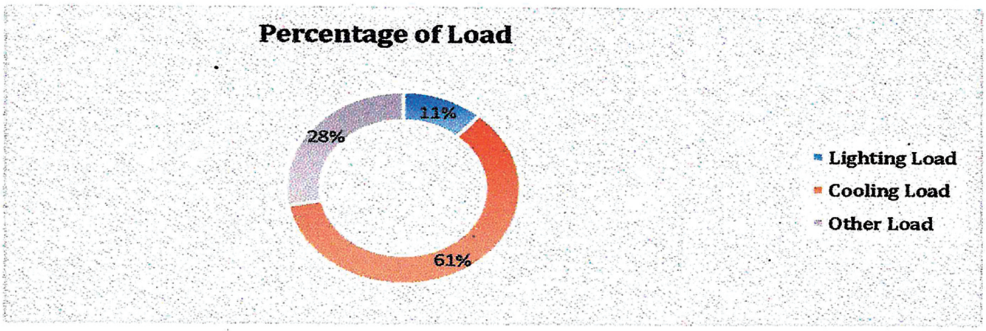
Table 2: Distribution Transformer Detail

6. PERFORMANCE EVALUATION, OBSERVATION AND ANALYSIS

6.1 ASSESSMENT OF ACTUAL OPERATING LOAD AND SCOPE FOR OPTIMIZING

6.1.1 Energy consumption by various loads

Presently the college campus is connected with the electrical power for state electricity board and own DG set supplying power to different buildings. The major energy consuming equipments/ utilities available in the building are-



Principal/DDO
Goalpara College, Goalpara

Figure 3:Energy consumption by various loads

Load	Appliances
• Lighting Load	LED Bulb, LED Tube
• Cooling Load	Air Conditioner/ Fan
• Other Load	Computer, Printer, Photostat machine, Laboratory equipment, Digital classroom equipment etc

6.1.2 Building wise estimation of loads:

Total 9 (Nine) numbers of building/blocks have been identified for study and it has been found that the maximum electrical load is in academic/administrative block. The academic/administrative block consist of all office room including principal and vice principal's room, teaching staff room, class room, conference room and the hall used as auditorium or cultural activity room. Although the library is inside the academic block, it has been studied separately to understand the illumination level and day light uses.

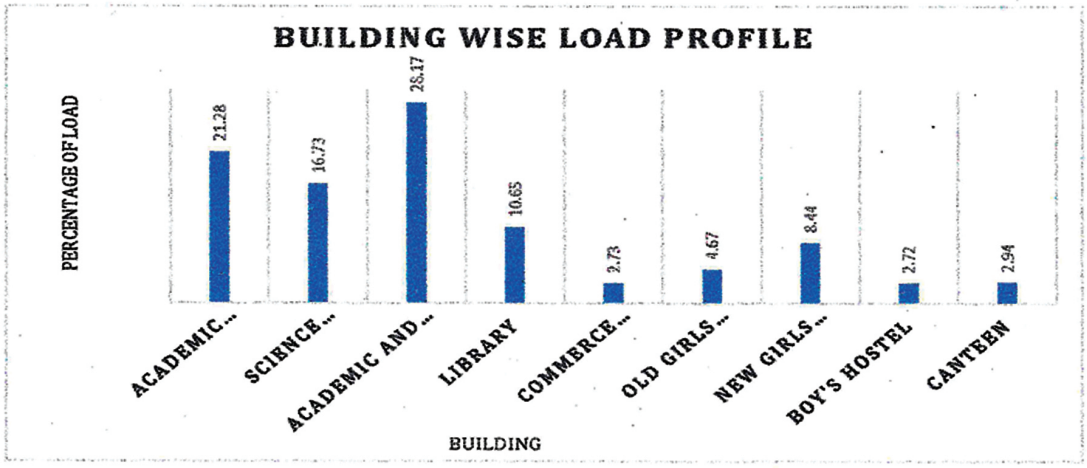


Figure 4: Building wise load profile

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

Principal/DDO
Goalpara College, Goalpara

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 estimated as 63 KW (Which include lighting load, Fan load, AC load, motor load etc.)
- 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 11% of energy consumption of the campus with respect to the connected load of 78 kW. The lighting load of the campus is consisting of 9 W LED bulb and 18 W LED Tube Lights to illuminate the workplace.

6.2.2 Lux Level Survey

The building 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:

Illumination Study					
Major Working Area	Luminaries used	Day Light utilization observation	Lux level (Measured)	Standard Lux level	Remarks
Administrative Office Room	LED Bulb/LED Tube	Good	220	300	
Teaching Staff Room	LED Bulb	Good	230	300	
Hostel Room	LED Bulb	Moderate	220	300	
Class Room	LED Bulb/LED Tube	Good	210	300	
Library	LED Bulb/LED Tube	Moderate	180	300	

Principal/DDO
Goalpara College, Goalpara

Laboratory	LED Bulb/LED Tube	Good	350	500	

Table 3: Illumination Level of different working area

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 building and computer laboratory, 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. Although most of the lights are converted to LED to save energy and to achieve the standard illumination level it is observed that there is still some higher energy consuming luminaire in the campus.

RECOMMENDATION

- Inculcate discipline and sense of participation in the energy conservation movement, any unnecessary lighting during day period should be avoided through awareness programmes.
- It is recommended that all luminaries should be converted to energy efficient LED as an energy conservation measures.
- 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.
- Practice of de-laming to reduce excess lighting during idle/ non-working period.

It is recommended to use standard practice of illumination level as follows (As per IES standard)

Type of interior/activity	**Standard illumination Level (Lux)**

Principal/DDO
Goalpara College, Goalpara

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	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 of different working area

6.3 DIESEL GENERATOR (DG) SET

6.3.1 Review of present Diesel Generator (DG) Set:

There are 3 (three) nos of DG sets with capacity of 25 kVA, 20 kVA and 15 kVA respectively. All three DG sets are used to supply electricity to entire college buildings. The salient technical specifications are as follows:

DG set of 25 kVA:

Make:	Jakson Limited
Model	JSP-25

Principal/DDO
Goalpara College, Goalpara

Sl. No	CJS-12050661
Rated kVA	25 kVA
Rated kW	20 kW
Voltage	415 V
Current	35 Amps
Frequency	50 Hz
Phase	3 Phase
Noise Level	<75dB (A) AT 1 MTR

Table 5: Detail of 25 kVA DG set

DG set of 20 kVA

Make:	Jakson Limited
Model	JSP-20
Sl. No	CJS-13037132
Rated kVA	20 kVA
Rated kW	16 kW
Voltage	415 V
Current	28 Amps
Frequency	50 Hz
Phase	3 Phase
Noise Level	<75dB (A) AT 1 MTR

Table 6: Detail of 20 kVA DG set

DG set of 15 kVA

Make:	Kohler Power Systems
Model	KES15II
Sl. No	IND15L0548
Rated kVA	15 kVA
Rated kW	12 kW
Voltage	230 V
Current	65 Amps
Frequency	50 Hz

Principal/DDO
Goalpara College, Goalpara

Phase	1 Phase
Noise Level	75dB (A) AT 1 MTR

Table 7: Detail of 15 kVA DG set

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 all the DG sets.

6.4 WATER PUMPING SYSTEM:

The campus has total 9 (nine) numbers of water pumps. Out of these 4(Four) are submersible and 5(five) are surface water pump. Although the detail specification of the water pumps are not available, it has been observed from the pump controller that all the water pumps are of 1 HP capacity. Water pumps were installed in old girl's hostel, new girl's hostel, canteen and KK Handique state open university study centre building. Principal's residence, academic/administrative building, new RCC building. One submersible water pump is used to meetup the water requirement for the garden. During study the measured value of current was found as 7.4 Amp whereas FLC value of the pump was 7.5 Amp.

7. GOOD ENGINEERING PRACTICES

7.1 GUIDELINES FOR ENERGY MANAGEMENT IN BUILDINGS

7.1.1 Illumination:

Natural light should be used as much as possible to meet the required illumination level during day time. While using the artificial lights, care should be taken of so that 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

Principal/DDO
Goalpara College, Goalpara

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

In some of the area 30 W FTL and CFL has been observed, replacing them with more efficient LED tube-lights should be used.

7.1.3 Air-Conditioning System

The Goalpara 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.

7.1.4 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.

Principal/DDO
Goalpara College, Goalpara

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.

8. INTEGRATION OF RENEWABLE ENERGY IN COLLEGE CAMPUS:

8.1 INITIATIVE ALREADY TAKEN

To minimize the dependency on electrical energy consumption from conventional energy sources, energy generation and utilization from the renewable energy sources has been adopted. Initially the college has installed 10 numbers of 30-Watt Solar Street light to replace the conventional street light in the campus.

Detail specification of Solar Street Light has been listed below-

Luminaries	30 Watt
Battery	12.8V 24AH Lithium PO4 Battery
Solar PV Module	75Wp Solar PV Module (Poly crystalline)
Pole	6M GI Pole with Light Arm, Panel Stand and Accessories

Principal/DDO
Goalpara College, Goalpara

Figure 5: 30-Watt Solar Street Light Installed in the Campus

Total load of existing street lights has been estimated as 1.7 %. Half of the total street light load will get reduced by utilization of solar street light I,e 0.84% (Approximate) of total installed load of the campus has been powered by the solar energy. The college administration is planning to install another 10 numbers of solar street light in the campus, which will further reduce the energy consumption from the distribution company.

8.2 POTENTIAL IDENTIFICATION OF POSSIBLE ROOFTOP SOLAR POWER PLANT.

The college campus has adequate rooftop area for solar installation. Most of the buildings are Assam type tin shed buildings and are of shadow free. A small assessment was made to estimate the solar installation potential on the rooftop of the new RCC building. As per the preliminary investigation, the total usable rooftop area for solar installation in the new RCC building is 1200 sq mtr which is sufficient to install 120 kWp Solar power plant.

Principal/DDO
Goalpara College, Goalpara

Annex 1

Data logging format for DG Set:

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				

Principal/DDO
Goalpara College, Goalpara

Annex 2

Data logging format for periodic maintenance of DG Set:

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

Principal/DDO
Goalpara College, Goalpara