ENERGY AUDIT REPORT

Pragjyotish College, Guwahati

Address:
Santipur, Guwahati-781009,
Assam.

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Conducted By

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DISCLAIMER

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All the calculations for energy savings and recommendations to achieve these savings given in this report is fully based on the data shared by the college with PPSES.

ACKNOWLEDGEMENT

We express our sincere gratitude to the authorities of Pragjyotish College, Guwahati for entrusting and offering the opportunity of energy performance assessment assignment.

- Dr. Manoj Kumar Mahanta - Principal

We are thankful to Pragjyotish College Guwahati for their positive support in undertaking the task of system mapping and energy efficiency assessment of all electrical system, air conditioners, utilities and other equipment. The field studies would not have been completed on time without their interaction and guidance. We are grateful to their cooperation during field studies and providing necessary data for the study.

We are also thankful to all field staff and agencies working with whom we interacted during the field studies for their wholehearted support in undertaking measurements and eagerness to assess the system / equipment performance and saving potential. Also thankful to all concerned staff interacted during the conduct of this exercise for completing official documentations.

WHY ENERGY AUDIT?

An energy audit determines the amount of energy consumption affiliated with a building and the potential savings associated with that energy consumption. Additionally, an energy audit is designed to understand the specific conditions that are impacting the performance and comfort in your facility to maximize the overall impact of energy-focused building improvements.

An energy audit is a systematic review of the energy consuming installations in a building or premises to ensure that energy is being used sensibly and efficiently. An energy audit usually commences with the collection and analysis of all information that may affect the energy consumption of the building or premises, then follows with reviewing and analyzing the condition and performance of various building services installations and building management, with an aim at identifying areas of inefficiency and suggesting means for improvement.

Through implementation of the suggested improvement measures, building owners can get the immediate benefit for paying less for energy bills. On the other hand, lowering of energy consumption in buildings will lead to the chain effect that less fossil fuel will be burnt for electricity generation by the power supply companies and relatively less pollutants and greenhouse gases will be introduced into the atmosphere, thus contributing to conserve the environment and to enhance sustainable development.

ENERGY AUDIT TEAM

The team members of PPSES:

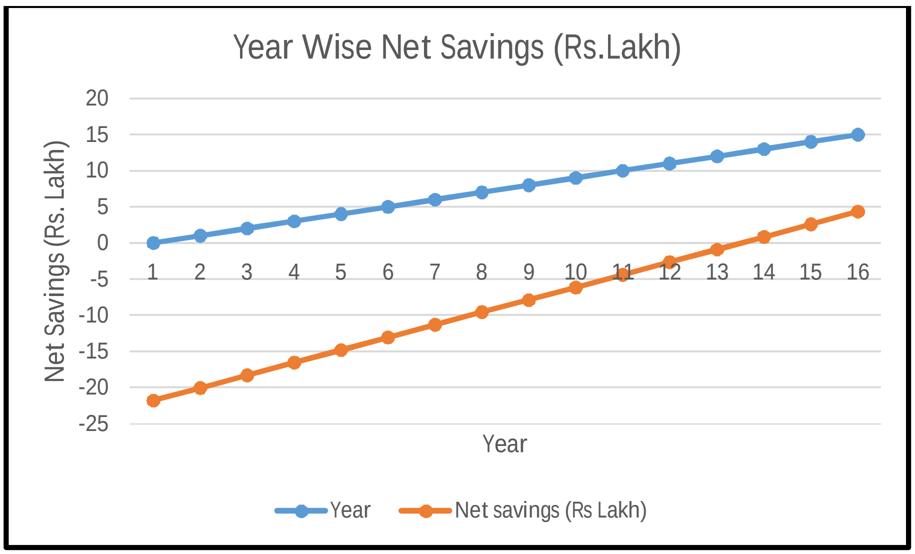
Name	Role	Field of expertise
Dr. Ravi G. Deshmukh	ECM verification, Report verification and presentation	Accredited Energy Auditor, Ph.D., M tech, MBA (Power), Graduate E&TC Engineer with over 20 years of experience in Energy Management, Management of Power System, Power Exchange Operations, Power Trading and Analysis, Electrical Automation. Has worked as Expert in Iron & Steel sector and Energy sector
Mr. Nilesh S. Saraf	Project Coordinator	Graduate Engineer with over 18 years of experience in Project Coordination. Field experience in Renewable Energy Projects, Energy Efficiency Assessment.
Mr. Mahesh Khode	Energy Analyst	Electrical engineer with 5 years of experience in Energy Efficiency Assessment, Electrical distribution system, Design, Power assets Evaluation and Project Management, resource management.
Mrs. Utkarsha Bharate	Data tabulation and analysis & report preparation	Graduate in Electrical & Electronics Engineering with 3 years of experience in Energy & Power projects

EXECUTIVE SUMMARY

Summary of recommended Energy Conservation Measures:

Sr. No	Equipment Name	ECM Details	Investment (Rs. In Lacs)	Savings (kWh/ year)	Carbon credit (Tons of Co2)	Saving (Rs. In Lacs /Year)	Payback (Years)
1	Air Conditioner	Optimize the Air Conditioner temperature setting to 23-25 degree Celsius	0	1687	1.5	0.11	0
2	Ceiling Fan (100 w)	Replacement of existing fans with energy efficient Super fans	0.68	1146.6	0.97	0.08	8.76
3	CFL	Replacement of conventional lights (CFL) with 12w LEDs	0.26	427.68	0.36	0.03	8.87
4	Tube Light	Replacement of conventional Tube light with 20w LEDs	6.81	9820.8	8.35	0.66	10.27
5	Ceiling Fan (70 w)	Replacement of existing fans with energy efficient Super fans	14.04	12789	10.87	0.86	16.27
TOTAL			**21.79**	**25871.08**	**22.05**	**1.74**	**12.5**

Year	Investment (Rs. In Lacs)	Saving (Rs. In Lacs /Year)	Cum Savings(Rs Lakh)	Net savings (Rs Lakh)
0	-22	0	0	-22
1	0	2	2	-20
2	0	2	3	-18
3	0	2	5	-17
4	0	2	7	-15
5	0	2	9	-13
6	0	2	10	-11
7	0	2	12	-10
8	0	2	14	-8
9	0	2	16	-6
10	0	2	17	-4
11	0	2	19	-3
12	0	2	21	-1
13	0	2	23	1
14	0	2	24	3
15	0	2	26	4



Particulars	Quantity	Energy In kW
CFL 18W	99	1.78
Tube Light 40W	682	27.28
LED 18W	354	6.37
SL LED 15W	10	0.15
Total	**1,145**	**35.58**

Particulars		Total Lighting requirement	Lighting met Through LED Bulb	Lighting met through other type lamp
(A)	Load in KW	35.58	6.52	29.06
	Percentage	100	18.33	81.67
(B)	Energy in KWH per year	32,026	5,870	26,156
	Percentage	100	18.33	81.67

Energy Generated by Present Solar System

Particulars	Value	Unit
A) 10 Solar Street Light with 40W panel each	2,520	kWh
B) Stand Alone Solar Plant of 5 kW	31,500	kWh
Total	**34,020**	**kWh**
Present Annual electrical consumption of premises	1,16,904	kWh
Renewable Energy to Conventional Energy Consumption	29.10	%

A. Energy Generated by Present Solar PV System of Street Light:

Particulars	Value	Unit
10 Solar Street Light with 40W panel each	0.4	kW
Electricity Generation for 0.4 kW plant	1.4	kWh
Daily running hours per day for 10 Solar Street Light	6	Hrs
Total Working Hours in 300 Days per year for 10 Solar Street Light	1,800	Hrs
Total Generation per Year for 10 Solar Street Light	2,520	kWh
Present Annual electrical consumption of premises	1,16,904	kWh
Renewable Energy to Conventional Energy Consumption	2.16	%

B. Energy Generated by Present Standalone Solar PV System at Library Building:

Particulars	Value	Unit
Stand Alone Solar Plant	5	kW
Electricity Generation for 1 kW plant	3.5	kWh
Daily running hours per day for 5 kW plant	6	Hrs
Total Working Hours in 300 Days per year for 5 kW plant	1,800	Hrs
Total Generation per Year for 5 kW plant	31,500	kWh
Present Annual electrical consumption of premises	1,169,04	kWh
Renewable Energy to Conventional Energy Consumption	26.95	%

Note- Above solar plant and solar street light Information mention in A and B point is as per the data provided by college vender and all the solar calculation made by us as per the information provided by college vender.

Observations and Recommendations:

Sr. No.	Equipment Name	Observation	Recommendation	Time frame for Execution
1	AC setting	Temperature settings are very low	Optimize the temperature setting to 23-25 degree Celsius	0.00 Years
2	Ceiling Fan (100 w)	Fans are older and without star rating. Replace it on priority	Replacement of existing fans with energy efficient Super fans	8.76 Years
3	CFL	College has installed CFL lights of 18 W	Replacement of conventional lights (CFL) with 12w LEDs lights	8.87 Years
4	Tube Light	College has installed Tube lights of 40 W	Replacement of conventional Tube light with 20w LEDs lights	10.27 Years
5	Ceiling Fan (70 w)	Fans are older and without star rating	Replacement of existing fans with energy efficient Super fans	16.27 Years

Observations and Recommendations:

- Presently 100 kVA transformer is installed in college campus and it will extend to 315 kVA in upcoming time.
- College has 125 kVA Diesel Generator set for uninterrupted power supply in case of supply failure from APDCL.
- Open lid found in main panel box and need to be closed.
- Earthing should be taken through the panel instead of wall connection.
- Fire extinguisher is present in campus area.
- Rusted wiring found in some places which needs to be replaced.
- 10 number of solar LED Street lights of capacity 40W each panel and 15W LED's are available in the campus area, as per the Information provide by college.
- 5 kW solar panel Installed on library building with 325W panel capacity as per the Information provide by college.
- The campus area is well facilitated with CCTVs for security purpose.
- Load unbalancing found during field visit in electrical distribution system of campus area and hence load needs to be balanced.
- Distribution panel boxes need to be cleaned.
- For the safety purpose, fire extinguisher present in the campus area are insufficient hence, additional fire extinguishers need be made available for every floor of the buildings.

A Block (Geology or Main Building):

- Distribution Box cover is missing in two places which should be covered.
- Two number of 1 kVA UPS systems found in Bad condition which are to be made operational.
- Water is supplied from bore well to tank. Pump set has capacity of 1.5 HP.

B Block (opposite to Main Building):

- New panel box will be installed in upcoming time.
- Distribution Box cover found missing in three places and need to be covered.
- 31 number of fans need to be replaced on priority basis since they are very old and outdated.

C. Block (Statistics Building): All the equipment's are in good condition.

D. Block (Zoology Building):

- One number of 15 kVA UPS system found in operational condition.
- 10 kVA UPS system found in non-operational condition and need to be made operational.
- For the safety purpose single fire extinguisher is not sufficient for the building hence fire extinguisher should be made available for every floor of the building.
- Terrace having area of 22 m X 7 m (Length X Width). Which can be utilised for solar Installation in future.

E. Block (Chemistry Building): All the equipment's are in good condition.

- Terrace having area of 27 m X 18 m (Length X Width). Which can be utilised for solar Installation in future.

F. Block (Commerce Building): All the equipment's are in good condition.

- Terrace having area of 33 m X 16 m (Length X Width). Which can be utilised for solar Installation in future.

G. Block (Art Building): All the equipment's are in good condition.

H. Block (Boys common Room): All the equipment's are in good condition.

I. Block (Gym Sub Room Building):

- Rusted wiring found in some places in the building which should be replaced.
- Distribution Box cover found missing in some places.

J. Block (Canteen Building):

- Two number of refrigerators and one number of mixer available for cooking purpose.
- All the equipment's are in good condition.

K. Block (Library Building):

- 5 kW solar plant is installed on the building.
- Most of the LED lights present in the building are of 12 W.
- 5 kVA UPS system with 12 V and 65 Ah battery set is present.

L. Block (Auditorium Building):

- One number of old AC (zero rating) of 1.5 TR is present in building.
- The Auditorium hall is used only during college function, as electricity is supplied by only DG set.

M. Block (NCC Building):

- Three number of fans need to be replaced on priority basis since they are very old and outdated.

N. Block (Boys toilet Building):

All the equipment's are in good condition.

O. Block (Girls hostel Building):

- Water is supplied from bore well to tank. Pump set has capacity of 1.5 HP. Every room has one number of 3W LED light.

1. INTRODUCTION

Pragjyotish College was established on 1st September 1954, seven years after Independence, it became a beacon of learning and a symbol of aspirations for the common people of Assam, rating to build a new nation. Pandit Tirthanath Sarma, eminent scholar and litterateur, responded to and actively participated in the nation building by taking charge as the founder principal of Pragjyotish College.

From its modest inception as an arts college, Pragjyotish College has now developed into one of the premier institutions of higher education in Guwahati. At present, it is a well-known full-fledged degree college imparting higher education in Arts, Science and Commerce streams. The college has also two post graduate department's viz. Assamese and Tourism Management. It is affiliated to Guwahati University and registered under 2(F) and 12(B) of the University Grants Commission Act, 1956. The College has the distinction of being assessed and accredited twice by the NAAC in 2003 and 2010 respectively. Preparations are afoot for undertaking the third-cycle of NAAC accreditation

1.1 Objective of Audit

The overall objective of the assignment is to quantify energy saving in existing system and achieve reduction in energy consumption pattern.

Hence the detail objectives are as under,

- To carry out the energy consumption
- To evaluate the performance of the equipment
- To find out the energy saving opportunities
- To quantify the total energy savings
- To find out the ways to achieve energy efficiency

1.2 Scope of Work

Following is the scope of work for this assignment,

a) <u>Field Study</u>

The field study should incorporate technical data collection. Physical verification of connected load, preparation of single line diagram of building & campus electrical distribution system & analysis of readings obtained from site measurement with the standard consumption.

1) Pragjyotish College Guwahati is a H. T. consumer of APDCL & has a single meter. University had created energy meter at maximum building points but it is to be checked for accuracy & faulty.
2) Carry out meter wise, building wise & department wise load survey of all existing Electrical installation in Building with details and submit the data with remarks and observation and with over all meter wise remarks and observations.
3) Submit the consolidated meter wise building wise department wise total existing load classifying as lighting/ power/ AC /load with remarks and observation.
4) Carry out the meter point wise Electrical para-meter measurements
5) Power parameter measurement data logging should be carried out building wise according to utilization pattern.

b) <u>Report</u>

1) Submit tabulated field study data as per formats with remarks & observations.
2) Draft Report: - The detail draft report giving the recommendation for energy saving shall be prepared. The report shall contain overview of existing conditions, parameters measured analysis methodology other details of equipment's suggestions for improvement to operating and maintenance for the activities to be carried out without or with major investments. The payback period calculations shall be given for the activities to be completed with investment.
3) The draft report should be submitted in standard format as per the guide lines of Energy Efficiency. Also it should consist of saving potentials, skills requirements, time frame for execution, investment cost, payback period, observation and recommendation.
4) Recommendation should incorporate short term, medium term and long terms implementation system with and without investment. The contractor should highlight the metering point / buildings / department with larger saving potential in the draft report. Incorporate updated technology in energy saving in Building in the draft report.

The scope of work given above is common for all the areas. The detail study as per the scope given shall be carried out in each area. The draft report should be prepared as mentioned above and same shall be discussed with the deputed authority of the Pragjyotish College Guwahati.

1.3 Approach and Methodology

1. Understanding the Scope of Work and Resource Planning
2. Identification of Key Personnel for the assignment/ project
3. Structured Organization Matrix
4. Steps in preparing and implementing energy audit assignment.
   a) Discussions with key facility personnel
   b) Site visits and conducting “walk-through audit”
   c) Preliminary Data Collection through questionnaire before audit team’s site visit
   d) Steps for conducting the detailed audit
      - Plan the activities of site data collection in coordination with the facility in charge.
      - Study the existing operations involving energy consumption
      - Collect and collate the energy consumption data with respect to electricity consumption
      - Conduct performance tests to assess the efficiency of the system equipment/ electricity distribution, lighting, and identify energy losses.
      - Discuss with facility operation / maintenance personnel about identified energy losses.
5. List proposed efficiency measures
   - Develop a set of potential efficiency improvement proposals
   - Baseline parameters
   - Data presentation
   - System mapping
   - List of potential Energy Savings proposals with cost benefit analysis.
   - Review of current operation & maintenance practices

6. Preparation of the Draft Energy Audit Report
7. Preparation of final Energy Audit Report after discussion with concern persons

1.4 Work Schedule:

- Field study- The field study that includes technical data collection, physical verification of connected load, and measurement of various energy intensive equipment's will be carried during office hrs. If it is required to extend the working hrs. Beyond the above-specified timings, PPSES will take permission of the concerned authority prior to commencement of work on that particular day. Pragjyotish College Guwahati has authorized person or the person nominated by authority should accompany PPSES person while carrying out the field study.
- Working days: The activities to be carried out in Pragjyotish College Guwahati premises like field study, report presentation, energy conservation measures discussions will be done during working days as per Pragjyotish College Guwahati rules.
- If it is required to work on non-working days, PPSES will take permission of the concerned authority prior to commencement of work on that particular day.
- Activities like data tabulation, energy conservation measures preparation, report preparation, single line diagram preparation will be done as per PPSES working hours and working days.
- Time Schedule:

Sr. No.	Activity	Start Date	End Date
1	Field study as mentioned in scope of work	11-Sep-19	14-Sep-19
2	Submission of final report	17-Dec-19	26-Dec-19

1.5 About PPSES

M/s. PPS Energy Solutions Pvt Ltd (PPSES) is an ambitious company, established by enterprising engineering professionals in the year 2004. The company offers services pertaining to Energy and Engineering to clients across the globe.

Our team is based in Pune, a city known for its Software and Engineering talent in India. We are a rapidly growing company with a team of about 100 people which includes highly trained and experienced Techno-Managers, Analysts, and Engineers & Detailers.

We are presently working in India (Maharashtra, Madhya Pradesh, Gujarat, Andhra Pradesh, Delhi, Orissa, Chhattisgarh, Bihar, Andhra Pradesh, Telangana, Assam, Rajasthan and Jharkhand) and Abroad (Bahrain, Stanford, Laos)

We provide services for,

- Energy Audit, Management and System Evaluations
- Power Distribution System Design, Evaluations and Monitoring
- MEP Design and Project management
- Research and Training
- Services for Solar Installation

2. ENERGY DETAILS

2.1 Energy Details

The electricity supply for Pragjyotish College is provided by Assam Power Distribution Company Limited. The energy consumed by Pragjyotish College falls under HT bulk Category. The facility also has 1 DG sets of 125 KVA. The DG set is mainly used for power failure from APDCL.

Sr. No	DG details	Name of the building
1	125 KVA	College Building

The energy efficiency assessment was conducted for the load connected to the mains supply.

Consumer details:

Name of Consumer	Tariff Category	Consumer Account No.
The Principal Pragjyotish college	HT Bulk supply	63000001300

Mainly energy is used on this facility for the following purposes:

1) Lightings load
2) Air conditioners
3) Fan

2.2 Major Energy use and areas

Based on data collected from all buildings present in campus. The connected load in kW of all buildings is shown below:

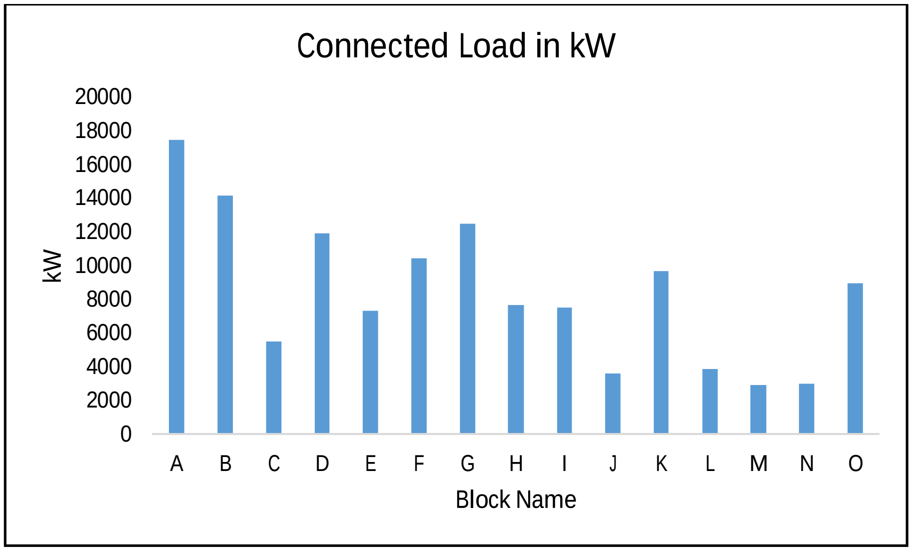


Figure 1- Connected load in Kw

Based on above it is clear that followings buildings have highest potential for energy savings.

Table 1- Block list

Name of the Building
A Block(Geology or Main Building)
B Block(opposite to Main Building)
C Block(Statistics Building)
D Block(Zoology Building)
E Block(Chemistry Building)
F Block(Commerce Building)
G Block(Art Building)
H Block(Boys common Room)
I Block(Gym Sub Room Building)
J Block(Canteen Building)
K Block(Library Building)
L Block(Auditorium Building)
M Block(NCC Building)
N Block(Boys toilet Building)
O Block(Girls hostel Building)

2.3 Electricity Bill Details

Energy meter details:

Name of Consumer	Tariff Category	Consumer Account No.
The Principal Pragjyotish college	HT Bulk supply	63000001300

Table 2- Monthly Energy Consumption

Month	kWh	PF	Maximum Demand (kVA)	Billed Demand (kVA)	Total Current Bill (Rs)
Dec-18	6048	0.97	21.6	94.11	56264
Jan-19	5023	0.97	20.7	94.11	48945
Feb-19	6585	0.98	28.8	94.11	46149
Mar-19	8922	0.99	40.2	94.11	76787
Apr-19	7325	0.98	45.6	94.11	65726
May-19	10139	0.99	50.7	94.11	84944
Jun-19	13188	0.99	73.5	94.11	106126
Jul-19	9468	0.98	30.6	94.11	80185
Aug-19	15999	0.99	89.7	94.11	126474
Sep-19	16781	0.99	84	94.11	131597
Oct-19	9945	0.98	63.3	94.11	83562
Nov-19	7481	0.98	47.4	94.11	66071

2.3.1 Energy Consumption

- Energy consumption of college building is from 16781 kWh to 5023 kWh.
- Energy consumption in the month of Sep-19 has been high. It was observed that the AC load was high during the Sep-19.

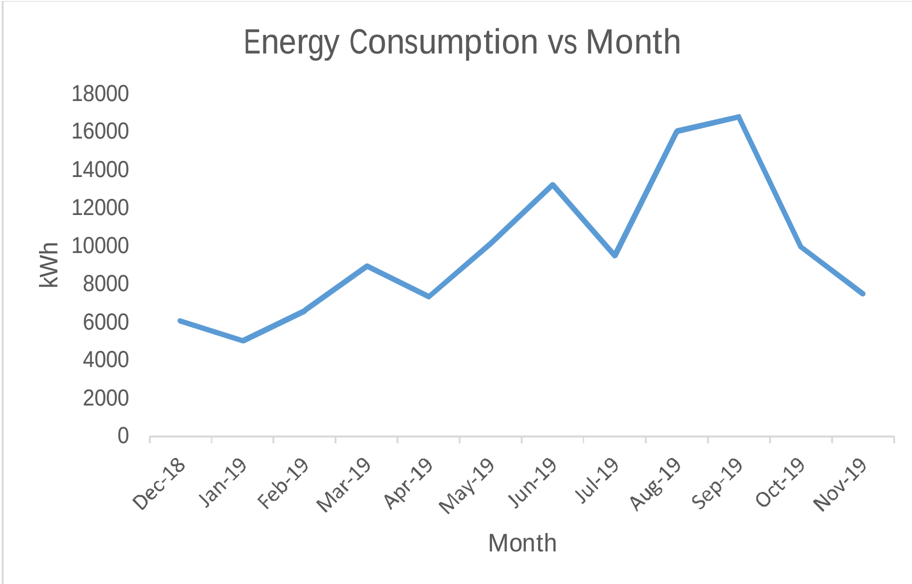


Figure 2 Monthly Energy Consumption

2.3.2 Power Factor Trend

- Power factor is in the range of 0.97 to 0.99. Incentives are well received by college from APDCL.

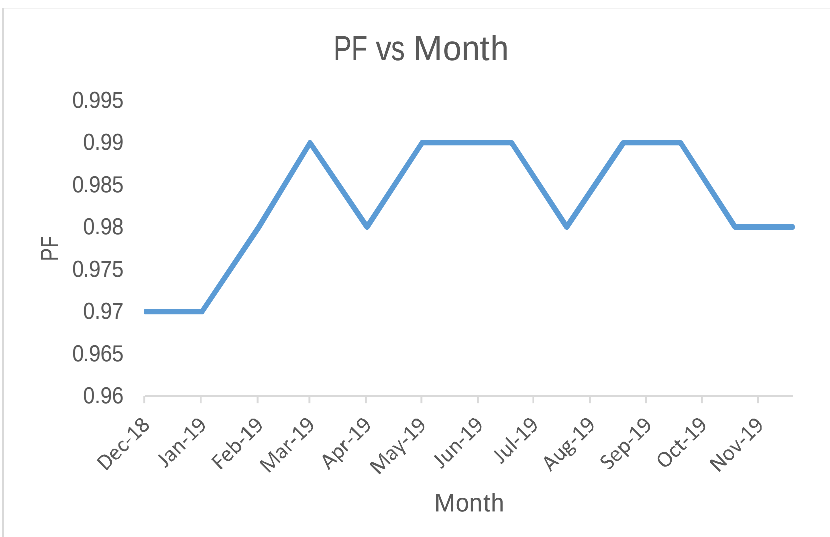


Figure 3 Power Factor Trend

2.3.3 Maximum Demand.

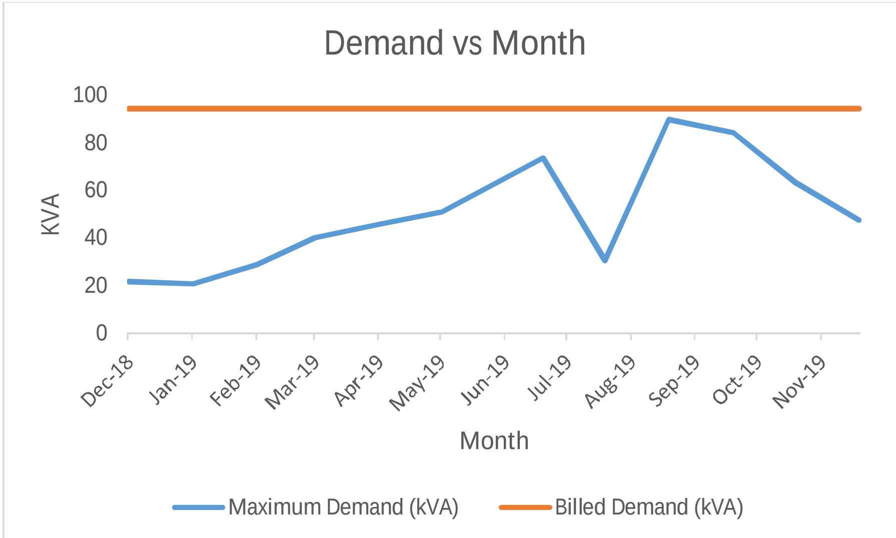


Figure 4 Maximum Demand

3. ENERGY AND UTILITY SYSTEM DESCRIPTIONS

3.1 List of Utilities

Pragjyotish College has following energy and utility systems.

- Electrical substation – The facility has one transformers of 100 KVA, 11kV/415V each.
- 2 Water Pumps of 1.5 HP across the facility at different locations.
- Street lights
- Electrical distribution network
- DG sets - 1 DG sets of 125 KVA

3.2. Electrical Substation

- Pragjyotish College has one transformers of 100 KVA, 11kV/415V each.

Figure 5 Transformer

3.3 List of Water Pump set

Table 3- List of Pump set

Sr. No.	Location	Connected Load (HP)	kW	Remark
1	College Campus	1.5	1.11	Submersible
2		1.5	1.11	Submersible

3.4 Street Lights:

Pragjyotish College has total 10 nos. of lighting poles are spread across the campus area. Solar street light 3W light LED Light

Figure 6 Street light

3.5 Electrical Distribution Network

Pragjyotish College has total 15 nos. of buildings. Electrical supply from transformer is given to the fifteen nos. building where from it is distributed across the facility.

Figure 7 Distribution panel

4. DETAILED ENERGY AUDIT

4.1 Performance assessment of Split AC

Cooling equipment systems used in small commercial buildings often express cooling system efficiency in terms of the Energy Efficiency Ratio - EER - For room air conditioners the commonly used efficiency ratio is the – ***EER - Energy Efficiency Ratio:***

EER is a measure of how efficient a cooling system operates in steady state (over time) when the outdoor temperature is at a specific level (outdoor conditions commonly used are 95°F). The higher EER, the more energy efficient system is.

$$EERinWatt = \frac{\text{Refigeration effect in watts}}{\text{Input power in watts}}$$

$$EER\ in\ Watt = \frac{\text{mass flow rate} * (\text{Enthalpy in} - \text{Enthalpy out}) * 1000/(4.18 * 860)}{\text{Input power in watts}}$$

<u>1.5 TR non star rated AC's</u>

Parameter	Value	Unit
Air flow in (m/s)	4	m/s
Area	0.1	m2
Air density	1.17	kg/m3
Dry Bulb temperature at Inlet	26	℃
Wet bulb temperature at Inlet	21	℃
Dry Bulb temperature at Outlet	21	℃
Wet bulb temperature at Outlet	18	℃
Enthalpy In	60.7	kJ/kg
Enthalpy out	50.8	kJ/kg
Measured current of the compressor	8	A
Energy demand of the compressor	1.656	kW
Watt refrigeration effect	4.64	kW
Energy Efficiency Ratio	2.8	-

<u>1.5 TR 5 star rated AC's:</u>

Parameter	Value	Unit
Air flow in (m/s)	4	m/s
Area	0.1	m2
Air density	1.17	kg/m3
Dry Bulb temperature at Inlet	26	℃
Wet bulb temperature at Inlet	21	℃
Dry Bulb temperature at Outlet	21	℃
Wet bulb temperature at Outlet	18	℃
Enthalpy In	60.7	kJ/kg

Parameter	Value	Unit
Enthalpy out	50.8	kJ/kg
Measured current of the compressor	6	A
Energy demand of the compressor	1.242	kW
Watt refrigeration effect	4.64	kW
Energy Efficiency Ratio	3.7	-

2 TR non star rated AC's

Parameter	Value	Unit
Air flow in (m/s)	4	m/s
Area	0.14	m2
Air density	1.17	kg/m3
Dry Bulb temperature at Inlet	26	℃
Wet bulb temperature at Inlet	21	℃
Dry Bulb temperature at Outlet	21	℃
Wet bulb temperature at Outlet	18	℃
Enthalpy In	60.7	kJ/kg
Enthalpy out	50.8	kJ/kg
Measured current of the compressor	11	A
Energy demand of the compressor	2.277	kW
Watt refrigeration effect	6.49	kW
Energy Efficiency Ratio	2.8	-

2 TR 5 star rated AC's

Parameter	Value	Unit
Air flow in (m/s)	4	m/s
Area	0.14	m2
Air density	1.17	kg/m3
Dry Bulb temperature at Inlet	26	℃
Wet bulb temperature at Inlet	21	℃
Dry Bulb temperature at Outlet	21	℃
Wet bulb temperature at Outlet	18	℃
Enthalpy In	60.7	kJ/kg
Enthalpy out	50.8	kJ/kg
Measured current of the compressor	9	A
Energy demand of the compressor	1.863	kW
Watt refrigeration effect	6.49	kW
Energy Efficiency Ratio	3.4	-

Figure 8 Air Conditioner

4.2 DG set

DG sets are used mainly in case of power failure and shutdown maintenance incidents. DG set performance assessment was carried out at 125 KVA DG set.

Figure 9 Diesel Generator Set

5. ENERGY CONSERVATION MEASURES & RECOMMENDATIONS

ECM 1: Replacement of Conventional Lights (CFL) with LED Lights

Name	Replacement of CFL light 18 W with 12 W LEDs
Location	All the buildings
Estimated Annual Savings	427.68 kWh/year, 0.03 Lakhs INR/year
Estimated investment Cost	0.26 Lakh
Estimated Payback	8.87 Years
Environmental Benefits.	Reduced CO_2 emissions from less electricity used @ 0.36 tCO_2e per year

Observations:

The CFL lights are used for lighting purpose. Overhanging wires were observed.

Recommendations:

The existing lighting fittings could be replaced with suitable LEDs. LEDs have better efficiency per watt as well as they have much larger lifespan than TFLs.

Type of Fitting	Wattage	Qty	Proposed LED W	Existing KW	Proposed KW	Saved kW
CFL	18	99	12	1.78	1.19	0.59
TOTAL	**18**	**99**	**12**	**1.78**	**1.19**	**0.59**

Energy Saving Calculation		
Particular	**Unit**	**Value**
Power consumption of existing 18W CFL Lights	KW	1.78
Power consumption of 12W LED light	KW	1.19
Average power saving after replacement with LED light	KW	0.59
Replacement of conventional lights (CFL) of 18 W with 12W LED Light	Nos	99
Average working hour per day	hrs	3
No. of working days in a year	Days	240
Cost Benefit Calculation		
Annual Energy Saving potential	kWh	428
Electricity tariff	Rs/unit	6.75
Annual Cost Saving	Rs. Lakh	0.03
Total investment cost	Rs. Lakh	0.26
Annual Saving	Rs. Lakh	0.03
Simple Payback Period	Years	8.9

Figure 10 CFL Lights

ECM 2: Replacement of Conventional Lights (Tube Light) with LED Lights

Name	Replacement of Conventional Tube Lights with 20W LED Lights
Location	All the buildings
Estimated Annual Savings	9821 kWh/year, 0.66 Lakhs INR/year
Estimated investment Cost	6.81 Lakh
Estimated Payback	10.3 Years
Environmental Benefits.	Reduced CO_2 emissions from less electricity used @ 8 tCO_2e per year

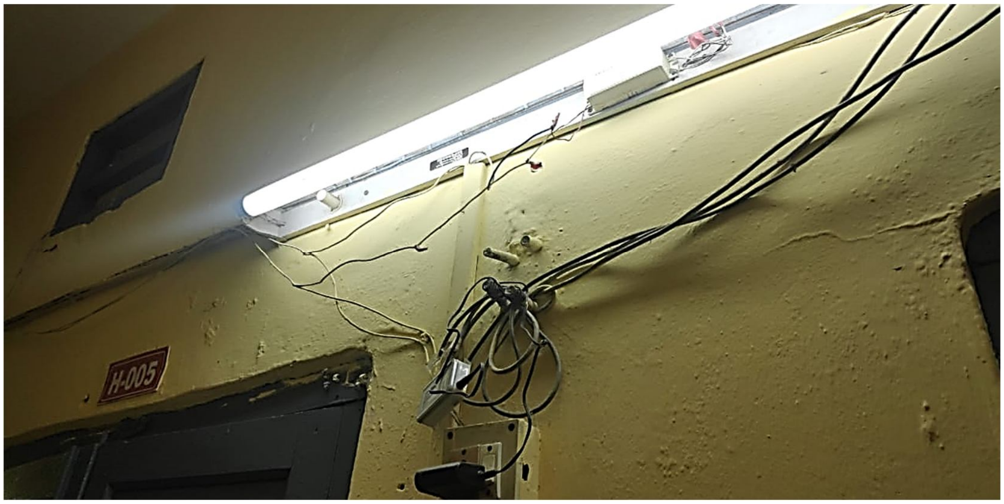


Figure 11 Tube Lights

Observations:

The Tube lights are used for lighting purpose. Overhanging wires were observed.

Recommendations:

The existing lighting fittings could be replaced with suitable LEDs. LEDs have better efficiency per watt as well as they have much larger lifespan than TFLs.

Type of Fitting	Wattage	Qty	Proposed LED W	Existing KW	Proposed KW	Saved kW
Tube light	40	682	20	27.28	13.64	13.64
TOTAL	**40**	**682**	**20**	**27.28**	**13.64**	**13.64**

Energy Saving Calculation		
Particular	**Unit**	**Value**
Power consumption of 40w tube lights	KW	27.28
Power consumption of 20w LED lights	KW	13.64
Average power saving after replacement with LED Street light	KW	13.64
Replacement of conventional lights of 40 W with 20w LED lights	Nos	682
Average working hour per day	hrs	3
No. of working days in a year	Days	240
Cost Benefit Calculation		
Annual Energy Saving potential	kWh	9821
Electricity tariff	Rs/unit	6.75
Annual Cost Saving	Rs. Lakh	0.66
Total investment cost	Rs. Lakh	6.81
Annual Saving	Rs. Lakh	0.66
Simple Payback Period	Years	10.3

ECM 3: Replacement of Conventional Fans (70 W) with Super-Efficient Fans

Name	**Replacement of existing old (without star rating) fans with 5 star rated energy efficient fans**
Location	Almost all locations where old fans exist
Estimated Annual Savings	12789 kWh/year, 0.86 Lakh INR/year
Estimated investment Cost	14.04 Lakhs
Estimated Payback	16.27 Years
Environmental Benefits.	Reduced CO_2 emissions from less electricity used @ 10.87 tCO_2e per year

Figure 12 Ceiling Fan

Observations:

Maximum fans are 70 W of old type without star rated.

Recommendations:

Super Fan is one of the latest Super-Efficient Ceiling fan in the market. This fan has a Brushless DC electronic motor that is super-efficient. The fan does not need a regulator and works with a remote control without remote as well. It can also work by toggling the switch on switchboard the same number of times as the desired speed. There is a LED at the centre of the fan that blinks and shows the fan speed when it is changed. Although this fan is a little different from other fans, the installation was quite easy and straightforward. Hence, it is recommended to replace existing all without star rated fans with new 5 star rated energy efficient fans (Super fans).

Energy Saving Calculations:

Type of Fitting	Wattage	Qty	Proposed W	Existing KW	Proposed KW	Saved kW
Ceiling Fan	70	725	35	50.75	25.38	25.37
TOTAL	**70**	**725**	**35**	**50.75**	**25.38**	**25.37**

Particular	Unit	value
Total Energy consumption of existing Fans	kW	36540
Total Energy consumption of proposed Fans	kW	35
Average power saving after replacement with proposed fans	kW	18270
Operating hrs/year	Hrs/year	720
Diversity factor	%	70%
Annual Saving	kWh/year	12789
Unit rate	Rs/kWh	6.75
Annual Saving	Rs. In Lakh	0.86

ECM 4: Replacement of Conventional Fans (100 W) with Super-Efficient Fans

Name	Replacement of existing old (without star rating) fans with 5 star rated energy efficient fans
Location	College building
Estimated Annual Savings	1146.60 kWh/year, 0.08 Lakh INR/year
Estimated investment Cost	0.68 Lakhs
Estimated Payback	8.76 Years
Environmental Benefits.	Reduced CO_2 emissions from less electricity used @ 0.97 tCO_2e per year

Figure 13 Ceiling Fan

Observations:

Maximum fans are 100 W of old type without star rated. On priority basis Change 100 W fans.

Recommendations:

Super Fan is one of the latest Super-Efficient Ceiling fan in the market. This fan has a Brushless DC electronic motor that is super-efficient. The fan does not need a regulator and works with a remote control without remote as well. It can also work by toggling the switch on switchboard the same number of times as the desired speed. There is a LED at the centre of the fan that blinks and shows the fan speed when it is changed. Although this fan is a little different from other fans, the installation was quite easy and straightforward. Hence, it is recommended to replace existing all without star rated fans with new 5 star rated energy efficient fans (Super fans).

Energy Saving Calculations:

Type of Fitting	Wattage	Qty	Proposed W	Existing KW	Proposed KW	Saved kW
Ceiling Fan	100	35	35	3.5	1.22	2.28
TOTAL	**100**	**35**	**35**	**3.5**	**1.22**	**2.28**

Particular	Unit	value
Total Energy consumption of existing Fans	kW	2520
Total Energy consumption of proposed Fans	kW	35
Average power saving after replacement with proposed fans	kW	882
Operating hrs/year	Hrs/year	720
Diversity factor	%	70%
Annual Saving	kWh/year	1147
Unit rate	Rs/kWh	6.75
Annual Saving	Rs. In Lakh	0.08

ECM 5: Optimize the Temperature Setting of ACs

Name	Optimize the temperature setting of ACs
Location	All ACs
Estimated Annual Savings	1687 kWh/year, 0.11 Lakh INR/year
Estimated investment Cost	Nil
Estimated Payback	Nil
Environmental Benefits	Reduced CO_2 emissions from less electricity used @ 1.5 tCO_2e per year

Observations:

Temperature settings are very low

Recommendations:

During EEA study at facility it was observed that temperature settings of AC in office & meeting rooms were in the range of 17^0 C to 22^0 C.

It is known that a 1°C raise in AC temperature can help to save almost 3 % on power consumption (this can also be verified in BEE guideline: Chapter 4. HVAC and Refrigeration System).

The TR capacity of the same AC systems will also increase with the increase in evaporator temperature (AC set points), as given in Table below:

Effect of variation in Evaporator Temperature on Compressor Power Consumption

Evaporator temperature(^{0} C)	Refrigeration Capacity* (tons)	Specific Power Consumption	Increase in kW/ton (%)
5	67.58	0.81	-
0	56.07	0.94	16
-5	45.98	1.08	33
-10	37.2	1.25	54
-20	23.12	1.67	106

** Condenser temperature 40°C*

Hence it was recommended that temperature setting of outlet will be changed from present 23 ^{0}C to 25 ^{0} C and keeping inlet temperature unaltered.

Pragjyotish College will further study the overall effect on the facility and may further tune the temperature settings.

Based on the recommended change of AC temperature settings, calculation for energy saving was completed and this has been elaborated in ECM calculation sheet (Annexure).

Energy Saving Calculations:

Particular	Unit	Value
Estimated consumption of Acs	kWh/hr	56235
Estimated Saving	%	3%
Operating Hrs per day	hrs/day	3
Operating days per year	Days/year	100
Estimated Saving	kWh/year	1687
Unit Rate	Rs/kWh	6.75
Annual Saving	Rs Lakh/year	0.1

Figure 14 Air Conditioner

6. PRIORITIZATION OF ENERGY CONSERVATION MEASURES

Sr. No	Equipment Name	ECM Details	Investment (Rs. In Lacs)	Savings (kWh/ year)	Carbon credit (Tons of Co2)	Saving (Rs. In Lacs /Year)	Payback (Years)
1	Air Conditioner	Optimize the Air Conditioner temperature setting to 23-25 degree Celsius	0	1687	1.5	0.11	0
2	Ceiling Fan (100 w)	Replacement of existing fans with energy efficient Super fans	0.68	1146.6	0.97	0.08	8.76
3	CFL	Replacement of conventional lights (CFL) with 12w LEDs	0.26	427.68	0.36	0.03	8.87
4	Tube Light	Replacement of conventional Tube light with 20w LEDs	6.81	9820.8	8.35	0.66	10.27
5	Ceiling Fan (70 w)	Replacement of existing fans with energy efficient Super fans	14.04	12789	10.87	0.86	16.27
TOTAL			**21.79**	**25871.08**	**22.05**	**1.74**	**12.5**

7. LIST OF INSTRUMENTS

Power analyser

Picture 1 Fluke Power analyser

Specification of the 434 Fluke power analyser:

Electrical	
Single Phase	YES
Three Phase	YES
USER INTERFACE	
LCD-Type	Graphic LCD
LCD-Dimension	127 x 88 mm
Traditional energy analysis	V, I, P, Q, S, F, PF, cos φ, peak, minimum, maximum, demand etc.
Voltage	1V to 1000 V phase to neutral
Current	Up to 6000 A
Frequency	42.50 to 57.50 Hz
Precision Voltage, Current, Power	±0.1 %

Lux meter

Picture 2 Lux meter

Indi 6171 Lux meter was used to measure the lux levels.

Digital Clamp Meter

Picture 3 Mastech M266 clamp meter

Mastech M266C Digital AC Clamp Meter is used to measure the instantaneous current. Following are the specification for this clamp meter:

Specification	Range	Accuracy
DC Voltage	200mV	-1.005
	2V/20V/200V	-3.005
	1000V	-3.008
AC Voltage	200V	-5.01

	750V	-5.012
AC Current	20A	-5.04
	200A	-5.025
	1000A	-10.03
Resistance	200Ω	-5.01
	2KΩ/20KΩ/200KΩ/2MΩ	-8.01
Temperature	0°C~400°C(32°F~752°F)	-3.01
	401°C~750°C(752°F~1382°F)	-3.02
Insulation Test	20MΩ	-2.02
	2000MΩ(Note<500Ω)	-2.04
	2000MΩ(Note>500Ω)	-2.05

Infrared thermometer

Picture 4 HTC IRX 64 Infrared thermometer

HTC IRX 64 infrared thermometer was used in order to record the temperature of the insulations. The following are the specifications:

Specification	Range
IR	-50°C~1050 °C
Contact	-50°C~1370 °C
IR Temp. Resolution	0.1°C
Basic Accuracy	+/- 1.5% of reading
Emissivity	Adjustable 0.10 ~ 1.0
Optical resolution	30 : 1

Thermal Imager

Picture 4 FLIR TG 167 Thermal imager

FLIR TG 167 Thermal imager was used in order to record the temperature of the insulations.

The following are the specifications:

Accuracy	±1.5% or 1.5°C (2.7°F)
Detector Type	Focal plane array (FPA), uncooled micro bolometer
IR Resolution	80 × 60 pixels
Laser	Dual diverging lasers indicate the temperature measurement area, activated by pulling the trigger
Memory Type	Micro SD card
Object Temperature Range	-25°C to 380°C (-13°F to 716°F)
Thermal Sensitivity/NETD	<150 mK
Display	2.0 in. TFT LCD

8. SOLAR ANNEXURE

1) Introduction

The solar energy has a great potential as future source of energy. With its availability in large quantity almost in every corner of the country, solar power has the distinctive advantage of generating power at local and decentralized levels and being one of the prime factors for empowering people at grassroots level. The solar mission, which is part of the National Action Plan on Climate change has been set up to promote the development and use of solar energy for power generation and other uses with the ultimate objective of making solar energy competitive with fossil-based energy options. The solar photovoltaic device systems for power generation had been deployed in the various parts in the country for electrification where the grid connectivity is either not feasible or not cost effective as also some times in conjunction with diesel based generating stations in isolated places, communication transmitters at remote locations. With the downward trend in the cost of solar energy and appreciation for the need for development of solar power, solar power projects have recently been implemented. A significant part of the large potential of solar energy in the country could be developed by promoting solar photovoltaic power systems of varying sizes as per the need and affordability coupled with ensuring adequate return on investment.

2) Benefits of Solar Energy

a. Power from the sun is clean, silent, limitless and free.

b. Photovoltaic process releases no CO_2, SO_2, or NO_2 gases which are normally associated with burning finite fossil fuel reserves and don't contribute to global warming.

c. Photovoltaic are now a proven technology which is inherently safe as opposed to other fossil fuel based electricity generating technologies.

d. Solar power shall augment the needs of peak power needs.

e. provides a potential revenue source in a diverse energy portfolio

f. Assists in meeting renewable portfolio standards goals.

This proposal is prepared for design, engineering, procurement / manufacture and installation of solar power generating system. The grid-tie solar photovoltaic power generation system is mainly composed of PV array, String Inverter, and PV mounting structure.

It also consists of supporting devices like AC / DC switchgears, Lighting Arrestor, Earth Electrodes, AC / DC cables. As there is no any battery, it's maintenance cost is negligible and initial investment per KW is very low.

3) Objective

- Provide reliable, clean, regulated, un-interrupted power on demand to the pre-identified critical loads
- System to provide low life cycle cost and maximize savings to the beneficiaries.
- To save diesel in institutions and other commercial establishments including industry facing huge power cuts especially during daytime.

4) Design Assumptions

General

a. The Solar Radiation Data's are based on standard books & simulation software as NASA and Metronome. The Mean Hourly Radiation Data is considered.

b. The module rating considered is tentative. The exact module sizing and rating will depend on the availability of cell grade and site suitability.

c. Solar Panels are roof/ground mounted in one location. Environmentally protected, closed, ventilated, inverter room at minimum distance from PV modules.

d. Application: Self consumption, captive grid or NET metering.

e. Emergency Backup: Generator or any other source in absence of Grid.

5) System Description

Solar Power Plant comprises of the main equipment and components listed below:

1. Solar PV Modules
2. String Inverter with MPPT

3. Module mounting system
4. Monitoring system
5. Cables & connectors

Each of the sub systems has been described for the functionality and operation modes. The physical construction of the system follows a modular approach, which is field-tested and is regularly used for delivery of power systems.

5.1 Solar PV Module (Electrical Features)

The PV modules convert the light reaching them into DC power. The amount of power they produce is roughly proportional to the intensity and the angle of the light reaching them. They are therefore required to be positioned to take maximum advantage of available sunlight within sitting constraints.

5.2 Solar PV Module (Mechanical Features)

Solar Module design will conform to following Mechanical requirements:

- Toughened,
- low iron content,
- High transmissivity from glass.
- Anodized Aluminium Frame.
- Ethyl Vinyl Acetate (EVA) encapsulating.
- Tedlar/Polyester trilaminate back surface.
- ABS plastic terminal box for the module output termination with gasket to prevent water & moisture.
- Resistant to water, abrasion hail impact, humidity & other environment of actors for the worst situation at site.

5.3 Module Mounting Structure

The structure shall be designed to allow easy replacement of any module and shall be in line with site requirement. Structure shall be designed for simple mechanical and electrical installation. It shall support SPV modules at a given orientation, absorb and transfer the mechanical loads to the ground properly. There shall be no requirement of welding or complex machinery at site. The array structure shall have tilt arrangement to adjust the plane of the solar array for optimum tilt.

5.4 Junction Box

The junction boxes shall be dust, vermin and waterproof and made of FRP/ABS Plastic with IP65 protection. The terminals shall be connected to copper bus bar arrangement of proper sizes. The junction boxes shall have suitable cable entry points fitted with cable glands of appropriate sizes for both incoming and outgoing cables. Suitable marking shall be provided on the bus bar for easy identification and cable ferrules shall be fitted at the cable termination points for identification

5.5 String Inverter

The STRING INVERTER is A combination of Solar Charger (MPPT), Inverter and synchronization unit for two different AC supplies, all housed in a single unit. Maximum power point tracker (MPPT) shall be integrated into it to maximize energy drawn from the solar array. The Inverter converts the DC available from the array into an AC output. The output of the inverter is filtered to reduce the harmonics to an acceptable level (less than 5%). MPPT shall be microprocessor/micro controller based to minimize power losses and maximize energy utilization. The efficiency of MPPT shall not be less than 90% and shall be designed to meet the solar PV Array capacity.

5.6 AC /DC Cables

We use DC & AC cables of Lap, Apar, Polycab, Havels, Finolex or equivalent make to ensure minimum losses in transmission.

In order to complete the energy study that leads to the construction of a photovoltaic installation, hourly series of global horizontal irradiation values for a complete year are used, which resume the irradiation and other meteorological parameters behaviour over a long term. We use PV. SYST. Software to workout optimum power production at site with minimum loses.

5.7 Grounding and Lighting Protection

- A protective earth (PE) connection ensures that all exposed conductive surfaces are at the same electrical potential as the surface of the Earth, to avoid the risk of electrical shock. It ensures that in the case of an insulation fault (a "short circuit"), a very high current flows, which will trigger an over current protection device as fuses and circuit breakers that disconnects the power supply.
- A functional earth connection serves a purpose other than providing protection against electrical shock. In contrast to a protective earth connection, a functional earth connection may carry a current during the normal operation of a device.
- Lightning protection is a very specialized form of grounding used in an attempt to divert the huge currents from lightning strikes. A ground conductor on a lightning arrester system is used to dissipate the strike into the earth.
- Lightning ground conductors must carry heavy currents for a short period of time. To limit inductance and the resulting voltage due to the fast pulse nature of lightning currents, lightning ground conductors may be wide flat strips of metal, usually run as directly as possible to electrodes in contact with the earth.
- In proposal, the entire system is fully provided with the required lighting and grounding protection.

6) Solar PV Location

Average Unit Consumption / year of Buildings is **116904** Units (Ref. 12 months Electricity Bills)

Sr. No.	Name of Building	Length (ft.)	Width (ft.)	Area (Sq. ft.)	Plant Installed (kW)
1	F Block	109	53	**5777**	**72.21**
2	E Block	89	59	**5251**	**65.64**
3	D Block	72	23	**1656**	**20.7**
	Total	**270**	**135**	**12684**	**158.55**

Total Available Area = 12684 Sq. Ft. & As per available shadow free Area maximum 158.55 KW Plant can be installed on buildings as per details mentioned in above table.

7) Capacity Evaluation

Calculation for Required Solar Capacity plant to fulfill In-house Requirement

Calculation to Full fill Building Total Load Requirement			
Sr. No.	Details	Value	Unit
1	Average electrical consumption per year	116904	KWh
2	Units generated per day per KWp	3.5	KWh/KWp/day
3	Units generated per Year per KWp (300 days / Year)	1,050	KWh/KWp/Year
4	Solar KW capacity For 116904 KWh consumption/year	111	KWp

As per electrical consumption (Building Load), capacity of Solar Power Plant required is 111KWp. As per shadow free space available on building maximum 150-160 KWp plant can be installed which is more than the actual requirement of full Electrical Load.

It is suggested to install Solar Plant of Capacity 111 KWp, which can be installed on building itself & it covers all required load.

The SPV power plant with proposed capacity of 111KWp would be connected to the main electrical distribution panel. The system would meet full load requirement of the connected load during the day. Advance control mechanism in the Power Conditioning Unit will ensure that the maximum power generated by PV modules will be utilized first and the balance requirement of power will be met by either grid or DG set

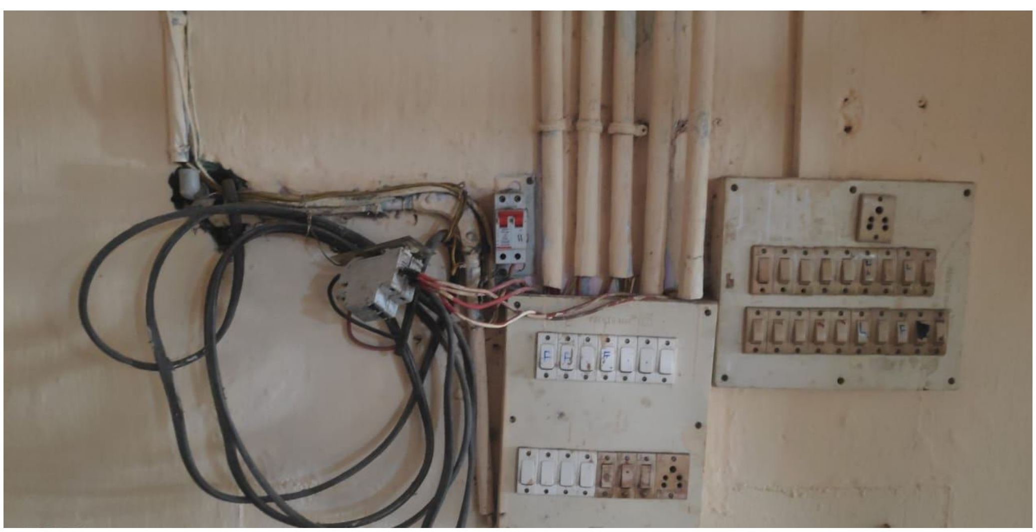
The 111 KWp SPV Power Plant is estimated to afford annual energy feed of 116904 KWh/year (After considering all losses) considering efficiency of the solar module as 15.16%, Power Conditioning Unit (PCU) efficiency as 98.3% and losses in the DC and AC system as 3%.

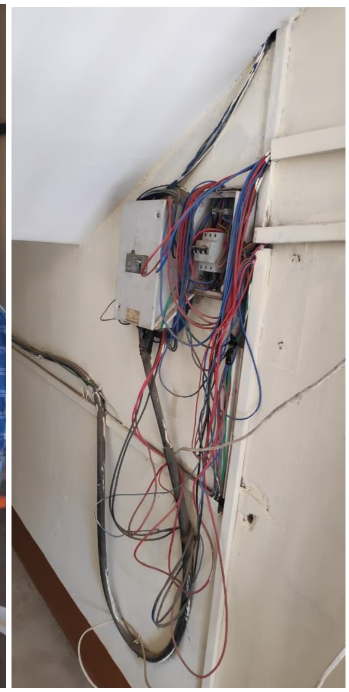
8) Budgetary Estimation of the Project

Details	Value	Unit
Shadow free space required for approx. 1 KWp Solar Plant	80	Sq.Ft
Shadow free space available on building	12684	Sq.Ft.
Solar Plant capacity to be Installed on building	158.55	KWp
Solar Plant Requirement as per actual consumption	111	KWp
Installation Cost Per KW for 1KWp Solar Plant	0.5	Rs. In Lakh
Gross Estimated System cost (For 111 KWp Grid Connected Solar Plant)	55.5	Rs. In Lakh
Unit generated per day per kWp	3.5	KWh
Electricity generation per day for 111 KWp Grid Connected Solar Plant	388.5	KWh/day
Electricity generation per year for 111 KWp Grid Connected Solar Plant (300 days / year)	116550	KWh/year
Average Electricity Unit Cost	6.8	Rs./KWh
Electricity cost saved per year	7.92	Rs. In Lakh
Simple payback period	**7.00**	**Years**

9. SITE PHOTOGRAPHS


OFFICE OF THE NCC
50 ASSAM AIR SQUADRON
NATIONAL CADET CORPS
PRAGJYOTISH COLLEGE
M-002
NATIONAL CADET CORPS
48 ASSAM NAVAL UNIT NCC
DIV I & II
PRAGJYOTISH COLLEGE, GUWAHATI-9
M-001



ANMOL
JUVAS