ENERGY AUDIT REPORT
OF
LORETO COLLEGE, KOLKATA
2025-26

CONSULTRAIN MANAGEMENT SERVICES
24A LAKE ROAD, KOLKATA 700029
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ENERGY AUDIT REPORT
OF
LORETO COLLEGE
7, Sir William Jones Sarani
(Formerly Middleton Row)
Kolkata- 700 071 West Bengal, India

Prepared By :

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1.0 Acknowledgement

Consultrain Management Services expresses sincere thanks to the management of Loreto College for awarding Consultrain Management Services to conduct 'Energy Audit for the FY 2025-26 at College Campus Building' Premises vide WO Ref. No.LC/WO/318/2024-25, dated 03.06.2025. The field study of this audit was carried out on 18.06.2025.

The following officials of Loreto College, Kolkata have coordinated and helped the audit team during the site visits:

Sr. Dr. A. Nirmala (Teacher In-Charge) & Coordinating team members:

Mrs. Sabiha Sethwala – Associate Professor – Dept. of Geography

Ms. Tania Mondal – Assistant Professor – Dept. of Education

Mr. Siddhartha Sankar Dasgupta – Electrical Supervisor

We extend our sincere gratitude to Dr. A. Nirmala and all other Teachers, officers, technicians and staffs for their keen interest shown in the study and the courtesy extended.

We are thankful to the management for giving us the opportunity to involve in this very interesting and challenging project of energy audit at their college premises.

We would be happy to provide any further clarifications, if required, to facilitate implementation of the recommendations.

SOMNATH MAITI
Certified Energy Auditor
Bureau of Energy Efficiency
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2.0 Executive Summary

Loreto College, located at south Kolkata, West Bengal is very energy conscious institution & belief of continuous improvement in their establishment. The working staffs & officers are co-operative and extend their hands to conduct the field trial & testing during field audit. Management of this college has taken many energy saving measures and continually improving day by day. Still, some of lacunas were identified by energy audit team during study.

This section presents a brief summary of the results of the Energy Audit carried out on 3rd week of June 2025, when ambient condition was favorable for human comfort & working comfort as it was a monsoon rain cloudy day. The study covers mainly the weaknesses of electrical energy aspects at college premises with a focus mainly on proposals and recommendations on energy & cost savings.

A team of specialist consultants of Certified Energy Auditor, BEE, Ministry of Power, Govt. of India were involved in this energy audit. The energy audit was mainly targeted at identifying practical, sustainable and economically viable ENCON measures in all sections of this commercial building, resulting from a detailed study and analysis of technical parameters. The energy audit involved using a wide range of sophisticated, portable, diagnostic and measuring instruments to generate the data and facilitated in analysis to understand the condition of energy aspects in the building premises. Following are the observations on field energy audit.

1.0 Electricity is the main source of energy in Loreto College. One is on grid system & others are off grid system. The electrical energy Consumption of this College from CESC for the FY 2024-25 works out to **28128** kWh (@ Rs.5.94/ kWh) for on grid meter connected loads & **11947** kWh (@ Rs.9.50/kWh) for off grid connected loads.

2.0 Loreto College has already adopted & harnessed roof top
8 kWp & 6.6 kWp, 415 volt rated renewable clean & green Solar Photo voltaic power since 2015-16, which facilitates college to consume electricity fully in daytime without incurring any cost and also injects & export power to CESC grid partly through bi-directional digital communicable energy meter and saves considerable amount of energy & money per month.

3.0 Loreto College has replaced 3 nos. old non-star air- conditioners with energy efficient 3-STAR rated Split Air- conditioners for office rooms & saves considerable amount of money per month.

4.0 Loreto College is started to adopt most energy efficient & long- lasting LED based lighting system in selected indoor application &

saves considerable amount of electrical energy.

5.0 At present this college uses small number of 36 Watt conventional & inefficient fluorescent tube lights (FTL) with copper ballast, whose efficacy is found to be very poor & consume excess amount of electrical energy compared to new generation long last 20-Watt LED tube light (TL). Audit addresses that if college is replaced all such 36-Watt fluorescent tube lights (FTL) & their copper ballast with new 20-watt LED tube tights, considerable amount (> 50%) of electrical energy in lighting system can be saved.

6.0 Presently this college uses large number of 70 & 110 Watt rated conventional & inefficient ceiling fans of 1200 mm & 1422mm sweep, which consumes excess amount of electrical energy compared to new generation most energy efficient 28-Watt smart BLDC ceiling fan. Audit addresses that if college is replaced all such 70 & 110 Watt conventional ceiling fans with new 28-watt rated smart BLDC fan of 1200 mmm sweep, considerable amount (> 60%) of electrical energy in room ventilation system can be saved.

7.0 At present college is not monitoring the energy generation in existing Solar PV systems, wherein the digital true r.m.s energy meters are existed & connected to two existing Inverter Panels. Audit addresses to monitor monthly energy generation mandatorily & maintain the records in a log book, which will facilitate to find out the monthly energy consumption of college building from Solar PV alone by subtracting the energy injected from energy generation.

8.0 Measured average & maximum current unbalance in full load condition at CESC LT incomer is found to be satisfactory.

9.0 For analysis purpose present off grid electricity cost is considered as ₹9.50/kWh.

3.0 Summary of Recommendation:

Proposal No.	Proposal	Annual Energy Saving		Annual Energy Cost Saving	Investment Required	Payback Period
		kWh	TOE	₹ Lakh	₹ Lakh	Month
1.	**On Energy Efficient Lighting System** ***Replacement of 75 Fixtures(150 units) existing 40W Conventional Fluorescent Tube Lights (FTL) in indoor application step by step with new generation energy efficient & Long Lasting 1 x 20W LED Tube Lights and saving of substantial amount of electrical energy and reduction of maintenance cost.***	8770	0.75	0.92	0.47	6.1
2.a)	**On Energy Efficient Smart BLDC Ceiling Fan:** ***Replacement of 121 nos. of 70 Watt 48" Conventional Ceiling Fans with new 121 nos. of 28 Watt 48" (□ 1200 mm Sweep) most Energy Efficient BEE 5-Star Rated Smart Ceiling Fans and save substantial amount of electrical energy.***	6098	0.52	0.58	3.45	71.4
b)	***Replacement of 161 nos. of 110 Watt 56" Conventional Ceiling Fans with new 121 nos. of 28 Watt 48" (□ 1200 mm Sweep) most Energy Efficient BEE 5-Star Rated Smart Ceiling Fans and save substantial amount of electrical energy.***	15842	1.36	1.51	4.59	36.6
3.	***Additional on grid Solar Plant of 10kWp to install for existing 3 nos. 2155014 09, 2155183 06 & 2155180 03 meter connected load & save substantial amount of elect. energy.***	12775	1.09	1.21	5.00	49.4
GRAND TOTAL (ELECTRICAL)		**43485**	**3.72**	**4.22**	**13.51**	**-**

4.0 Introduction

Energy Audit is an effective means of establishment present efficiency levels and identifying potential areas of improvement in energy consumption. Energy audit of utility systems largely helps in reducing the energy consumption with resultant reduction in electricity bills. Audit involves data collection, data verification and detailed analysis of the data. The analysis leads to focus recommendations, which are short term (with minimum investment), medium term (with moderate investment) and long term (with capital expenditure). The cost benefit analysis of various energy conservation proposals enables managements to take decisions regarding implementation schedules.

Energy conservation is a worldwide objective to save the human being from possible disaster. Under the mandate of The Energy Conservation Act 2001, the Bureau of Energy Efficiency (BEE) and Government of India are implementing various programs to provide momentum of the energy conservation movement in the country. Energy Auditing is most vital part of the conservation of energy. In order to improve the efficiency of the Energy consuming system, energy auditing is the first necessary action to be taken by the concerned firm. Through the energy auditing actual parameters can be detected at each step, which can be compared with the standard achievable parameters. For proper Energy auditing and energy accounting, parameters need to be monitored on regular basis and for any deviation immediate action is needed to rectify and retain the efficiency at the optimum level.

5.0 Scope of Work

Electrical energy audit reviews the entire distribution of loads with different electrical parameters from sending end to consumption end, which includes grid supply LT incomer, Solar PV Power Generation outgoing feeders, Air Conditioners, Lighting, UPS, Pump, Ceiling Fan & Electricity Bill Analysis etc.

Review of Energy Monitoring & Accounting System; Detail review of present energy monitoring & accounting system in terms of metering, record keeping, data logging, period performance analysis etc.- Recommendations for improvement.

Recording the parameters in the monthly Electricity bills and analyzing the load demand & sanctioned Load, benefits of solar power injection to CESC grid etc.

6.0 Approach & Methodology

Energy Audit includes the review of documentation with regard to the scope covered in audit, an on-site visit, and data collection, their review and analysis. This may also require the cross check and verification of data and data which can include industry norms and peer data. Following is that the methodology in detail:

a. A Pre-Audit Meeting (opening meeting) discussing the main guidelines with the college management team and other concerned departments.

b. Data collection for monthly electricity bills, unit injected to CESC grid, total built-up area, lighting system, ceiling fan, air conditioners, AC & non-AC Rooms or areas, water pump capacity, capacity of Solar PV System etc.

c. Review of existing energy accounting system (Energy Meter) in main grid incomer Panel, Solar PV outgoing feeders etc. & identification any gaps in energy accounting.

d. Measurement of all electrical parameters at main grid incomer Panel & Solar PV outgoing feeders & exploring energy saving opportunities if any.

e. Study of Split Air-conditioners & exploring further energy saving opportunities if any.

f. Check & Measurement of illumination at different areas & estimation of energy consumption pattern in lighting system.

g. Monthly electricity Bill analysis & exploring further monetary saving.

h. Discussion with members of the house.

i. Review of Documentation/Records (All the relevant maintenance documentation, test records, electrical records etc.

During study several interactions were made to the college personnel and staffs to share the actual operational features of equipment, college maintenance schedule and equipment break down, down time of machineries, safety measures etc. At the same time required drawings, documents, data sheets were collected from the college level and the same was reviewed with the operational actual data.

The study focused on improving energy efficiency and identifying energy saving opportunities at various equipment & systems. The analysis include simple payback period & ROI calculations where investments are required to be made to implement recommendations, to establish their economic viability.

7.0 Instrument used in Energy Audit:

The audit study made use of various portable instruments along with premises online instrumentations, for carrying out various measurements and analyses. The specialized instruments that were used during the energy audit include:

- Digital Multi Meter.
- Digital Smart Hygrometer for dry bulb temperature (DBT), wet bulb temperature (WBT) & relative humidity. (RH)
- Digital LUX Meter.
- Digital Infrared Thermometer.
- Digital Anemometer. (Vane Type)

8.0 Energy Audit Team:

1. Somnath Maiti (Certified Energy Auditor, BEE, Govt. of India)

2. Indrajit Dasgupta – Sr. Consultant, CMS

9.0 College Profile:

Loreto College, Calcutta founded in 1912 by the Sisters of the Institute of the Blessed Virgin Mary (IBVM), commonly known as Loreto, is a Christian Minority women's college aided by the Government in Kolkata, West Bengal, India. It is affiliated with the University of Calcutta. The mission of the college is committed to provide the highest quality education for women to enable them to develop their intellect and talents and to participate effectively and fully in society. This institution, which is now 113 years old, has been awarded 'Heritage' status certified by the KMDA.

The college aims towards a greener campus through use of rain water harvesting system and already adopted & harnesses grid connected solar photo voltaic (Solar PV) power generation system for generation of clean electricity. The college regularly opts for green audits.

10.0 Energy Conservation Measures Taken by Loreto College

a. **I**nstallation of 8 kWp and 6.6 kWp, 415 volt rated Solar Photo voltaic Power Generation System & harnessing clean & green power for college use in daytime & excess power is exported to grid through bi-directional energy meter.

b. **M**easured power factor (efficiency of electrical system) is found to be high (avg.-0.90) without using any capacitor banks and saving of some amount line losses & kVA demand.

c. Old non-star air-conditioners with energy efficient 3-STAR rated Split Air-conditioners for 3 nos. of rooms & saves considerable amount of money per month.

d. **C**ollege is started to adopt most energy efficient & long-lasting LED based lighting system in selected indoor application & saves some amount of electrical energy.

e. **S**ome of old wiring cables in ground floor conference room & office room are replaced with new cable with pipe wiring, resulting in lesser conductor resistance & lesser line losses.

f. **P**artly natural day light harnesses in the all-class room floors through clear wall glass, resulting in less use of existing lighting system in day time & reduction lighting power consumption further.

g. **S**olar PV Inverter Panels are equipped with high accuracy of 0.5 class digital Energy Meter.

h. Street lighting system controls through timer operated system which avoids energy wastage due to manual operation & saves substantial amount of energy.

i. Loreto College has taken initiative to implement the Rain Water Harvesting system & conserve precious rain water.

11.0 Barriers towards Energy Conservation

The study identified following barriers towards energy conservation & Energy Savings in the Loreto College:

a. Use of notable population of 36 Watt conventional & low efficacy fluorescent tube lights (FTL) with copper ballast in most class rooms(ground floor), Library etc. which consume excess amount of electrical energy compared to new generation long last 20-Watt LED tube light (TL).

b. Use of large population of 70 Watt & 110 Watt rated conventional & inefficient ceiling fans of 1200 mm & 1422mm sweep, which are consumed excess amount of electrical energy compared to new generation most energy efficient 28- Watt smart BLDC ceiling fan.

c. At present college is not monitoring the energy generation in existing Solar PV systems, wherein the digital true r.m.s energy meters are existed & connected to two existing Inverter Panels.

d. Presently no energy accountability system exists in the college.

e. Presently no log book is being maintained for DG set. No energy consumption & fuel consumption record found.

12.0 Base Line Data & Energy Scenario:

12.1 Summary of Energy Consumption Profile:

Main Source of energy in Loreto College is electricity from Grid (CESC) & Solar PV Generation. A summary and comparison of the annual energy consumption & Energy Performance Index (specific energy consumption) is given in tables below:

Table 1 Summary of Energy Consumption Profile

SUMMARY OF ENERGY CONSUMPTION PROFILE				
Sl. No.	**Particulars**	**Unit**	**2023-24 (CESC)**	**2024-25 (CESC)**
1.0 Electrical Energy Purchased & Cost Figure:				
1a.	**Annual Grid Energy Purchased & Consumed**	**kWh**	**35651**	**40075**
1b.	Annual Energy Generation from Solar PV	kWh	-	-
1C.	Annual Energy Injected to CESC Grid	kWh	12595	11872
1d.	**Annual Solar Energy Consumed by College**	**kWh**	**-**	**-**
1e.	Ton of Oil Equivalent (TOE)	TOE	3.06	3.45
1f.	Cost of Electricity Purchased & Consumed	₹ Lakh	2.26	2.81
1g.	Unit Rate of Electricity Purchased & Consumed	₹/kWh	**6.35**	**7.00**

NOTE: "TOE" stands for Metric Tonne of oil Equivalent Energy

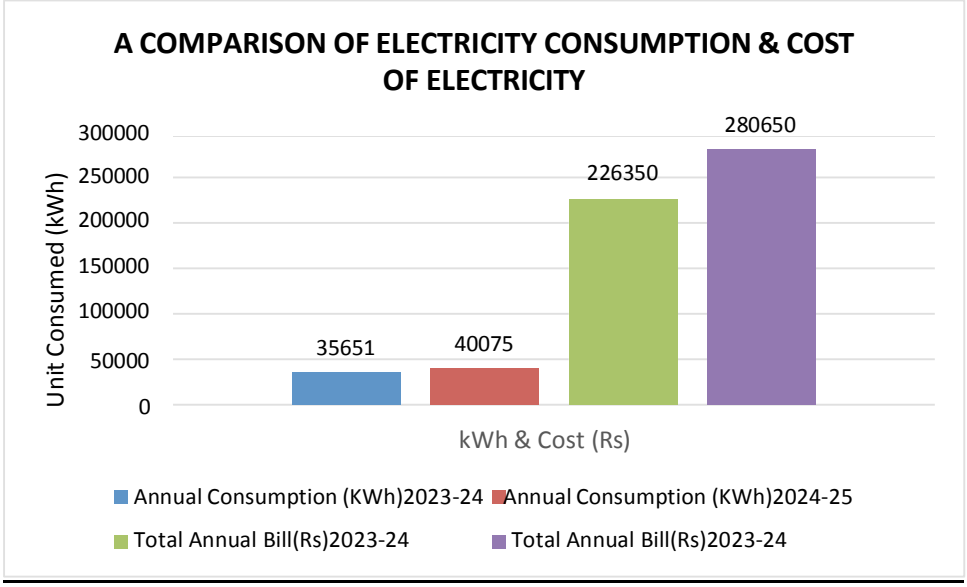

Figure 1 A Comparison of Annual Electricity Consumption & Cost of Electricity

COMMENTS:

Energy consumption from grid for the FY 2024-25 is found to be increased by **12.41%** as compared to the FY 2023-24.

12.2 Estimation of Energy Performance Index (EPI):

As per ECBC 2017, the Energy Performance Index (EPI) of a building is its annual energy consumption in kilowatt-hours per square meter of the building. At present built up area of air-condition areas & non-air conditioning areas college building is found to be 999.53 m^2 & 10769.96 m^2 respectively i.e. 8.49% is air-conditioned area & 91.50% is non-airconditioned area. EPI can be determined by:

$$EPI = \frac{Annual\ energy\ consumption\ in\ kWh}{Total\ built\text{-}up\ area\ (excluding\ unconditioned\ basements)}$$

Energy Performance Index of Loreto College for FY 2023-24

- Total Built-up areas Loreto College : 11769.49 m^2
- Annual energy consumption of Loreto College **:** 35651 kWh
- Specific Energy Consumption by Loreto College **: 3.02 kWh/m^2/year**

Energy Performance Index of Loreto College for FY 2024-25

- Total Built-up areas Loreto College : 11769.49 m^2
- Annual energy consumption of Loreto College **:** 40075 kWh
- Specific Energy Consumption by Loreto College **: 3.40 kWh/m^2/year**

NOTE: Considering *11769.49 m^2 total built-up areas for EPI Calculation & there is no basement in this College.*

As per ECBC published by BEE, in warm & humid climate "Specific Energy Consumption" as "Energy Performance Index" (EPI) for 5-star rated building having less than 50% Air-conditioned area is below 45 kWh/m^2/year with 5-Star Level-***.**

Table 2 Building Energy Star Rating less than 50% Air-conditioned built-up Area at Warm & Humid Climate

Building Energy Star Rating in Less than 50 % air- conditioned built-up area at Climatic Zone - Warm and Humid	
EPI (kWh/sqm/year)	Star Label
85-75	1 Star
75-65	2 Star
65-55	3 Star
55-45	4 Star
Below 45	5 Star

12.2.1 Comments on EPI:

During the FY 2023-24 & FY 2024-25, Energy Performance Index is found to be **3.02** kWh/m^2/Year & **3.40** kWh/m^2/Year respectively, which are very less & highly satisfactory and belong to 5 Star Category as per ECBC 2017**.** Still**,** there is further scope for reduction by replacement of conventional high wattage fluorescent tube lights & ceiling fans and additional solar plant installation & accordingly fix the target for action plan.

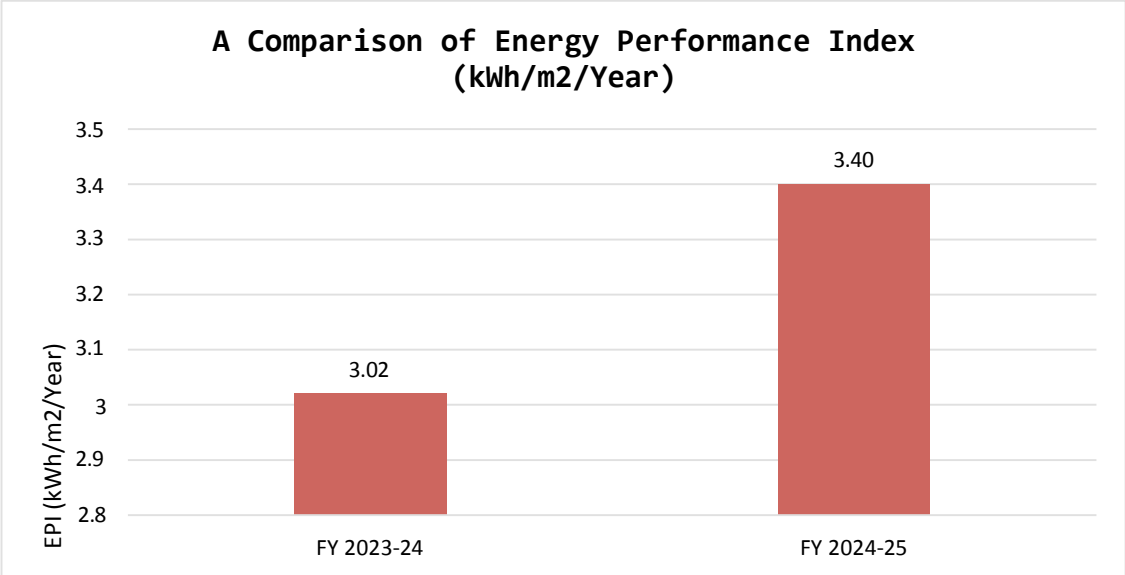

Figure 2 A Comparison of EPI for FY 2023-24 & FY 2024-25

COMMENTS:

Energy Performance Index pattern for FY 2023-24 & FY 2024-25 is found to be similar in nature & no such big gap is found after analysis.

13.0 Details of Major Energy Consuming Machinery

At present there are many major energy consuming machineries like star rated Split Air conditioners, Water Pump, LED based lighting system, Conventional Fluorescent Tube Lighting system, Ceiling fans, Computers, UPS etc. in Loreto College.

Table 3 Details of Energy Consuming Equipments of Loreto College

Type of Equipments	Unit	Number
2TR/1.5TR/1TR Split Air-conditioner	Nos.	17
17TR/8.5TR/3TR Duct/cassette AC	Nos.	6
3.7kW/5H.P Bore-well Water Pump & Overhead Water Tank Pump (one stand by)	Nos.	3
20-Watt LED Tube Light Fixture	Nos.	101
10 Watt/14 Watt LED Lamp Light Fixture	Nos.	24
40-watt Fluorescent Tube Light Set	Nos.	75 sets/150 Nos.
1200 mm Sweep(48") 70-watt Ceiling Fan	Nos.	121
1422 mm Sweep(56") 110-watt Ceiling Fan	Nos.	159
8 kWp Solar PV Generator	Nos.	1
6.6 kWp Solar PV Generator	Nos.	1
Computer (Desktop & Laptop)	Nos	140

14.0 Electrical Load Measurements on CESC Incomer & Solar PV Incomers

During different electrical parameters were measured & noted at Main Incomer of CESC Supply Point. During study several electrical parameters, like Voltage, Load Current, Neutral Current, Voltage Unbalance, Current Unbalance, Power factor etc. were studied.

14.1 Measured Electrical Parameters at Main Supply Incomer

Table 4 Measured Electrical Parameters for Main Supply Incomer Panel

Line Voltage Measurements at Main Incomer of 415V Grid Supply					
Name	Date	AVG.	MIN.	MAX.	Units
U12 rms	18-06-2025	412.8	406.7	415.6	V
U23 rms	18-06-2025	414.4	410.4	416.9	V
U31 rms	18-06-2025	410.4	406.8	413.5	V
Line Current Measurements at Main Incomer of 415V Grid Supply					
Name	Date	AVG.	MIN.	MAX.	Units
A1 rms	18-06-2025	14.810	12.850	19.79	A
A2 rms	18-06-2025	27.450	23.140	33.31	A
A3 rms	18-06-2025	10.140	8.750	14.59	A
AN rms	18-06-2025	22.0	20.3	24.3	A
Power Factor Measurements at Main Incomer of 415V Grid Supply					
Name	Date	AVG.	MIN.	MAX.	Units
PF1	18-06-2025	0.945	0.925	0.951	p.u.
PF2	18-06-2025	0.965	0.955	0.969	p.u.
PF3	18-06-2025	0.866	0.836	0.895	p.u.
PFT	18-06-2025	0.940	0.931	0.948	p.u.

Figure 3 Electrical Measurement by Power Analyzer at Grid Incomer Main Panel

COMMENTS:

Voltage & current profile found satisfactory. Power factor without APFC panel is maintaining average 0.90 which is helping to reduce line losses

15.0 Measured Solar Power Generation at 4th Floor Solar PV Inverter Panel

At present there 58 nos. of 250Wp rated solar modules. Located at 4th floor roof top. During audit, different electrical parameters were measured at AC Outgoing feeder of Inverter LT Panel (MAKE-SOLAX POWER & POWADOR), located at 4th floor stair case. During study several electrical parameters, like Voltage, Load Current, Neutral Current, Voltage Unbalance, Power factor, Powers etc. were studied.

15.1 Measured Electrical Parameters at 8 KWP Solar PV Panel-1

Table 5 Measured Electrical Parameters for 8 kWp Solar PV Panel-1

Line Voltage Measurements at Incomer of 8 kWp 415V Solar PV-1 Generation					
Name	Date	AVG.	MIN.	MAX.	Units
U12 rms	18-06-2025	412.3	409.8	415.0	V
U23 rms	18-06-2025	414.2	411.8	416.4	V
U31 rms	18-06-2025	415.9	413.5	418.9	V
Line Current Measurements at Incomer of 8 kWp 415V Solar PV-1 Generation					
Name	Date	AVG.	MIN.	MAX.	Units
A1 rms	18-06-2025	2.50	2.23	2.91	A
A2 rms	18-06-2025	2.55	2.24	2.97	A
A3 rms	18-06-2025	2.41	2.15	2.82	A
AN rms	18-06-2025	0.2	0.2	0.2	A
Power Factor Measurements at Incomer of 8 kWp 415V Solar PV-1 Generation					
Name	Date	AVG.	MIN.	MAX.	Units
PF1	18-06-2025	0.984	0.983	0.987	p.u.
PF2	18-06-2025	0.985	0.983	0.989	p.u.
PF3	18-06-2025	0.986	0.984	0.990	p.u.
PFT	18-06-2025	0.985	0.983	0.989	p.u.
Measured Power at Incomer of 8 kWp 415V Solar PV-1 Generation					
Name	Date	AVG.	MIN.	MAX.	Units
P1 (W)	18-06-2025	589.3	580.4	597.7	W
P2 (W)	18-06-2025	597.7	588.2	607.2	W
P3 (W)	18-06-2025	572.0	563.1	580.6	W
PT (W)	18-06-2025	1.76	1.73	1.79	kW

COMMENTS:

Above measured parameters parameter indicates that hourly average & maximum generation are found to be 1.76 kWh (Unit) & 1.79 kWh (unit) with near to unity power factor & also with pure sine curve, which are highly satisfactory.

Figure 8 Measurement of Solar PV Generation at 8kWp Inverter LT Panel-1

15.2 Measured Electrical Parameters at 6.6kWp Solar PV Panel-2

Table 6 Measured Electrical Parameters for 6.6 kWp Solar PV Panel-2

Line Voltage Measurements at Incomer of 6.6 kWp 415V Solar PV-2 Generation					
Name	Date	AVG.	MIN.	MAX.	Units
U12 rms	18-06-2025	411.4	409.0	413.8	V
U23 rms	18-06-2025	413.8	411.9	416.2	V
U31 rms	18-06-2025	414.8	412.8	417.0	V
Line Current Measurements at Incomer of 6.6 kWp 415V Solar PV-2 Generation					
Name	Date	AVG.	MIN.	MAX.	Units
A1 rms	18-06-2025	1.91	1.70	2.43	A
A2 rms	18-06-2025	1.95	1.77	2.46	A
A3 rms	18-06-2025	1.86	1.67	2.36	A
AN rms	18-06-2025	0.11	0.11	0.12	A
Power Factor Measurements at Incomer of 6.6 kWp 415V Solar PV-2 Generation					
Name	Date	AVG.	MIN.	MAX.	Units
PF1	18-06-2025	0.976	0.971	0.978	p.u.
PF2	18-06-2025	0.977	0.970	0.981	p.u.
PF3	18-06-2025	0.979	0.973	0.982	p.u.
PFT	18-06-2025	0.977	0.972	0.98	p.u.
Measured Power at Incomer of 6.6 kWp 415V Solar PV-2 Generation					
Name	Date	AVG.	MIN.	MAX.	Units
P1 (W)	18-06-2025	446.3	442.7	450.3	W
P2 (W)	18-06-2025	453.9	449.8	457.4	W
P3 (W)	18-06-2025	436.2	432.9	439.6	W
PT (W)	18-06-2025	1.34	1.33	1.35	kW

COMMENTS:

Above measured parameters parameter indicates that hourly average & maximum generation are found to be 1.34 kWh (Unit) & 1.35 kWh (unit) with near to unity power factor & also with pure sine curve, which are highly satisfactory.

Figure 9 Measurement of Solar PV Generation at 6.6 kWp Inverter LT Panel-2

16.0 Illumination & Lighting System

16.1 Introduction:

Lighting energy contributes to major consumption of power in Loreto College, wherein a number of areas use energy efficient & long-lasting LED Lighting Fixtures 20-Watt LED Fixture areas compared to conventional fluorescent tube light (FTL). Hence, there is a further scope for cutting down the lighting power consumption by the adoption of energy efficient LED based lighting system.

Part 8 of National Building Code of India enlisting standards for Building services (Illumination) are the set of standards required to be implemented across all warehousing structures. (IS 3646 Part 1) of BIS.

The field study was included the LUX measurements randomly in class room, office rooms, library and teachers' room etc. & estimation of lighting power consumption and comparison with IS standard, condition of lamp/luminaries' survey.

Details of LUX measurements in all floors of college building room and electrical measurements on lighting feeder are given in tables below.

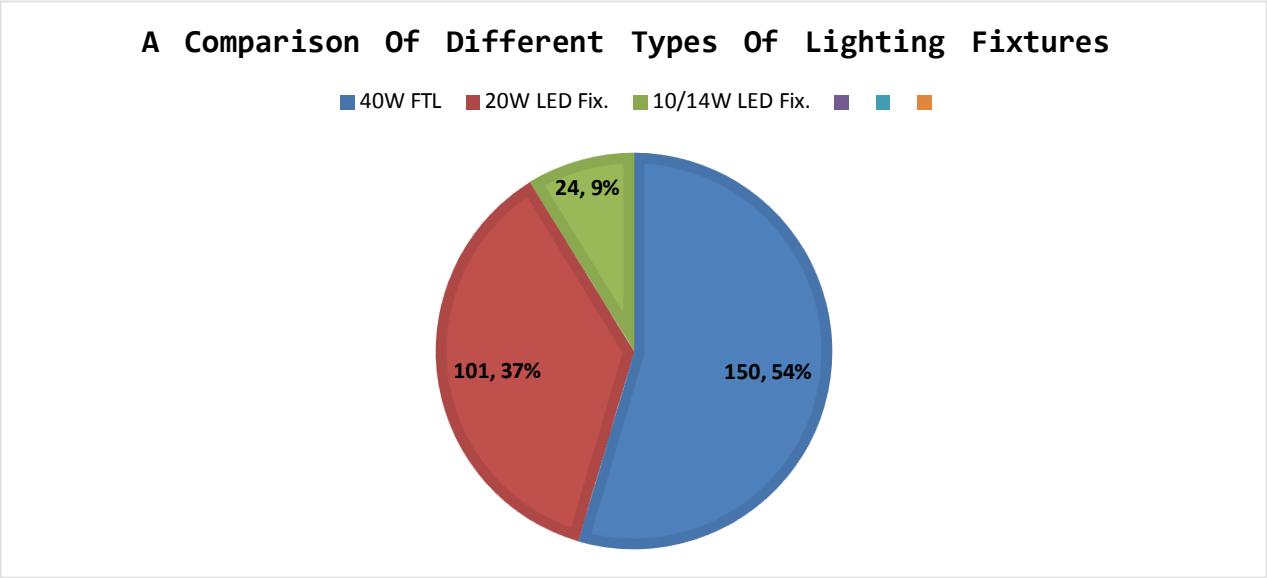

Figure 12 Population of Different Kinds of Lighting System

COMMENTS:

College management should focus mainly to use energy efficient & high efficacy LED Fixture than conventional & high wattage fluorescent tube lights, which will bring down the overall energy consumption of college substantially.

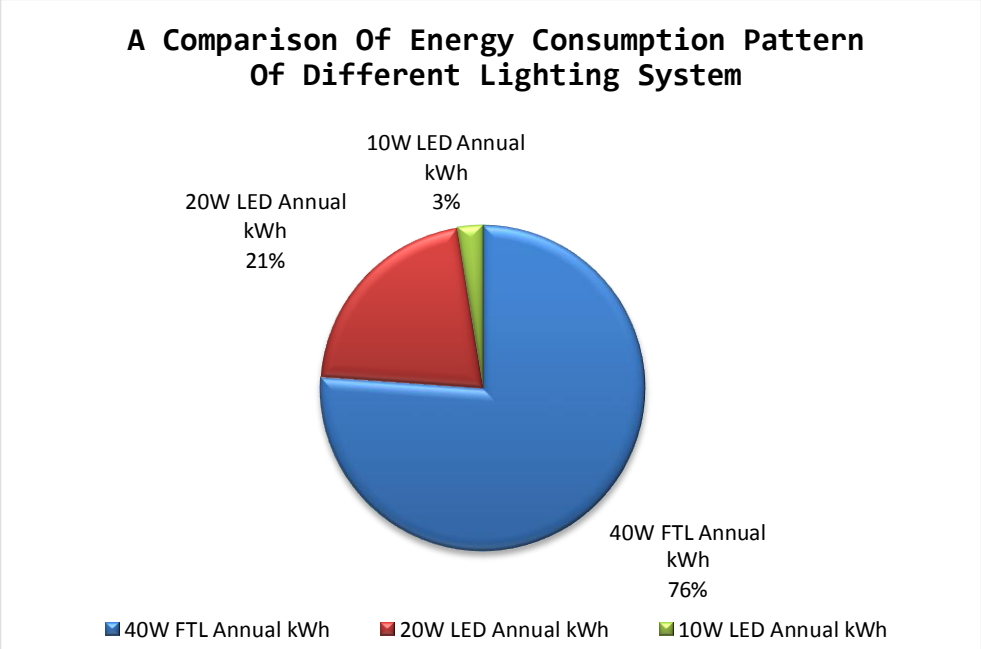

Figure 13 Energy Consumption (kWh) Pattern of Different Lighting System

COMMENTS:

College management should focus mainly to use energy efficient & high efficacy LED Fixture than conventional & high wattage fluorescent tube lights, which will bring down the overall energy consumption of college substantially.

16.2 Salient Observations:

- Most cases in ground floor found college is using extensively high wattage conventional fluorescent tube light, which increases lighting power consumption substantially.
- Most cases measured LUX in class room in ground floor areas was found to be poor as compared to recommended value of IS 3646 (Part-1)-1992 as most cases low efficacy fluorescent tube lights are used.
- Most cases class rooms, library are harnessing Natural Day light through glass window, leading to reduction of necessity of additional lighting loads.
- At present switching of indoor lighting system is done manually and no sensor based automatic switching is available after completion of classes. Hence, there is an uncertainty in switching of circuit in correct time, which may lead to loss of power unnecessarily.
- At present there is no cloud (IoT) based lighting control system, wherein today switching of lighting system can be easily controlled efficiently by Smart Mobile or Laptop or Desktop through Internet based Router Connection from any single location.

16.3 Recommended Illumination [Source: IS 3646 (Part 1): 1992]

L – R – H (L– Lower Value of illuminance, H– Higher Value of illuminance, R– Recommended illuminance).

	L	R	H
Office Room	200	300	500
Class Room	200	300	500
Laboratory	300	500	750
Library	200	300	500
Conference Hall	100	200	300

Figure 14 LUX Measurement at different Room

Table 7 Measured Illumination & Power Consumption Profile in Lighting System

Measured illumination & Energy Consumption for Loreto College										
Sl. No.	**Location/Room**	**Type of Lamp & Fittings**	**No. of Glowing Lamp**	**Watt / Lamp**	**Watt / ballast**	**Total Power (kW)**	**Annual Running Hours**	**Annual Energy Consumed (kWh)**	**Avg. LUX Level**	**LUX As per IS 3646 (Part-1)- 1992 (L-R-H)**
1.	3rd Fl. Media Room	36W LED Fixture	8	36	1	0.296	900	266	298.3	200-300-500
2.	4th Fl. Room No.413		6	20	1	0.126	900	113	189.5	200-300-500
3.	4th Fl. Corridor	Natural Day light/15W LED (R)	2	15	1	0.032	900	29	350.6	200-300-500
4.	1st Fl. Library	2 x 40W FTL	52	40	10	2.60	900	2340	200.1	200-300-500
5.	Gr. Fl. Room No G-8	2 x 40W FTL & 20W LED TL	6/2	40/20	10/1	0.342	900	308	225.5	200-300-500
6.	Gr. Fl. Room No G-9	2 x 40W FTL & 20W LED TL	6/2	40/20	10/1	0.342	900	308	135.8	200-300-500
7.	Electrical Panel Room	1 x 36W FTL	1	36	10	0.46	450	207	71.0	200-300-500
8.	Gr. Fl. Room No G-7	2 x 40W FTL & 20W LED TL	6/1	40/20	10/1	0.321	900	289	115.2	200-300-500
9.	Gr Fl. Entrance Lobby	12W LED (R) Fixture	14	12	1	0.182	900	164	154.1	200-300-500
10.	Gr. Fl. Entrance Corridor	30W LED Fixture	1	30	1	0.031	900	28	171.2	200-300-500
11.	Gr. Fl. Room No G-4	1 x 36W FTL & 20W LED TL	1/3	36/20	10/1	0.109	900	98	150.6	200-300-500
Total			**111**	**-**	**-**	**4.84**	**-**	**4150**	**187.4**	

17.0 Energy Conservation Proposal

Proposal-17.1 (On Energy Efficient Lighting System)

Replacement of all 40W Conventional Fluorescent Tube Lights (FTL) in indoor application step by step with new generation energy efficient & Long Lasting 1 x 20W LED Tube Lights and saving of substantial amount of electrical energy and reduction of maintenance cost

17.1.1 Background:

Presently Loreto College uses 150 nos.(75 Fixtures) of 40W Conventional Fluorescent Tube Light with copper ballast, located mainly at all class rooms, library, office room etc, which consume excess power than new generation energy efficient & long-lasting LED lighting fixture. It is well proven that LED Light Fixture is very efficient, which consumes less power corresponding to lumen output.

Power LED Round Fixture for indoor application is designed with high-illumination Power LEDs having a life of 30,000 hours to 50,000 hours. This light has light output similar to fluorescent, and involves a much lower initial investment. The light output is more homogenized then in the existing model, and it provides flicker-free operation from 110V-260VAC.

17.1.2 Features of Power LED Tube Light Indoor Fixture:

- Light emission divided over a greater number of LEDs (for same wattage and total light output), hence more homogenous light and less 'spotty'
- Light output similar to that of standard FTL
- Simplified passive control circuitry provides high reliability of driver; no active SMPS circuitry involved
- Contributes to Power Factor improvement
- Large-chip power LED construction for efficient thermal management of the LED chip, thus providing high reliability and long life

17.1.3 Technical Specifications for 20-watt LED Tube Light (indoor):

- Equivalent to about 36-watt FTL
- Working Voltage- 110 - 260 V AC
- LED lamp Efficacy- Minimum 100 lumens/watt
- Rated system Wattage- 18W ± 3%
- Frequency- 50 ± 1 Hz
- Colour Rendering Index (CRI)- > 80
- Total harmonic distortion (THD)- Should not be more than 20%
- Corrected Colour Temperature (CCT)- 5700 ± 300 K
- Average Lighting Angle- 160°
- System lumen efficacy- Should be min. 100 lumens / watt
- Power factor- > 0.95
- LED / Type- High Power LEDs should be used
- Life Expectancy (Design life)- Min. 30,000 burning hours

- Ingress Protection- IP20 (Indoor)
- Driver efficiency- More than 85 %

17.1.4 Summary of Techno-economic Analysis:

SUMMARY OF TECHNO ECONOMICS FOR REPLACEMENT OF FLUORESCENT TUBE LIGHT

➢ Annual Energy Saving Potential	: 8770 kWh
➢ Annual Cost Saving Potential	: ₹0.92 Lakh
➢ Investment Required	: ₹0.47 Lakh
➢ Payback Period	: 6.1 Months

Details of techno-economic analysis are given in annexure-1.

Proposal-17.2 (On Energy Efficient Smart BLDC Ceiling Fan)

Replacement of total 282 nos. of 70-Watt 48" & 110W of 56" Conventional Ceiling Fans with new 18 nos. of 28 Watt 48" (□ 1200 mm Sweep) most Energy Efficient BEE 5-Star Rated Smart Ceiling Fans and save substantial amount of electrical energy.

17.2.1 Background:

At present Loreto College uses 121 nos. of 70 watt Conventional 48" & 161 nos. of 110W Conventional 56" Ceiling Fans at all class rooms, office rooms, laboratory rooms, conference hall, auditorium etc. During study it was observed that such conventional ceiling fan consumes excess power than new generation low wattage (28 Watt) smart (sensor based) ceiling fan, which saves considerable amount of electrical energy. Hence, it is suggested to replace all conventional ceiling fans with new generation smart energy efficient fans and save considerable amount of electrical energy.

17.2.2 Features of Smart Ceiling Fan:

a. > Super energy efficient (Brushless Direct Current Motor, BLDC)
b. >High service value (air delivery/watt)
c. > Runs 3 times longer on inverter resulting
d. > No humming noise
e. > No heating of fan even after long hours of runtime resulting in extra-long life
f. > Easy speed control using smart remote
g. > Consistent performance even at low voltage and power fluctuation
h. > Timer features to auto switch off the fan
i. > Sleep mode that reduces the speed after set hours and saves energy

17.2.3 Technical Specifications:

1. > Blade Span (mm/inch)	: 1200/48
2. > RPM	: 380
3. > Service Value	: > 8
4. > Input Voltage (V)	: 140 – 285

5. > Power Consumption (W)	: 28
6. > Frequency (Hz)	: 48 – 52
7. > Air Delivery (CMM)	: 230
8. > Power Factor	: > 0.98
9. > No. of Blades	: 3
10. > Voltage THD	: < 10%
11. > Current THD	: < 2%
12. > Bearing (Double)	: Deep Groove Double Sided Steel Shielding
13. > Remote Control (12 Keys)	: Speed Control, Timer and Sleep Mode

17.2.4 Summary of Techno-economic Analysis:

SUMMARY OF TECHNO ECONOMICS FOR ENERGY EFFICIENT SMART BLDC CEILING FAN (48")

- Annual Energy Saving Potential : 6098 kWh
- Annual Cost Saving Potential : ₹0.58 Lakh
- Investment Required : ₹3.45 Lakh
- Payback Period : 71.4 Months

SUMMARY OF TECHNO ECONOMICS FOR ENERGY EFFICIENT SMART BLDC CEILING FAN (56")

- Annual Energy Saving Potential : 15842 kWh
- Annual Cost Saving Potential : 1.51 Lakh
- Investment Required : 4.59 Lakh
- Payback Period : 36.6 Months

Details of techno commercial analysis are shown in Annexure-2.

Figure 15 BLDC Smart Ceiling Fan

Proposal-17.3 (On Additional Solar Plant Installation)

Presently two nos. on grid Solar Photo Voltaic Power Generation System of 6.6kWp & 8kWp is installed in the rooftop of Loreto College harnessing clean & green power in daytime & excess power is exported to grid through bi-directional energy meter hence achieving substantial amount of energy saving yearly.

17.3.1 Background:

During audit it is observed that another 3 nos. CESC energy meter (ENERGY METER NO. 2155014 09, 2155183 06 & 2155180 03) is also connected to the Loreto College through which Loreto College is consuming notable amount of energy every day.

17.3.2 Study & Analysis:

After through study & analysis it is found that during FY 2024-25 CESC chargeable unit was 11947 kWh & Loreto College have paid an Electricty bill of Rs 1.13 Lakh to CESC for the aforesaid financial year.

17.3.3 Recommendation:

It is recommended to install one 10kWp, 415 volt rated Solar Photo voltaic Power Generation System for the aforementioned yearly load in the rooftop of college for harnessing clean & green power for college use in daytime & excess power is exported to grid through bi-directional energy meter.

Existing all three existing energy meter (2155014 09, 2155183 06 & 2155180 03) should be replaced by one grid connected bi-directional energy meter. All the loads fed through these existing three meter should be connected with one grid connected bi-directional meter. Substantial amount of energy saving can be made following this module & a step towards net zero electrical energy can be achieved through this project.

SUMMARY OF TECHNO ECONOMICS FOR ANALYSIS OF ENERGY SAVING FOR THE INSTALLATION OF ADDITIONAL SOLAR PLANT FOR EXISTING ENERGY METER NO. 2155014 09, 2155183 06 & 2155180 03

- Annual Energy Saving Potential : 12775 kWh
- Annual Cost Saving Potential : 1.21 Lakh
- Investment Required : 5.00 Lakh
- Payback Period : 49.4 Months

Details of techno commercial analysis are shown in Annexure-3.

18.0 Annexure

Annexure 1 Techno-Economic Analysis for Replacement of Existing 40W Conventional Fluorescent Tube Light (FTL) with EE 20W LED Tube Light

Techno-Economic Analysis for Replacement of Existing 40W Conventional Fluorescent Tube Light (FTL) with 20W LED Tube Light			
Particulars	**Unit**	**Existing**	**Proposed**
Fixture		**40W FTL**	**20W LED Tube Light**
Power consumed per Lamp	W	40	20
Power consumed by Ballast	W	10	1
Total power consumed by fixture	**W**	**50**	**21**
Operating Hours/day	Hr	6.0	6.0
Annual days of operation	Day	240	240
Energy Used per year/fixture	**kWh**	**144**	**60**
Energy Rate	Rs/kWh	9.50	9.50
Lamp life	hrs	5000	50000
Project Life of Lighting system	Yrs	34.7	34.7
Average Project Life	Yrs	34.7	
Replacement frequency during project lifetime	No.	9.00	0
Replacement frequency/year	No.	0.26	0
Initial Cost/unit	Rs	250	300
Annual R & M cost	Rs.	10800	0
No. of Fixture	Unit	**150**	
Annual Saving Calculation			
Load Factor	**%**	70	70
Energy Saving	kWh	8770	
Energy Cost Saving	Rs	83311	
Saving in R & M Cost	Rs	10800	
Total Annual Saving	Rs.	**94111**	
Cost Benefit Calculation			
Capital cost of LED	Rs.		
Labour & Other Cost	Rs./Fixture	15	
Implementation Cost	Rs.	2250	
TOTAL INVESTMENT	Rs.	**47250**	
Annual M & V cost	Rs.	**1500**	
Net Annual Monetary Saving	Rs.	**92611**	
Simple payback	Month	**6.1**	

Annexure 2 Analysis of Energy Saving for the Replacement of Conventional Ceiling Fan with Most EE Smart Ceiling Fan

Analysis of Energy Saving for the Replacement of Conventional Ceiling Fan (sweep 48") with Most Energy Efficient Smart Ceiling Fan			
Sl. No.	**Particulars**	**Unit**	**Analysis & Result**
1	Avg. Power Consumed by 48" Conventional each Ceiling fan	Watt	70
2	Number Ceiling Fan exist	Nos.	121
3	Avg. Running hour per day	hour	6
4	Running hours per annum	hour	1200
5	Annual energy consumed by 48" Conventional all Ceiling Fans	kWh	10164
6	Avg. Power Consumed by each 48" Energy Efficient Smart Ceiling Fan	Watt	28
7	Power Consumed by all 48" Energy Efficient Smart Ceiling Fans	Watt	3388
8	Annual energy consumed by 48" Energy Efficient Smart Ceiling Fans	kWh	4066
9	Annual energy saving potential	kWh	6098
10	Cost of Electricity	₹/kWh	9.50
11	Net annual energy cost savings	₹ Lakh	**0.58**
12	Net Cost of 48" Energy Efficient Smart Fans	₹ Lakh	**3.45**
13	Payback period	Month	**71.4**

Analysis of Energy Saving for the Replacement of Conventional Ceiling Fan (sweep 56") with Most Energy Efficient Smart Ceiling Fan			
Sl. No.	**Particulars**	**Unit**	**Analysis & Result**
1	Avg. Power Consumed by 56" Conventional each Ceiling fan	Watt	110
2	Number Ceiling Fan exist	Nos.	161
3	Avg. Running hour per day	hour	6
4	Running hours per annum	hour	1200
5	Annual energy consumed by 48" Conventional all Ceiling Fans	kWh	21252
6	Avg. Power Consumed by each 48" Energy Efficient Smart Ceiling Fan	Watt	28
7	Power Consumed by all 48" Energy Efficient Smart Ceiling Fans	Watt	4508
8	Annual energy consumed by 48" Energy Efficient Smart Ceiling Fans	kWh	5410
9	Annual energy saving potential	kWh	15842
10	Cost of Electricity	₹/kWh	9.50
11	Net annual energy cost savings	₹ Lakh	**1.51**
12	Net Cost of 48" Energy Efficient Smart Fans	₹ Lakh	**4.59**
13	Payback period	Month	**36.6**

Annexure 3 Analysis of Energy Saving for the Additional Solar Plant.

Analysis of Energy Saving for the Installation of additional Solar Plant For Existing Energy Meter No. 2155014 09, 2155183 06 & 2155180 03			
Sl. No.	**Particulars**	**Unit**	**Analysis & Result**
1	Proposed Solar Plant Capacity	KWp	10
2	Average generation capacity per day of the solar palnt	KWh	35
3	Annual average generation capacity of the solar palnt	KWh	12775
4	Annual average energy saving potential in electricity bill	KWh	12775
5	Cost of purchased Electricity from CESC	₹/kWh	9.50
6	Net annual energy cost savings	₹ Lakh	**1.21**
7	Proposed Solar Plant purchase & installation cost	₹ Lakh	**5.00**
8	Payback period	Month	**49.4**

19.0 Some More Energy Savings Tips For College:

Given below some more energy saving tips for the college. College can follow & implement the same wherever applicable for more energy saving.

- Install Energy Saver/Voltage stabilizer for AC which lead to 10 % Energy Saving.
- Install Auto Voltage stabilizer where Voltage is low.
- Install Timer for AC.
- Remove the load/equipment from college which is not repairable.
- Install Timer For Sign Board.
- Use LED Light in place of any conventional light and save 80 % energy.
- Mark Fan and Light switch As F and L.
- Run AC at 22-24 Degree centigrade to save more energy.
- Replace Old AC with Energy efficient BEE star Rated AC.
- Install Capacitor where PF is Low.
- Install Auto Changeover For DG Set.
- Switch of the light and fan when no occupancy is there. Occupancy sensor can be installed wherever required for more energy saving.
- Electrical Load should be balanced so loss due to unbalance should be avoided.
- Replace Electromagnetic Fan Regulator with Electronic Dimmer type regulator and save 60% of regulator energy consumption.

20.0 Details of Vendors & Service Providers

Sl. No.	NAME OF THE PROPOSED SYSTEM	NAME OF THE PROBABLE SUPPLIERS & IMPLEMENTORS
1.	Supplier of 5-Star Rated BLDC Smart Ceiling Fan	Available in many shops of Ezra Street Electrical goods market, Kolkata-700001
2.	Supplier of 20-Watt Rated LED Tube Light	Available in many shops of Ezra Street Electrical goods market, Kolkata-700001
3.	Supplier of Solar Plant	HCK Solar Energy Ltd. (Kankaria Group) Address: Kankaria Estate, 6 Little Russel Street, Kolkata-700071, Contact: Mr. Arpan Banerjee (Sales Manager) 9147385292 (M) Web: www.hcksolar.com Email: arpan.banerjee@kcksolar.com
4.	Supplier of Solar Plant	Magnifico Solar Energy Pvt. Ltd. Mumbai: D-116, 1st Floor, Crystal Plaza. Opp. Infinity Mall, Andheri New Link Road, Andheri West, Mumbai-400053 Kolkata: 16No Ghosal Para, Barasat, Kolkata- 700124 Contact: Mr. Biswajit Ray – founder & CEO +91 9136799865, +91 9836311103 Web: www.magnificosolar.com Email: biswajit@magnificosolar.com magnificosolar@gmail.com

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