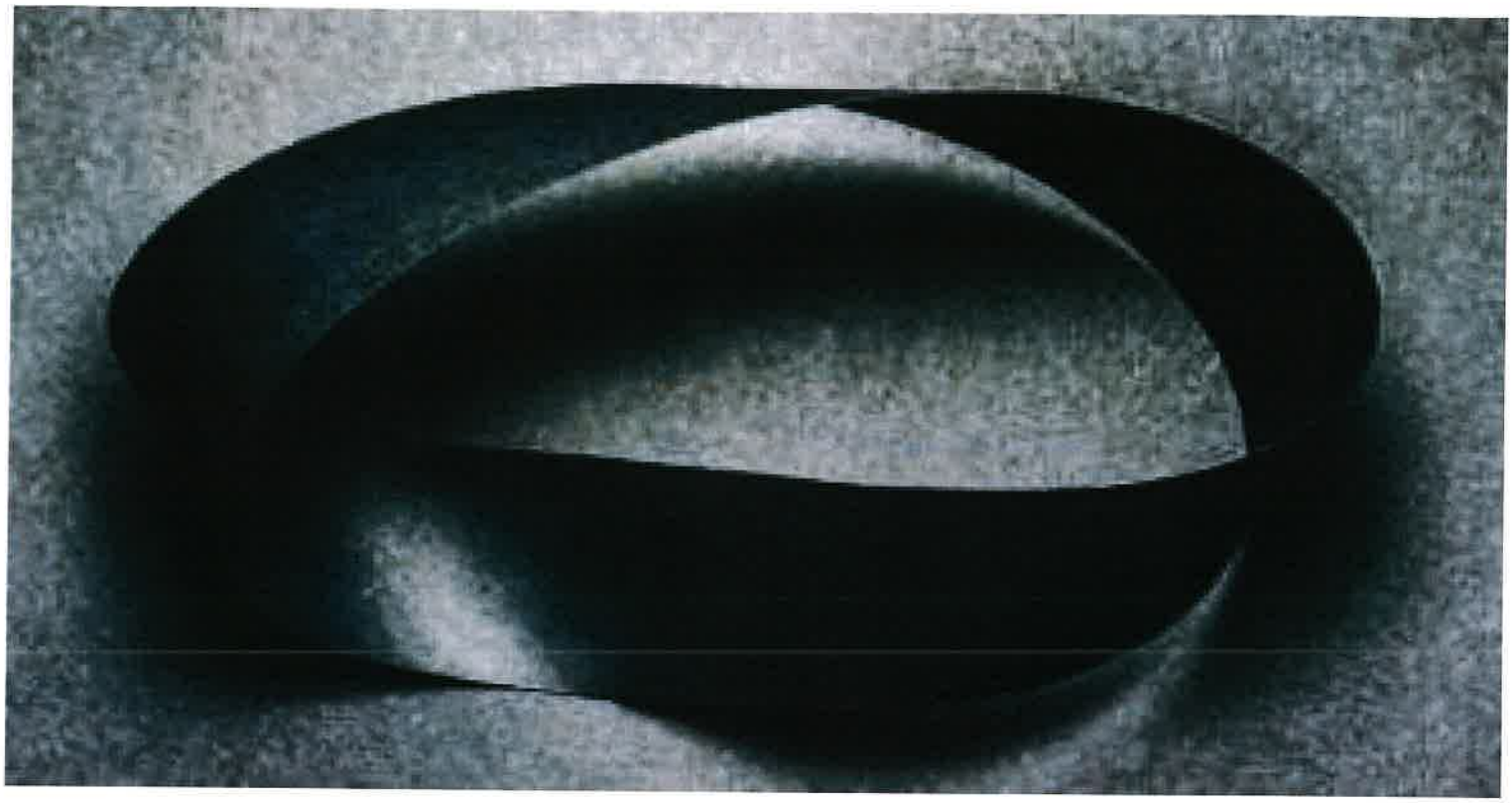

Energy Audit Report – 2019

Submitted to

Kristu Jayanti College, Autonomous
Bengaluru

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Cover page photographs:

Mobius strip – is a surface with only one side and only one edge. It has the mathematical property of being non-orientable. It can be embedded in three-dimensional Euclidean space.

The Mobius strip stands for Constancy of Change, Unconventional, Continuity and Sustainability. It represents something simple, yet profound -- something anyone could have discussed centuries prior to its discovery, but didn't – ***a Paradigm shift!***

Table of Content

List of Figures

List of Tables

Abbreviation

BESCOM	Bangalore Electrical Supply Company Limited
DG	Diesel Generator
Hrs	Hours
IS	Indian Standards
KJC	Kristu Jayanti College
kVA	Kilo Volt- Ampere
kVA	Kilo Volt
KVAR	Kilovolt-Ampere Reactive
kWh	Kilo Watt hour
kWh	kilo Watt
LED	Light Emitting Diode
LT	Low Tension
P.F	Power Factor
PG	Post Graduate
PO	Post Box
SMF	Sealed Maintenance Free
STP	Sewage Treatment Plant
UPS	Uninterruptible Power Source
V	Volt
WP	Watt Peaks

0. Executive Summary

1. Kristu Jayanti College (KJC) is a private college managed by Bodhi Niketan Trust and located at Kothanur, Bengaluru and established in 1999. It is affiliated to Bengaluru North University. The college is recognized by the University Grants Commission (UGC) and the National Assessment and Accreditation Council (NAAC) awarded it 'A' grade in 2015. The total student strength is 6804 inclusive of 1109 residential students.

2. The campus of Kristu Jayanti College is spread over 9 acres and provides all the necessary facilities at par with scientific and technological advancements, including a library, labs, and a fully Wi-Fi enabled campus. It has spacious classrooms, conference halls, auditoria, panel rooms, and sports facilities. The colleges have 13 departments that are housed in the main block along with the administrative sections. The MBA and MCA programs function in a separate block. The college has four research centers in the field of Social Work, Biotechnology, Commerce and Psychology.

3. KJC has instituted several measure to conserve water- A Rain water harvesting tank of 4.4 ML is established which is in compliance with the regulations. The overal consumption of freshwater is controlled to about 30lpcd as against 45 lpcd (NBC2016). Treated waster from the the 96KLD STP is recycled fo flushing and landscaping.

4. The college consumes energy in primarily 5 areas namely Air conditioners, Lighting, Fans, Blower and pumps in STPs and Passenger lift among others. The total connected load is 627KW. The college also has two captive DG sets of 200KVA and 125KVA to provide backup power with an operation of 6–75 hours per month. UPS with 98% of contract demand is also installed. Two Solar photvoltaic 50KW +10KW is installed in the roof top. It has succesfully supplied an excess energy of 450kWh for the year 2019.

5. The analysis of power factor and harmonics indicate that the institution has implemented adequate capacitive compensation. The Total Harmonics Distortion is less than 5% which is acceptable. The total annual energy consumed per student is 83kWh and per unit area is 9.81, which is appreciable.

6. The Analysis of loads indicate that nearly ₹4.72 lakhs and 6.95 lakhs can be realized from LED substitution for lighting and replacement of current fans by brush less DC fans. The expenditure required for lighting replacement is only ₹3.72 implying a payback period of less than 8 months, while the fan replacement would require about ₹40 lakhs with a payback period of 5.7 years.

1. Background

Kristu Jayanti College is a private college managed by Bodhi Niketan Trust and located at Kothanur, Bengaluru. It was established in 1999 and is affiliated to Bengaluru North University. The college is recognized by the University Grants Commission (UGC) and the National Assessment and Accreditation Council (NAAC) awarded it 'A' grade in 2015. The total student strength is 6804 inclusive of 1109 residential students.

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As per the India Today MDRA Survey 2020, Kristu Jayanti College, Bengaluru is awarded as the "Best Emerging College" of the Century at the national level. Also, it was awarded Asia's Best Emerging Science, Commerce and Arts College in Innovation category by Asia's Education Award 2019.

Kristu Jayanti College has implemented many initiatives is to make the institute sustainable such as rain water harvesting, sewage treatment plant, solar photovoltaic for renewable energy generation etc. The Institution has forged partnerships with eminent organisations to advise on its sustainability actions.

In continuation of the annual schedule, the Institution has approached Paradigm Environmental Strategies (P) Ltd (Ecoparadigm), a reputed Environmental and Energy consulting organization to carry out an energy audit of the premises and advise them about the necessary actions.

2. Introduction

The institution has carried out a periodic annual energy audit and implemented the recommendation in the past. The energy audit has been conducted by Ecoparadigm.

Annual energy cost is during the year 2019- 20 is around ₹ 40 Lakhs. The instution has been able to effect a 35 reduction in overall energy consumption per student. With the current rate of inflation, the energy cost will increase at

the rate of 6 to 8 % per year. Energy wastages should be identified and minimized to reduce energy costs.

3. Scope of work

The scope of work of the energy audit is as given below

a) Review of Electricity Bills, Contract Demand and Power Factor: For the last one year, in which possibility will be explored for further reduction of contract demand and improvement of P.F.

b) Electrical System Network: This would include a detailed study of all the Transformer operations of various Ratings / Capacities, their Operational Pattern, Loading, No Load Losses, Power Factor Measurement on the Main Power Distribution Boards, and scope for improvement if any. The study would also cover possible improvements in energy metering systems for better control and monitoring.

c) Electrical Motors, the study of various capacity motors and utilization, loading, efficiency, and thereby suggesting measures for energy saving like reduction in the size of motors or installation of an energy-saving device in the existing motors.

d) Study of other electrical loads like air-conditions, lifts, etc for . their efficiency and scope for further improvements if any.

e) Illumination System: Study of the illumination system, LUX level in various areas, area lighting, etc. and suggest measures for improvements and energy conservation opportunity wherever feasible.

f) DG Sets: Study the operations of DG Sets to evaluate their average cost of Power Generation, Specific Energy Generation, and subsequently identify areas wherein energy savings could be achieved after analyzing the operational practices, etc. of the DG Sets.

4. Approach and Methodology

The approach shall be to acquire and analyze past data and finding the energy consumption pattern of these facilities. The second objective shall be to calculate the wastage pattern based on the analysis. The final objective is to find and implementable solutions that are acceptable and feasible.

Energy audit of KJC has been conducted by analysis of power consumption patterns over the year, total connected load, and utilization of power. All the sections of Kristu Jayanti College have been studied to understand power distribution patterns, load utilization, utilization of various facilities, details of records maintained, and analysis of documents.

- Visual inspection and data collection.
- Observations on the general condition of the facility and equipment and quantification
- Identification / verification of energy consumption and other parameters by measurements
- Detailed calculations, analyses
- Validation
- Identifying potential energy saving opportunities.
- Recommendations.

5. Salient features of the project

Table 1: Details of Kristu Jayanti College

1	Name of Consumer:	M/s. Kristu Jayanti College- Bangalore
2	Name of the contact person	Mr. Edward – Dean
3	Address of the consumer	K Narayanapura , Kothanur(PO) ,Bangalore
4	Transformer capacity	500 kVA, 11kV / 433 V . ONAN,
5	Capacity of back generators	200 kVA and 125 kVA
6	Contract Demand	300 kVA
7	Demand Charges	
8	Roof top solar power plant	50kWP and 60 kWP
9	Power factor correction	70 kVAR capacitor
10	Annual Energy consumption	Jan-19 to Dec-19, 3,84,765 Units
11	Annual Amount paid to BESCOM	₹ 38,11,170 /-
12	Type of connection	HT2C2
13	Period of Audit	August -2020

6. Baseline data for the energy audit

The annual energy consumption pattern of the year 2019 has been compared with previous years to understand consumption patterns, yearly load variation patterns.

Fig 1 shows the relationship between the monthly energy consumption over the years.

6.1. Energy consumption trend.

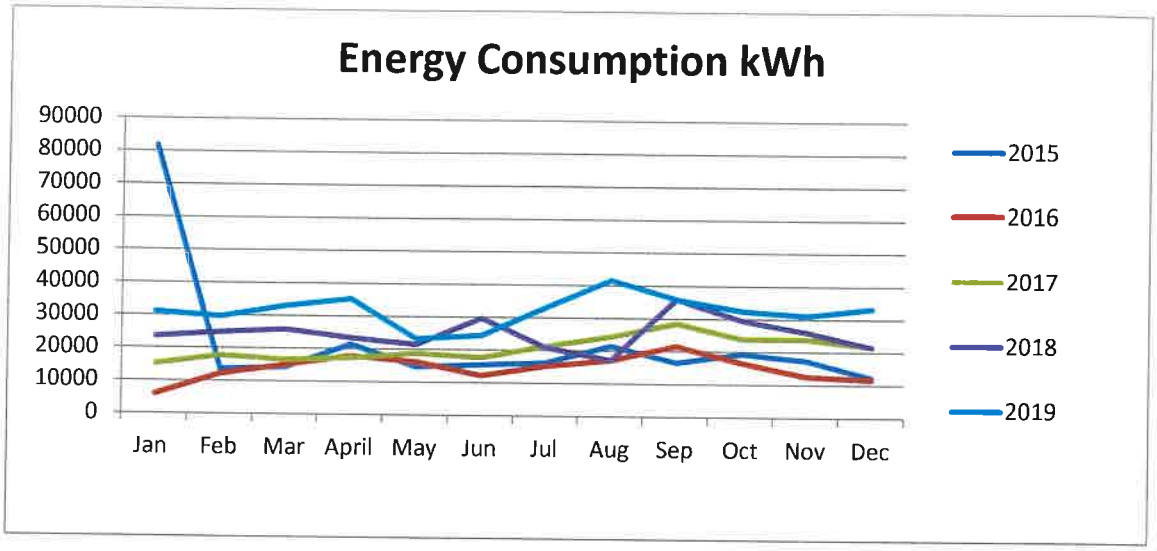

Figure 1: Year-wise monthly energy consumption pattern

a. Average Monthly energy consumption trend

Fig 2 shows a rising power utilization trend from the year 2015 to 2019. The power utilization pattern remains the same. The increase in power consumption from 2016 onwards is compared below.

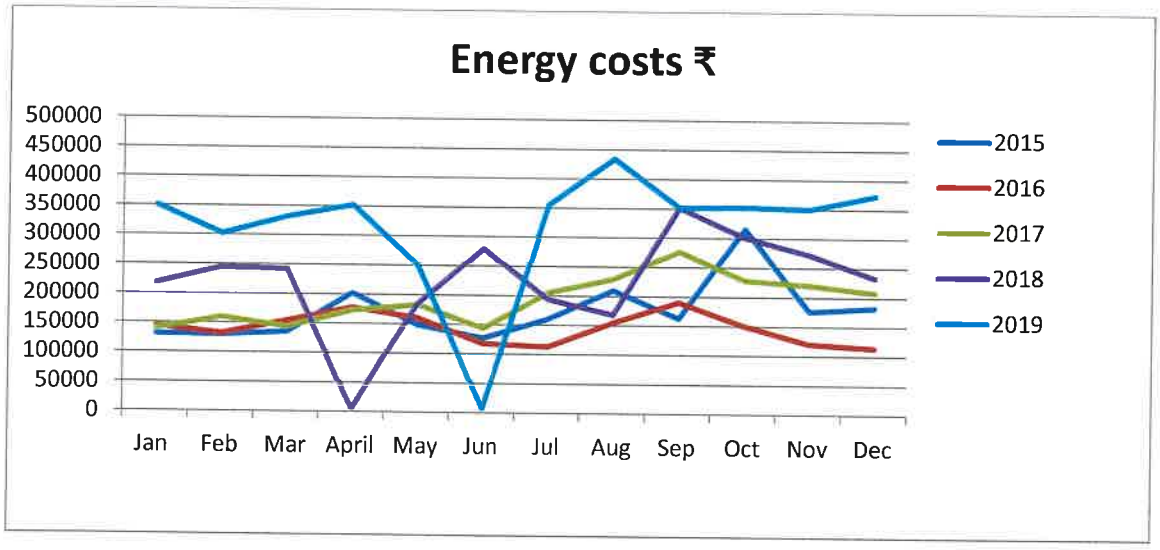

Figure 2: Average Monthly energy consumption pattern

It can be observed that energy consumption is increasing over the years with nearly 41% during 2016-17, 21% during 2017-18, and 28% during 2018-19.

6.2. Average Monthly power consumption cost.

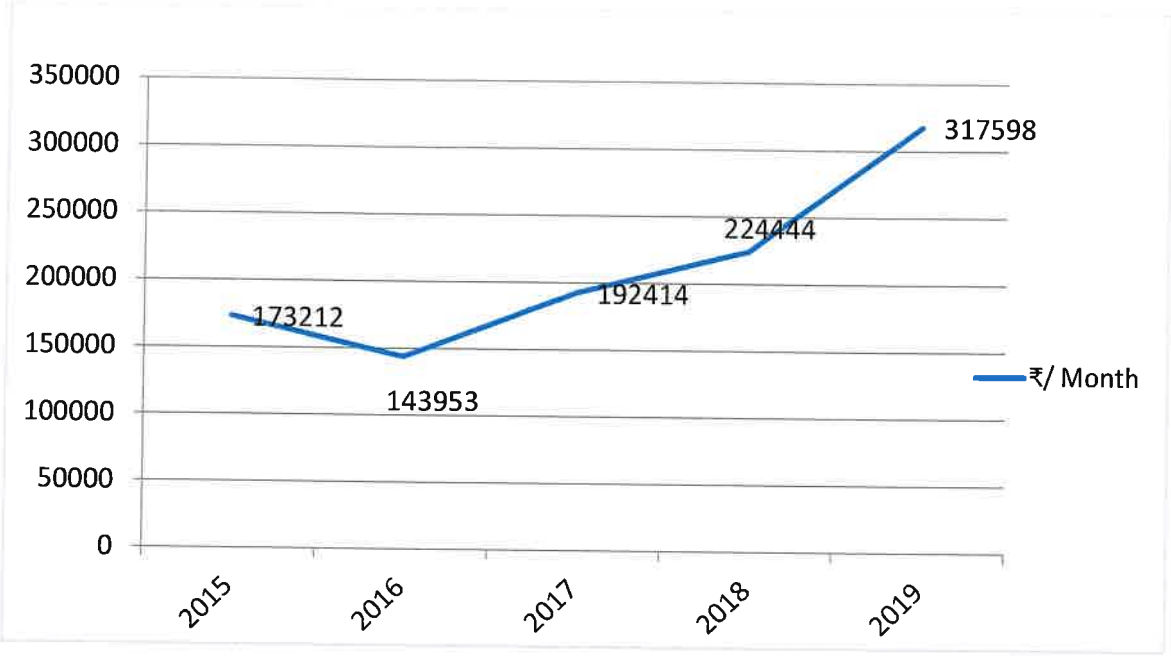

Figure 3: Average Monthly Power consumption cost

The analysis of energy cost also shows a direct relation to consumption.

6.3. Energy source and Utilization

An analysis of power consumption pattern over the year , total connected load and utilization of power . The loads were segregated based on the end use as listed below. Total connected load is 567 kW and load distribution is given below

Table 2: Seggregated system with connected loads

Sl.No	System	Actual Load- kW
1	AC	298
2	Fans	100
3	Lights	90
4	Lifts	46
5	Pumps	56
6	Geysers	35
7	Fridges	2
	Total load - kW	627

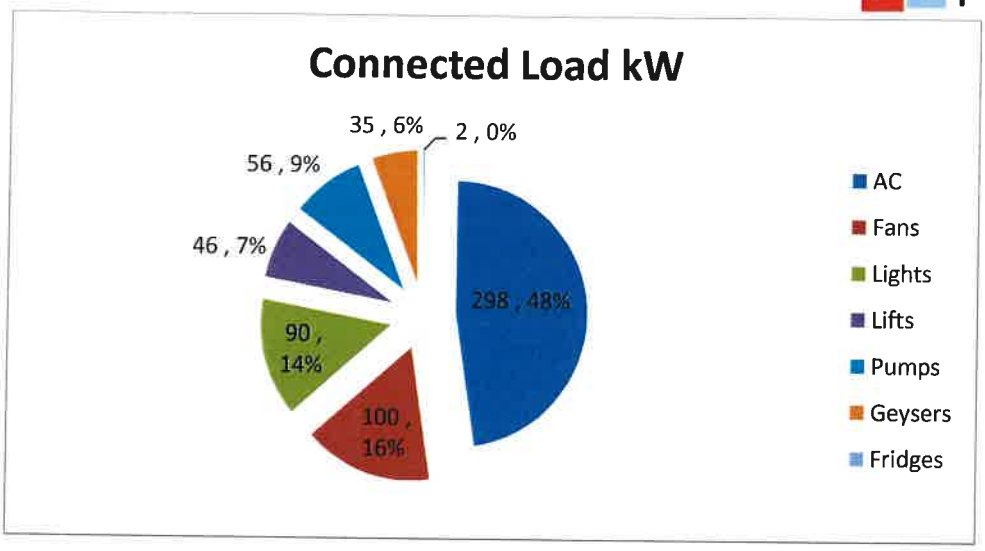

Figure 4: Connected load distribution

6.4. Energy costs analysis

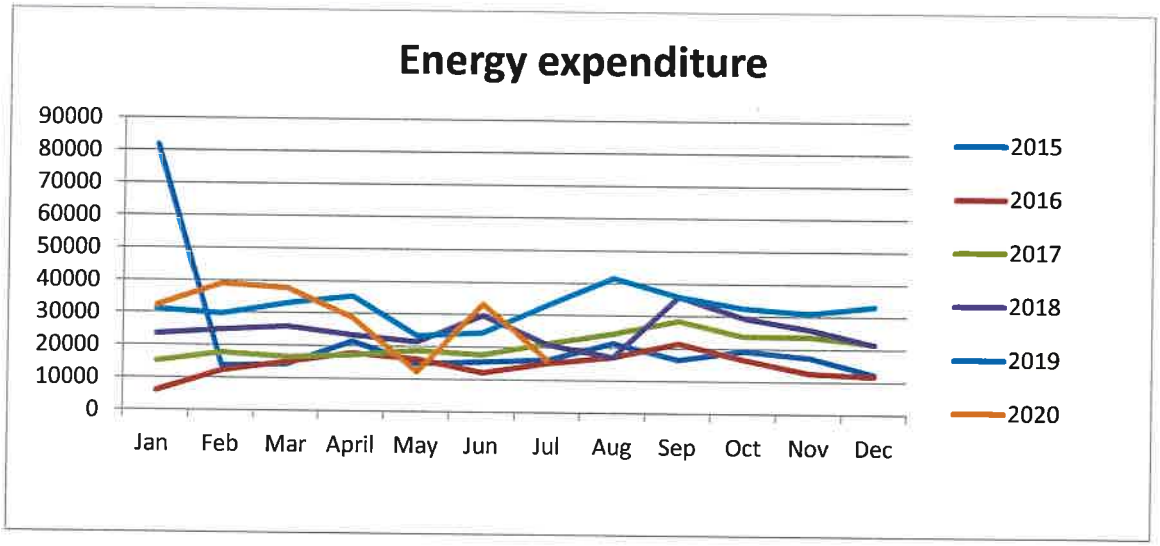

Figure 5: Yearly power consumption -kWh

BESCOM bill of 2019 has been referred for various analysis. Maximum power consumption has been observed in the month of Aug and minimum consumption in May. Consumption pattern depends of programs and activities of the institute.

7. Transformer and Electrical Distribution System

The Kristu Jyothi College is receiving power from BESCOM grid at 11 kV and steps it down to 440 V using following transformer

Table 3: Transformers Specification

Sl.No	Specification	Details
1	Rated kVA	500
2	Voltage HV/ LV , V	11,000/433
3	Type	ONAN
4	Phase	3
5	% Impedance	5 %
6	Oil in Ltrs	400
7	Vector Group	Dyn-11

The following table will give loading percentage of Transformer

Table 4: Loading percentage of Transformer

Loading in kVA			% Loading		
Minimum	Maximum	Average	Minimum	Maximum	Average
56	221	139	15.2 %	44.2 %	27.8 %

Table 5: Percentage Energy losses in transformer

Energy losses of 500 kVA transformer		
Annual energy consumption	384765	kWh
Annual Energy losses	12096	kWh
In terms of % losses are -	3.14 %	

Due to low average loading, no load losses are contributing in higher percentage to total losses.

8. Diesel Generator Sets

There are two Diesel Generator sets of 200 kVA and 125 kVA capacity. Based on the demand, DG sets are operated. Average monthly utilization is around 60 to 75 Hrs.

9. Roof Top Solar Photovoltaic

Solar photovoltaic panels of 50KW and 10KW grid connected power plant is installed in the campus. The total energy supplied to the grid after meeting the captive consumption is 450kWh.

Figure 6: Roof top SPV in campus

10.Power factor and Harmonics.

Capacitors installed for power factor correction is line with the current demand.70 kVAR capacitors are connected to circuit at the output of the transformer. For the present load and demand sufficient capacitive compensation has been provided.

Due to lower factor (< 0.9) penalty has been paid in some months. Details indicated in the table below.

Table 6: Penalty paid in particular month

Month	MD	PF	Units	Penalty - ₹
May-20	56	0.77	12265	4486
Jun-20	71	0.85	15765	2365
Apr-20	126	0.96	23475	0
May-20	139	0.96	24525	0
Oct-19	183	0.76	32550	13761

Following harmonics generating loads are connected to the system.

a) Uninterruptible power supply units.
b) LED lights.

c) Variable frequency drives of Lifts.
d) Computers and related loads.

However, the total harmonic distortion is less than 5 % .

11.Load Analysis

11.1. Lighting loads

Detailed list of lighting loads at various buildings in as per the detailed given below.

Table 7: Lighting Load Calculations

Sl.No	Particulars	Nos	Gross Watt	Load in kW
1	Tube Lights Main Block	378	44	16.64
2	CFL Lights Main Block	0	22	0
3	LED Lights Main Block	405	22	8.91
4	Tube Lights PG Block	304	44	13.38
5	CFL Lights PG Block	152	22	3.35
6	LED Lights PG Block	197	22	4.34
7	Tube Lights Admin Block	44	44	1.94
8	CFL Lights Admin Block	0	22	0
9	LED Lights Admin Block	1588	22	34.94
10	Tube Lights CMI Ashram	19	44	0.84
11	CFL Lights CMI Ashram	9	22	0.2
12	LED Lights CMI Ashram	107	22	2.36
13	Tube Lights Guest House	0	44	0
14	CFL Lights Guest House	0	22	0
15	LED Lights Guest House	137	22	3.02
16	Street Lights	18	31	0.56
	Total Power		44	90.48

Average monthly power utilization is between 14000 units to 17,000 units. Lighting load contributes 13 – 15% of total power consumption.

Lux levels:

As per IS 3616, average lighting level of 200 to 300 Lux should be maintained at teaching spaces, offices, and meeting rooms. Lighting Levels have been measured at various locations as indicated in the table below.

Table 8: Lighting levels in functional areas

Location	Measured Lux level	Recommended Lux level
Conference rooms	110 – 139	300 – 500
Library	57	200- 300
Workstation at library	50	200 -300
Classrooms	66-175	200 – 300

Recommendations: Provide additional lighting fixtures based on the layout of the area/ room to have minimum lux level as per the standard mentioned above.

11.2. Lighting load - Energy Saving Potential

Table 9: Energy Saving potential from replacement of Fluroescent lamps

Replacement of Fluorescent lamps with LED fixtures / tubes								
SL. No	**Location of installation**	**Nos**	**Load in KW**	**Power consumption /day - kWh**	**Power consumption / Month - kWh**	**Load in KW with LED fixtures**	**Power consumption / Day with LED fixtures - kWh**	**Power consumption / Month with LED fixtures -kWh**
1	Tube Lights Main Block	378	17	133	3459	8	60.48	1572.48
2	Tube Lights PG Block	304	13	134	3478	6	60.8	1580.8
3	Tube Lights Admin Block	44	2	15	403	1	7.04	183.04
4	Tube Lights CMI Ashram	19	1	7	174	0.4	3.04	79.04
	Total	745	33	289	7514	15	131	3415

Table 10: Cost saving analysis lighting load

Power cost / Month with Fluorescent tubes @ average unit Rate of ₹ 9.60	₹ 72132/-
Power cost / Month - ₹ with LED fixtures	₹ 32787/-
Savings / Month	₹ 39,345/-
Savings / Year	₹ 4,72,139/-
Proposed investment for LED fixtures.	₹ 372500/-
Return on investment – Years	0.8

11.3. Air conditioners

Detailed list of air conditioners at various buildings in as per the detailed given below.

Table 11: Details of Air Conditioning units

SL. No	Location of installation	Tonnage	Load in kW
1	ACs Main Block	36.5	47.45
2	ACs PG Block	119	154.70
3	ACs Admin Block	44	57.20
4	ACs CMI Ashram	8	10.40
5	ACs Guest House	22	28.60
	Total Air conditioning load		**298.4**

Average monthly power utilization is between 16500 to 18000 units. Air-conditioning load contributes 46% to 50 % of total power consumption.

Energy Saving Potential

Energy saving potential of 5 %, which amounts to 9850 kWh /year by implementing following recommendations.

1. Proper heat insulation of roof and having correct door closures.
2. By controlling the operation of air conditioners. Switch on the units 15 to 20 minutes before start of programs.
3. By having proper thermal insulation of refrigerant pipes.
4. By setting the room temperature at 22 to 24 °C range.
5. Periodical maintenance of Units.

11.4. Fans

Detailed list of fans at various buildings in as per the detailed given below.

Table 12: Details of Fans

Sl. No	Location of installation	Nos.	Load in KW
1	Main Block	523	
2	PG Block	243	
3	Admin Block	500	
4	CMI Ashram	62	
5	Guest House	114	
	Wall mounting fans	194	
	Total fan load	**1536**	**99.84**

Average monthly power utilization of fan load is about 8785 units. Fan load contributes 19 % of total power consumption.

Energy Saving Potential

There is an energy saving potential of 60 % by installing brush less direct current fans. Payback period is around 66 Months.

Table 13: Cost saving Analysis - Fans

Monthly Average power consumption in kWh with regular fans	8785 kWh
Monthly average power consumption with BLDC fans	3514 kWh
Total savings / Month – kWh	5271 kWh
Total savings / Year	63258 kWh
Total investment for replacement of fans ₹	₹39,93,600/-
Cost savings/ year	₹. 6,94,855/-
Payback period	5.73 Years.

11.5. Lifts

Detailed list of air conditioners at various buildings in as per the detailed given below.

Table 14: Details of lift installation

Sl. No	Particulars	2019 - 20
1	Lift 15 pax	6
2	Lift 12 pax	1
3	Lift 10 pax	3
4	Lift 8 pax	1
5	Lift 6 pax	2
	Total numbers	13
	Total power @ 3.5 kW / lift	**45.5**

Average monthly power utilization of Lift load is about 980 units. Lift load contributes to 7 % of total power consumption. Lifts have been installed with variable frequency drives.

11.6. Water pump loads.

The institution uses electrical pump to pump water that is utilised in the campus.

The details are as follows

Sl. No	Particulars	Number	Power HP	Total Power KW	Operating hours	Total energy
1	Submersible 90m, 550lpm Submersible pumps 75m	3	10	22.5	2	45
2	450lpm Submersible pumps 28m	4	7.5	22.5	4	90
3	80lpm	3	5	11.25	1.5	16.88
	Total			**56.25**		**151.88**

Total energy consumption is about 3978 Units which is about 9% of total consumption.

12.Electrical safety aspects and observations .

12.1. Power receiving yard

There is no breaker on LT side of the transformer. The cables are directly connected to busbar followed by going feeders. It is recommended to install LT circuit breaker on secondary side of the transformer.

12.2. UPS room

Power backup in the form of 295KW UPS is implemented which is about 98% of the contract demand. The UPS room is located at the middle of academic

block. Lead acid batteries have been used with UPS. Considering safety aspects, it is recommended to install sealed maintenance free batteries (SMF). These batteries do not require topping up of distilled water and spillage of acid. Neat and clean environment can be maintained.

12.3. Electrical panel rooms

At present doors provided are opening inside. It is recommended to provide out operable doors with two-hour fire rating.

12.4. Fire evacuation routes and safe gathering points

Fire evacuation routes and safe gathering points should be displayed in all passages. Safe gathering point board shall be displayed near identified gathering point.

12.5. Miscellaneous

12.5.1. Water consumption

Water is utilised by students, faculty, and other persons for meeting the domestic water requirements including drinking water. The water demand for the campus is estimated as 420KL as per the NBC 2016 which specifies 45lpcd for non-boarding students and 135lpcd for boarding. The water demand is met through BWSSB and bore wells. The institution utilizes only 175KLD at a per unit consumption of 30 lpcd.

12.5.2. Sewage Treatment Plant

This fresh water utilised results in sewage generation. The projected demand of 420KLD would necessitate a STP of 351KLD. Since the actual usage is only 175KLD, the actual STP capacity required is only 140KLD. However, a sewage treatment plant of 96KLD is installed within the premises. The rest of the sewage is managed by three septic tanks of capacity 150, 50 and 60KLD. This indicates a gap in treatment capacity, which needs to be addressed quickly.

Sewage treatment plant and other miscellaneous contribute to 8 to 10 % of the load. Blowers consume maximum power. Power consumption of blowers can be controlled by implementing following measures.

1. Clean screens and filters regularly.
2. Check belt tension regularly
3. Eliminate variable pitch pulleys.
4. Turning off blowers when they are not needed.

12.5.3. Rain Water Harvesting

The total built up area in the campus is 57688 Sqm. The average rainfall in Bengaluru is about 840mm. The roof top rainwater harvest potential is estimated to about 41.19ML per annum. The Institution has already implemented 4.4ML which is greater than the 3.46ML RWH tank mandated by BWSSB.

13.Conclusions and Recommendations

The energy usage per Sqm and per student is tabulated below

Table 15: Benchmarking of annual energy consumption

Sl No	Measure	Standard	KJC values
	Energy/Student	210	**83.12**
	Energy/Sqm builtup area	-	**9.81**

The following table summarises the total savings that can be realised in two areas- lighting and fans.

Table 16: Executive Summary of Lightings

1	Annual Energy savings ₹	₹ 4,72,000
2	Annual demand savings ₹	NIL
3	Annual savings in terms kWh	48,181
4	Proposed investment for kWh savings	₹ 3,72, 500/-
5	Payback period months	0.8

Table 17: Executive Summary of Fans

1	Annual Energy savings ₹	₹ 6,95,844
2	Annual demand savings ₹	NIL
3	Annual savings in terms kWh	63,258
4	Proposed investment for kWh savings	₹ 39,93,600
5	Payback period months	68

It can be observed that nearly ₹4.72 lakhs and 6.95 lakhs can be realized from LED substitution for lighting and replacement of current fans by brush less DC fans. The expenditure required for lighting replacement is only ₹3.72 implying a payback period of less than 8 months, while the fan replacement would require about ₹40 lakhs with a payback period of 5.7 years