Energy Audit Report – 2021

PES/2020-21/44

Submitted to

Kristu Jayanti College, Autonomous
Bengaluru

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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!***

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Abbreviation

BESCOM	Bangalore Electrical Supply Company Limited
DG	Diesel Generator
Hrs	Hours
IS	Indian Standards
KJC	Kristu Jayanti College
kVA	Kilo Volt- Ampere
kV	Kilo Volt
KVAR	Kilovolt-Ampere Reactive
kWh	Kilo Watt hour
kW	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

Executive Summary

1. Kristu Jayanti College (KJC) is a private, autonomous college managed by Bodhi Niketan Trust and located at Kothanur, Bengaluru and established in 1999. It is an autonomous college under 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 7692 and total pollution including teaching and non-teaching staffs is 81448.

2. The campus of Kristu Jayanti College is spread over 9.7 acres with built up area of 11533.54 sq. m 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 and have two research centers in the field of Commerce and Psychology.

3. KJC has instituted several measure to conserve water- Rain water harvesting tank of 4.5 ML is established which is in compliance with the regulations. The overall consumption of freshwater is controlled to about 30lpcd as against 45 lpcd (NBC2016). Treated water from the 90 KLD STP is recycled for 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 644 KW. 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 photovoltaic 50KW +10KW is installed in the roof top. It has successfully generated energy of 55500 KWh for the July 2020- June 2021.

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 75.4 kWh and per unit area is 10.11 kWh /Sqm, which is appreciable.

6. The analysis of loads indicate that nearly ₹4.19 lakhs and ₹7.01 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 ₹3.3 lakhs implying a payback period of less than 8 months, while the fan replacement would require about ₹40 lakhs with a payback period of 5 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 an autonomous college under Bengaluru 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 7692.

The campus of Kristu Jayanti College is spread over 14.1 acres with built up area of 57217.403 sqm 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 and have two research centers in the field of Social Work and Biotechnology

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 organizations 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 during the year 2020- 21 is around ₹ 55.6 Lakhs. The institution 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	Dr. Priya Josson, Asst. Prof., Dept. of Life Sciences
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 10 kWP
9	Power factor correction	70 kVAR capacitor
10	Annual Energy consumption	June-20 to Dec-21 , 4,73,255 Units
11	Annual Amount paid to BESCOM	₹ 55,68,863/-
12	Type of connection	HT2C2
1	Period of Audit	June 2020 – Dec 2021

6. Baseline data for the energy audit

The annual energy consumption pattern of the year 2021 has been compared with previous years to understand consumption patterns, yearly load variation patterns.

6.1. Energy consumption trend.

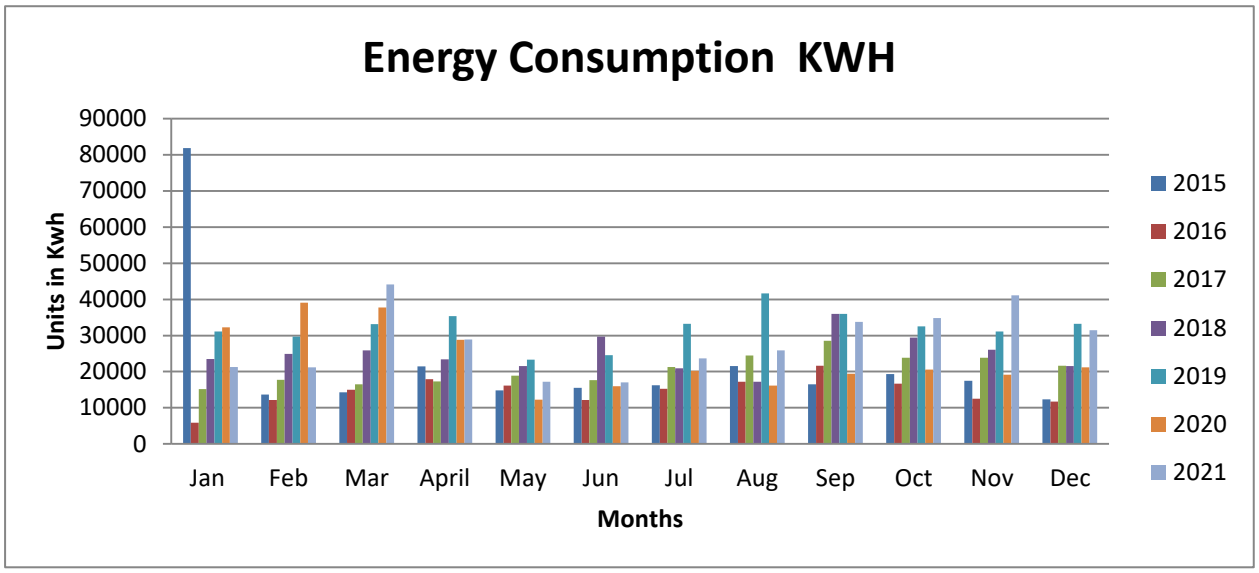

Figure 1: Year-wise monthly energy consumption pattern

Fig 1 shows power utilization trend from the year 2015 to 2021. The power utilization pattern remains the same. The increase in power consumption from 2016 onwards is compared below.

It can be observed that energy consumption various over the years with nearly 41% during 2016-17, 21% during 2017-18, and 28% during 2018-19 and 20 % during 2020-2021. The normal operation in following months (2019-2020) were affected due to COVID and hence not considered in the analysis.

6.2. Average Monthly power consumption cost.

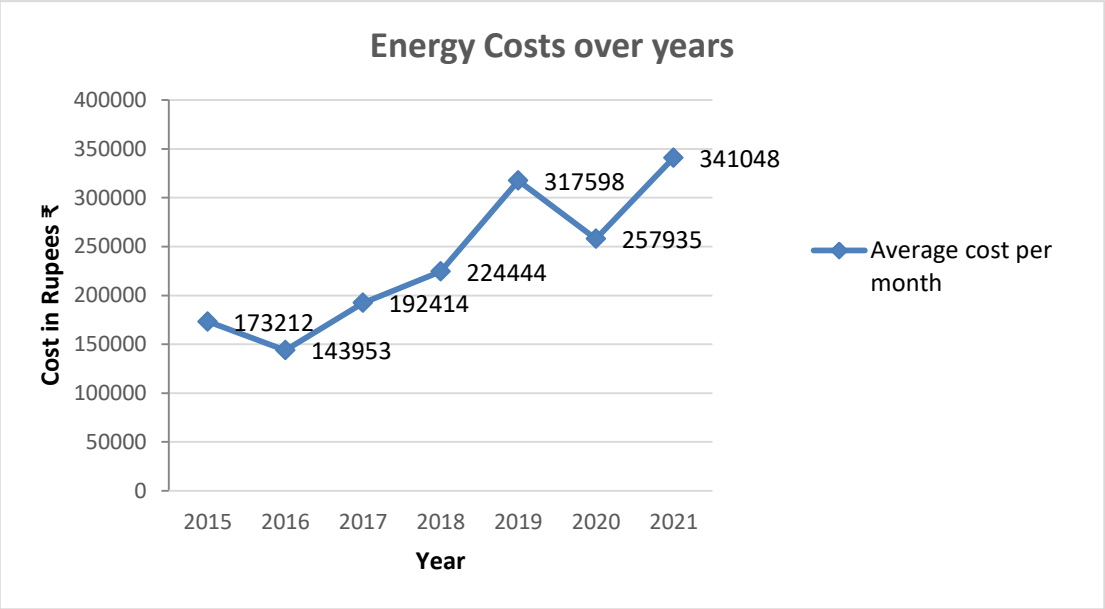

Figure 2: Average Monthly Power consumption cost

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

6.3. Energy source and Utilization

The loads were segregated based on the end use as listed below. Total connected load is 644 kW and load distribution is given below.

Table 2: Segregated system with connected loads

Sl.No	System	Actual Load- kW
1	AC	312
2	Fans	100.62
3	Lights	92.52
4	Lifts	46
5	Pumps	56.25
6	Geysers	35
7	Fridges	2.25
	Total load - kW	**644**

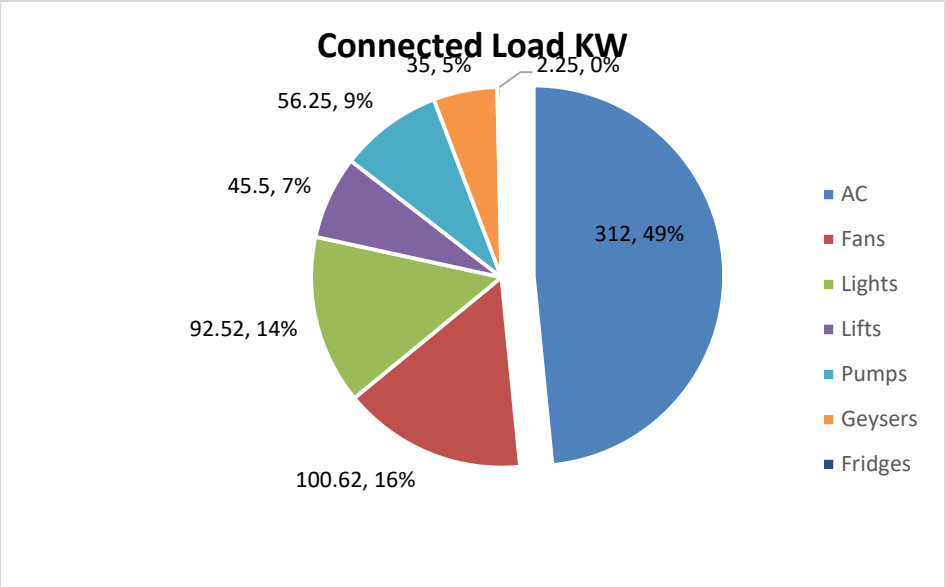

Figure 3: Connected load distribution

6.4. Energy cost analysis

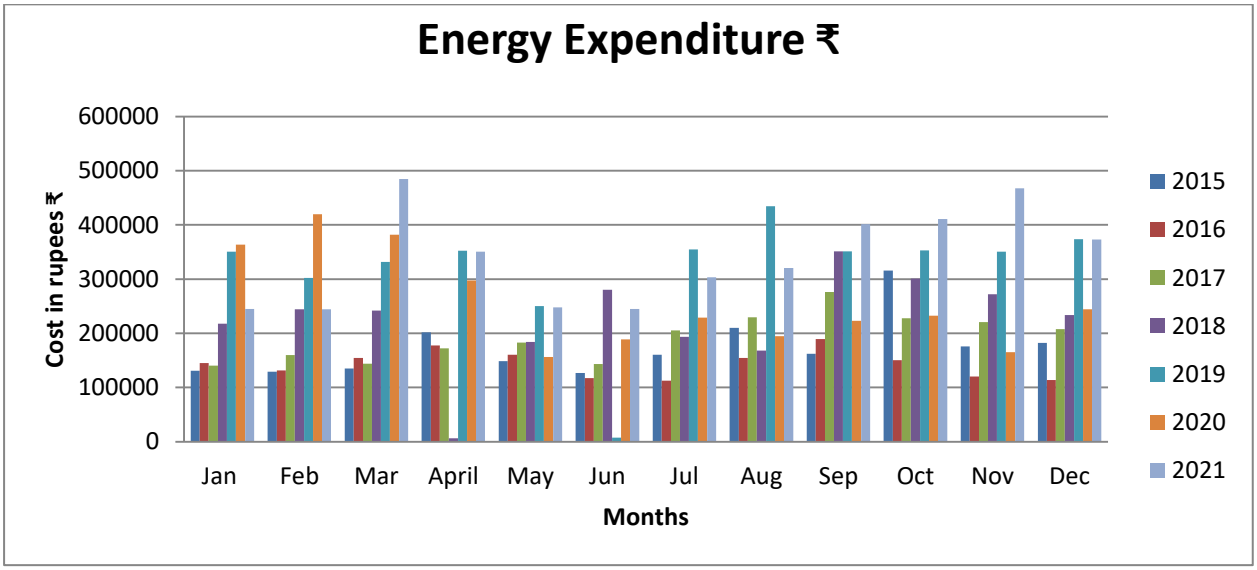

Figure 4: Yearly power consumption -kWh

BESCOM bill from 2015 - 2021 has been referred for various analysis. Maximum power expenditure has been observed in the month of march 2021 and minimum consumption in May 2021. Consumption pattern depends of programs and activities of the institute.

7. Transformer and Electrical Distribution System

The Kristu Jayanti 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 SPV has generated an average value of 4625 KWh per month for the year July 2020-June 2021.

Figure 5: 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.

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 6: Lighting Load Calculations

Sl.No	Particulars	Nos	Gross W	Load in Kw
1	Tube Lights Main Block	336	44	14.79
2	LED Lights Main Block	461	22	10.15
3	Tube Lights PG Block	274	44	12.06
4	CFL Lights PG Block	152	22	3.35
5	LED Lights PG Block	231	22	5.09
6	Tube Lights Admin Block	37	44	1.63
7	LED Lights Admin Block	1634	22	35.95
8	Tube Lights CMI Ashram	14	44	0.62
9	CFL Lights CMI Ashram	9	22	0.2
10	LED Lights CMI Ashram	112	22	2.47
11	LED Lights Guest House	137	22	3.02
12	Street Lights	25	31	0.78
13	Service block Led light	48	22	1.06
14	Led lights	90	15	1.35
Total Power				**92.52**

Average monthly power utilization is between 14000 units to 17,000 units. Lighting load contributes 14 % 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 7: Lighting levels in functional areas

Location	Measured Lux level	Recommended Lux level
Conference rooms	110 – 139	300 – 500
Library	100-120	200- 300

Electronic lab	50-60	200 -300
Classrooms	200-210	200 – 300

Figure 6: Measuring the LUX level

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 8: Energy Saving potential from replacement of Fluorescent lamps

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	336	15	118	3075	7	53.76	1397.76

2	Tube Lights PG Block	274	12	121	3135	5	54.8	1424.8
3	Tube Lights Admin Block	37	2	13	339	1	5.92	153.92
4	Tube Lights CMI Ashram	14	1	5	128	0.3	2.24	58.24
	Total	**661**	**29**	**257**	**6676**	**13**	**117**	**3035**

Table 9: Cost saving analysis lighting load

Power cost / Month with Fluorescent tubes @ average unit Rate of ₹ 9.60	₹ 64,093/-
Power cost / Month - ₹ with LED fixtures	₹ 29,133/-
Savings / Month	₹ 34,960/-
Savings / Year	₹ 4,19,520/-
Proposed investment for LED fixtures.	₹ 3,30,500/-
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 10: 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	54.5	70.85
4	ACs CMI Ashram	8	10.40
5	ACs Guest House	22	28.60

	Total Air conditioning load		**312**

Average monthly power utilization is between 16500 to 18000 units. Air-conditioning load contributes 57 % to 60 % of total power consumption.

Energy Saving Potential

Energy saving potential of 5 %, which amounts to 17160 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 $^{\circ}$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 11: Details of Fans

Sl. No	Location of installation	Nos.	Load in KW
1	Main Block	523	33.995
2	PG Block	243	15.795
3	Admin Block	412	26.7
4	CMI Ashram	62	4.03
5	Guest House	114	7.41
	Wall mounting fans	194	12.62
		1548	**100.62**

Average monthly power utilization of fan load is about 8855 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 12: Cost saving Analysis - Fans

Monthly Average power consumption in kWh with regular fans	8855 kWh
Monthly average power consumption with BLDC fans	3514 kWh
Total savings / Month – kWh	5312.7 kWh
Total savings / Year	63752 kWh
Total investment for replacement of fans ₹	₹40,24,800/-
Cost savings/ year	₹. 7,01,281/-
Payback period- years	5.7

11.5. Lifts

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

Table 13: Details of lift installation

Sl. No	Particulars	2020 - 21
1	Lift 15 pax	**4**
2	Lift 13 pax	**2**
3	Lift 12 pax	**1**
4	Lift 10 pax	**3**
5	Lift 8 pax	**1**
6	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 8 % 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

Table 14: Details of Pump installation

Sl. No	Particulars	Number	Power HP	Total Power KW	Operating hours	Total energy
1	Submersible 90m, 550lpm	3	10	22.5	2	45
2	Submersible pumps 75m 450lpm	4	7.5	22.5	4	90
3	Submersible pumps 28m 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 92% of the contract demand. The UPS are located at Main block Ground floor electrical panel room-I nos each of 15KVA, 25KVA and 30KVA, Basement of PG Block-3 nos-50KVA and at the Administrative Block First floor 1 Nos -50 KVA. 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.

Figure 7: Fire evacuation point

12.5. 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 366 KL as per the NBC 2016 which specifies 45lpcd for non-boarding students and 135lpcd for boarding. The water demand is met through bore wells. The institution utilizes only 35 KLD at a per unit consumption of 30 lpcd. Due to covid restriction online classes are held for students and the only population in the college campus is technical and non-technical staff accounting of about 500 nos' approximately

12.6. Sewage Treatment Plant

This fresh water utilised results in sewage generation. The projected demand of 366 KLD would necessitate a STP of 90 KLD. Since the actual usage is only 35 KLD, the actual STP capacity required is only 140KLD. However, a sewage treatment plant of 90 KLD 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.

Figure 8: Air blowers

Figure 9: Filter press

Figure 10: Sequential Batch Reactor (SBR)

Figure 11: Pressure Sand Filter and Activated Carbon filter

12.8 Rain Water Harvesting

The total roof area in the campus is 9.7 acres. The average rainfall in Bengaluru is about 840mm. The roof top rainwater harvest potential is estimated to about 15.2 ML per annum. The Institution has already implemented 2.5 ML and 2 ML which is greater than the 1.56ML 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**	**75.40**
	Energy/Sq.m built-up area	**57688**	**10.14**

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

Table 16: Summary of annual energy saving for Lightings

1	Annual Energy savings ₹	₹4,19,520/-
2	Annual demand savings ₹	NIL
3	Annual savings in terms kWh	55767
4	Proposed investment for kWh savings	₹ 3,30,500/-
5	Payback period months	8

Table 17: Summary of annual energy saving for Fans

1	Annual Energy savings ₹	₹ 7,01,281 /-
2	Annual demand savings ₹	NIL
3	Annual savings in terms kWh	63,752
4	Proposed investment for kWh savings	₹ 40,24,800/-
5	Payback period months	67

It can be observed that nearly ₹4.19 lakhs and ₹7.01 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 ₹3.30 Lakhs implying a payback period of less than 8 months, while the fan replacement would require about ₹40 lakhs with a payback period of 6 years.