Energy Audit Report – 2022

PES/2022-23/EA-KJC/02/R3

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**

Document No: PES/2023-24/EA-KJC/02/R3

Date: 06/06/2023

PO Reference: KJC/PO-581/2023; dated 19.01.2023

Internal Document Control

Sl. No.	Document Number & Date	Prep	Chk	App	Remarks
1.	PES/2022-23/EA-KJC/02/R3 & 06/06/2023	AA	AP	PKP	Final

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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. The College is affiliated to Bengaluru North University and is reaccredited with grade 'A++' in 2021 by NAAC in the third cycle of Accreditation. And the total student strength is 9510.
2. The campus of Kristu Jayanti College is spread over 9.7 acres with a total built up area of 615883.88 sq ft.and lawn cover area of 48673 sq ft. The new block 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 institute offers 36 UG, 16 PG, 3 LL. B & 1 Post graduate diploma programs in various departments such as Commerce and Management, Science, Law and Humanities.
3. KJC has instituted several measures to conserve water- Rain water harvesting tank of 4.95 ML is established which is in compliance with the regulations. 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 679.69 KW. The college also has three captive DG sets of 200KVA, 125KVA and 250KVA. UPS with 69% of contract demand is also installed; Two Solar photovoltaic 50KW +10KW is installed in the roof top. It has successfully generated energy of 80700 KWh for 2022.
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 61.23 kWh and per unit area is 4.38 kWh /Sqm, which is appreciable.
6. The analysis of loads indicates that nearly ₹1.36 lakhs and ₹7.18 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 ₹2.23 lakhs implying a payback period of less than 20 months, while the fan replacement would require about ₹44.51 lakhs with a payback period of 6.2 years.

1. Background

Kristu Jayanti College, founded in 1999, is managed by "BODHI NIKETAN TRUST", formed by the members of St. Joseph Province of the Carmelites of Mary Immaculate (CMI). The College is affiliated to Bengaluru North University and is reaccredited with grade 'A++' in 2021 by NAAC in the Third Cycle of Accreditation. The college is recognized by UGC under the category 2(f) & 12(B). The College has been accorded Autonomous Status since 2013 by the University Grants Commission, the Government of Karnataka & Bangalore University. In the NIRF 2022 rankings, the college was placed among the top 150 colleges in the country and ranks as one of the five colleges from Karnataka. The programmes of School of Management are internationally accredited by the Accreditation Council for Business Schools and Programs [ACBSP, USA]. The college was accorded 'DBT Star College status under the strengthening component' by the Department of Biotechnology, the Ministry of Science & Technology and the Government of India. The institution received first prize at the National Level for 'Clean and Smart Campus Award' from Shri. Dharmendra Pradhan, Minister of Education, Govt. of India.

In the India Today - MDRA survey 2022, Kristu Jayanti College, Bengaluru is consecutively ranked as the Best Emerging College of the Century at National Level for Commerce, Science and Arts. The survey also ranked the college as 5th Best in BCA, 14th Best in MSW, 21st Best in BBA & Commerce, 23rd Best in Arts, 29th Best in Science and 33rd Best in Mass Communication among the Colleges in India. The College also ranked 2nd best in MSW, 3rd best in Commerce, Arts & BCA, 4th best in science, 5th best in Mass Communication and 7th best in BBA among the colleges in Bengaluru. The institution strives to fulfill its mission to provide educational opportunities for all aspiring young people to excel in life by developing academic excellence, fostering values, creating civic responsibility, inculcating environmental concern and building global competencies in a dynamic environment.

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. An energy audit is process for energy inspection, building survey and analysis of energy flow for energy conservation in a building without affecting the output of the building. This energy audit has been conducted by Eco paradigm from the year 2015-2022.

Monthly average energy cost during the year 2022 is around ₹4.6 Lakhs. 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, 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 Akkara, 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 ,125 kVA and 250KVA
6	Contract Demand	500 kVA
7	Demand Charges	-
8	Roof top solar power plant	50kWP and 10 kWP
9	Power factor correction	70 kVAR capacitor
10	Monthly Average Energy consumption	45,639 Units
11	Monthly Average Amount paid to BESCOM	₹ 4,60,496/-
12	Type of connection	HT2C2
13	Period of Audit	Jan 2022 – Dec 2022

6. Baseline data for the energy audit

The annual energy consumption pattern of the year 2022 has been compared with previous years to understand consumption patterns, yearly load variation patterns.

6.1 Energy consumption trend

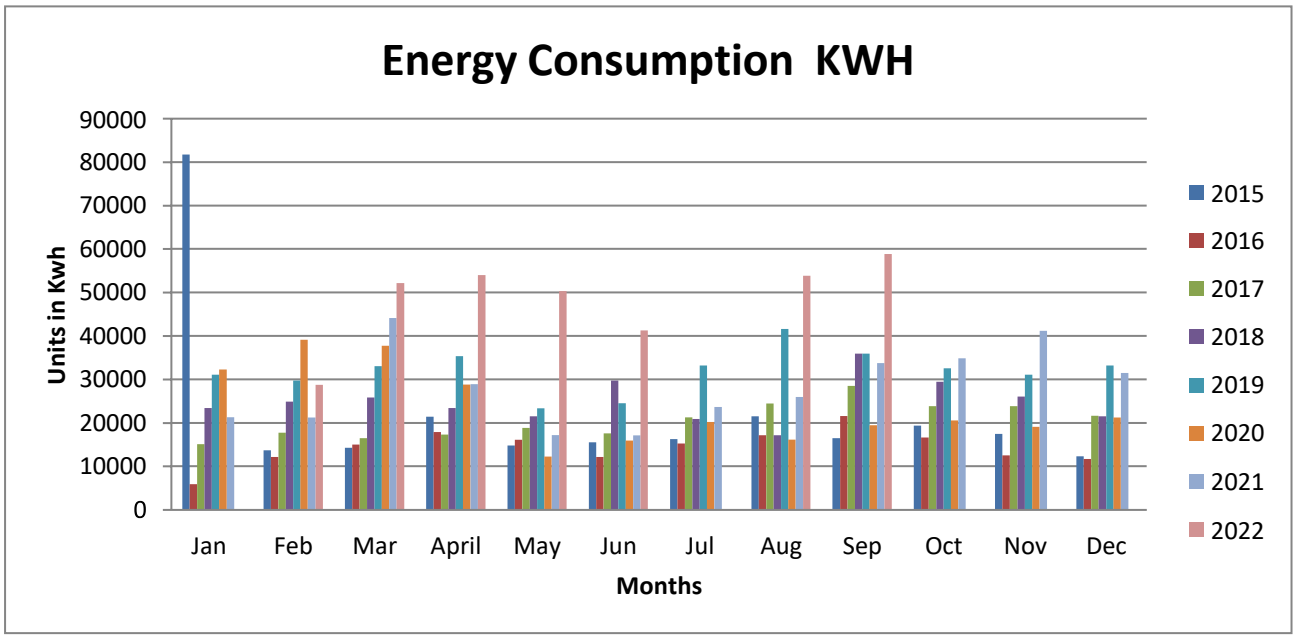

Figure 1: Year-wise monthly energy consumption pattern

Fig 1 shows power utilization trend from the year 2015 to 2022. The power utilization pattern remains the same. The increase in power consumption from 2015 onwards is compared below.

It can be observed that energy consumption varies over the years with nearly 41% during 2016-17, 21% during 2017-18, and 28% during 2018-19, 20 % during 2020-2021 and 40 % during 2021-22. The normal operation in following months (2019-2020) were affected due to COVID and hence not considered in the analysis.

6.2 Energy source and Utilization

The loads were segregated based on the end use as listed below. Total connected load is 697.69 kW and load distribution are given below:

Table 2:Segregated system with connected loads

Sl.No	System	Actual Load- kW
1	AC	351.65
2	Fans	103.07
3	Lights	78.09
4	Lifts	45.5
5	Pumps	69.38
6	Geysers	47
7	Fridges	3
	Total load - kW	**697.69**

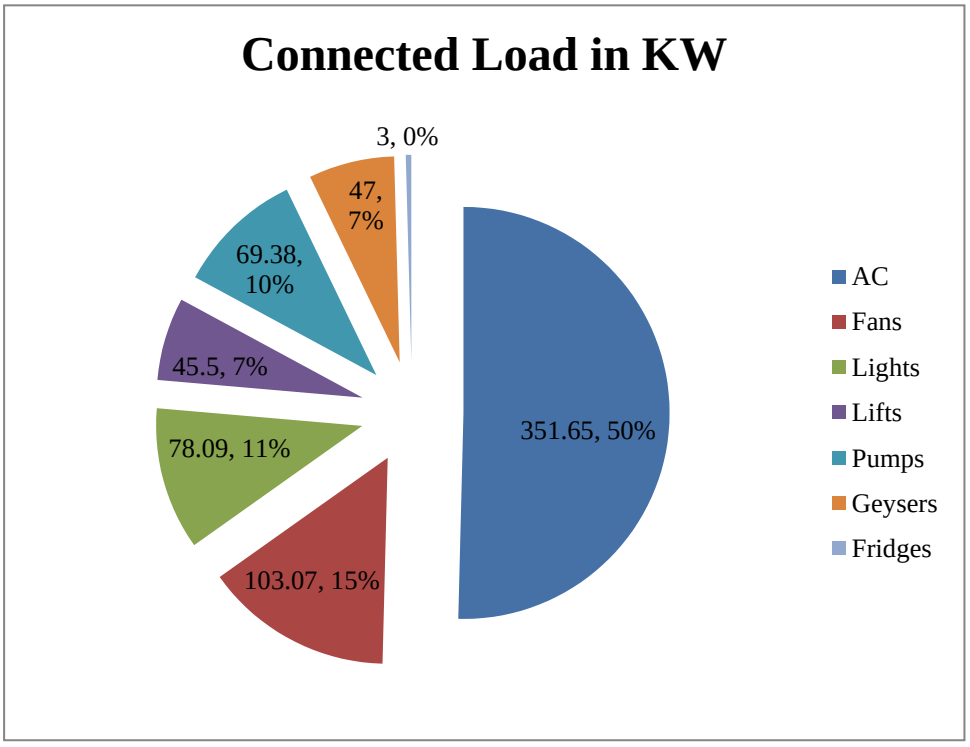

Figure 2 : Connected Load Distribution

6.3 Energy cost analysis

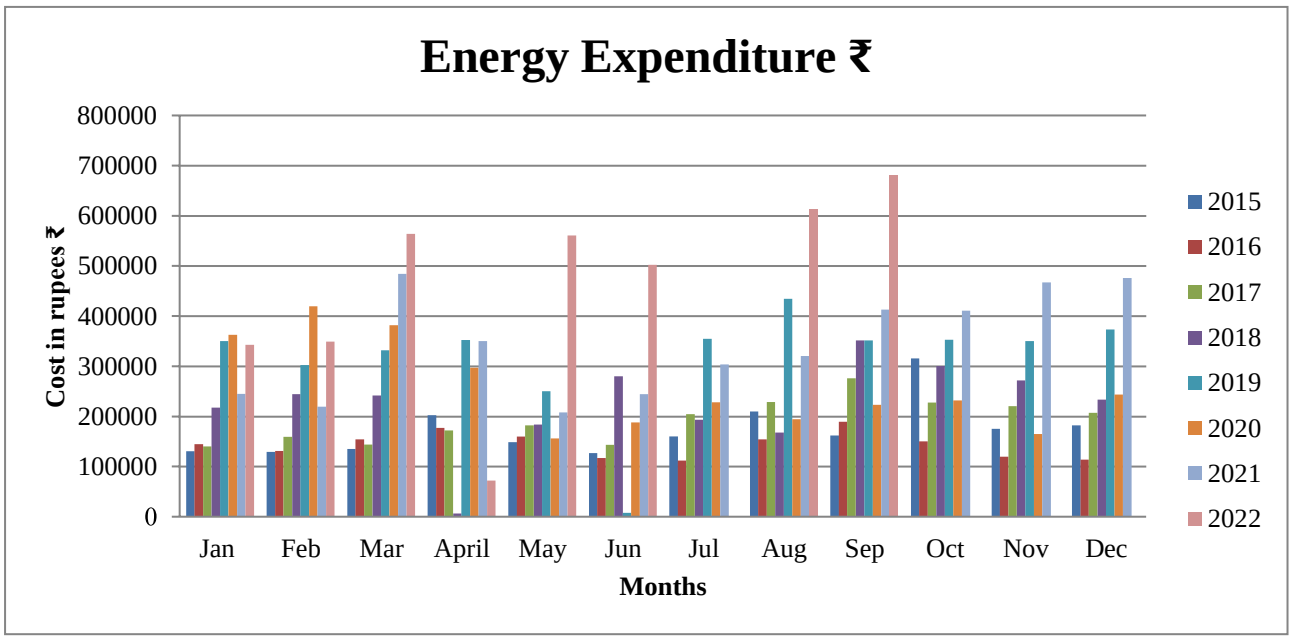

Figure 3 : Yearly power consumption -kWh

BESCOM bill from 2015 - 2022 has been referred for various analysis. Maximum power expenditure has been observed in the month of September 2022 and minimum consumption in April 2022. Consumption pattern depends of programs and activities of the institute. Compared to previous year, energy consumption in 2022 is high due to the variation in COVID restrictions. In 2021, number of students in the college were very less because of it. Climate change is another factor which lead to the increased energy consumption.

Remarks:

During April-2022 study holidays were there which led to low consumption of power. And during September-2022 extracurricular & series of events were there which led to high energy consumption. In previous year, energy consumption was high on March. Due to the COVID restrictions in that year, number of students in the college were less which effected the variation in energy consumption.

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 Specifications

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

8. Diesel Generator Sets

There are three Diesel Generator sets of 200 kVA, 125 kVA and 250kVA capacity. Based on the demand, DG sets are operated.

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 of about 80700 kWh during the period of 2022.

Figure 4 : 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 4: Lighting Load Calculations

Sl.No	Particulars	Nos	Gross W	Load in Kw
1	Tube Lights Main Block	188	36	6.768
2	LED Lights Main Block	609	20	12.18
3	Tube Lights PG Block	227	36	8.172
4	CFL Lights PG Block	152	22	3.344
5	LED Lights PG Block	278	20	5.56
6	Tube Lights Admin Block	32	44	1.408
7	LED Lights Admin Block	1707	20	34.14
8	LED Lights Guest House	137	20	2.74
9	Street Lights	44	31	1.364
10	Service block Led light	48	22	1.056
11	Led lights	90	15	1.35
Total Power				**78.09**

Average monthly power utilization is between 13,000 units to 14,000 units which is 30 % 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 5 : Lighting levels in functional areas

Location	Measured lux level	Recommended lux level
Conference Rooms	85	300-500
Library	79.8	200-300
Workstation at library	79.5	200-300
Classrooms	70-180	200-300

Recommendations:

Provide additional lighting fixtures based on the layout of the area/ room to have minimum lux levels as per the standards mentioned above.

Figure 5: Measuring the LUX level

11.2 Lighting load - Energy Saving Potential

Table 6 : Energy Saving Potential from the 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	188	6.77	54.16	1191.52	3.76	30.08	661.76
2	Tube Lights PG Block	227	8.18	65.44	1439.68	4.54	36.32	799.04
3	Tube Lights Admin Block	32	1.16	9.28	204.16	0.64	5.12	112.64
	Total	**447**	**16.11**	**128.88**	**2835.36**	**8.94**	**71.52**	**1573.44**

Table 7 : Cost saving analysis lighting load

Power cost / Month with Fluorescent tubes @ average unit Rate of ₹ 9.00	₹ 25,518/-
Power cost / Month - ₹ with LED fixtures	₹ 14,161/-
Savings / Month	₹ 11,357/-
Savings / Year	₹ 1,36,287/-
Proposed investment for LED fixtures.	₹ 2,23,500/-
Return on investment – Years	1.6

11.3 Air conditioners

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

Table 8 : Details of Air Conditioning units

SL. No	Location of installation	Tonnage	Load in kW
1	ACs Main Block	40.5	52.65
2	ACs PG Block	119.5	155.35
3	ACs Admin Block	82.5	107.25
4	ACs Guest House	28	36.4
	Total Air conditioning load		**351.65**

Average monthly power utilization is between 19000 to 20000 units which is 42 % of total power consumption.

Energy Saving Potential

Energy saving potential of 5 %, which amounts to 11605 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 9 : Details of Fans

Sl. No	Location of installation	Nos.	Load in KW
1	Main Block	531	37.17
2	PG Block	247	17.29
3	Admin Block	424	29.68
4	Guest House	114	7.98
5	Wall mounting fans	219	10.95
Total		**1535**	**103.07**

Average monthly power utilization of fan load is about 9000 to 10000 units which is 20 % 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 74 Months.

Table 10 : Cost saving Analysis - Fans

Monthly Average power consumption in kWh with regular fans	9070 kWh
Monthly average power consumption with BLDC fans	3628 kWh
Total savings / Month – kWh	5442 kWh
Total savings / Year	65305 kWh
Total investment for replacement of fans ₹	₹44,51,500/-
Cost savings/ year	₹7,18,356/-
Payback period- years	6.2

11.5 Lifts

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

Table 11 : Details of lift installation

Sl. No	Particulars	2021 - 22
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 900 to 1000 units which is 2 % 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 utilized in the campus. The details are as follows:

Table 12 : Details of Pump installation

Sl. No	**Particulars**	**Number**	**Power HP**	**Total Power KW**	**Operating hours**	**Total energy**
1	Submersible 90m, 550lpm	4	10	30	2	60
2	Submersible pumps 75m 450lpm	5	7.5	28.13	4	112.52
3	Submersible pumps 28m 80lpm	3	5	11.25	1.5	16.88
	Total			**69.38**		**189.4**

Total energy consumption is about 4000 to 5000 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 345KW UPS is implemented which is about 69% of the contract demand. The UPS are located at Main Block Ground floor electrical panel Room-I 3 no's- 30KVA, Basement of PG Block-3 no's- 50KVA, Guest house has 5KVA and at the Administrative Block First floor 2 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 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 6: Fire evacuation point

Remarks:

As per the recommendations from our side, more numbers of brush less DC fans were introduced in the campus.

12.4 Water consumption

Water is utilized by students, faculty, and other persons for meeting the domestic water requirements including drinking water. Kristu Jayanti College with a student and staff population of 9510 persons is estimated to consume 528 KLD or 190 million liters annually (as per NBC guidelines- 45lpcd). As per the data provided by the Kristu Jayanti College, average water consumption in the college campus is approximately 65 KLD.

12.5 Sewage Treatment Plant

This fresh water utilized results in sewage generation. The projected demand of 528 KLD would necessitate a STP of 422 KLD. And the actual water consumption is only 65 KLD. 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 aggregating to 260KLD. This indicates a gap in treatment capacity, which needs to be addressed quickly. From the observation during the period of 2022, STP has contributed about 29 KL/day. Sludge from the STP being disposed to authorized BBMP contractors.

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 7: Air blowers

Figure 8: Filter press

Figure 9: Sequential Batch Reactor (SBR)

Figure 10: Pressure Sand Filter and Activated Carbon filter

12.6 Rain Water Harvesting

The total built up area in the campus is 14.14 acre. The average rainfall in Bengaluru is about 880mm. The rainwater harvest potential is estimated to about 15.2 ML. The Institution has implemented 4.95ML RWH tank. As the RWH tank provided capacity is less than the required capacity we recommend you to expand the RWH tank capacity.

13.Conclusions and Recommendations

The energy usage per Sq. and per student is tabulated below:

Table 13 : Benchmarking of Annual Energy Consumption

Sl No	Measure	Standard	KJC values
1	**Energy/Student**	210	61.23
2	**Energy/Sq.m built-up area**	-	4.38

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

Table 14 : Summary of annual energy saving for Lightings

1	Annual Energy savings ₹	₹1,36,287/-
2	Annual demand savings ₹	NIL
3	Annual savings in terms kWh	14,161
4	Proposed investment for kWh savings	₹ 2,23,500/-
5	Payback period months	20

Table 15 : Summary of annual energy saving for Fans

1	Annual Energy savings ₹	₹ 7,18,357 /-
2	Annual demand savings ₹	NIL
3	Annual savings in terms kWh	65,305
4	Proposed investment for kWh savings	₹ 44,51,500/-
5	Payback period months	74

It can be observed that nearly ₹1.36 lakhs and ₹7.18 lakhs can be realized from LEDsubstitution for lighting and replacement of current fans by brush less DC fans. The expenditurerequired for lighting replacement is only ₹2.23 Lakhs implying a payback period of less than 20 months, while the fan replacement would require about ₹44.51 lakhs with a payback periodof 6.2 years.