Energy Audit Report – 2021-22

PES/2021-2022/15

Submitted to

Presidency University, 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!***

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Abbreviation

BESCOM	Bangalore Electrical Supply Company Limited
DG	Diesel Generator
Hrs	Hours
IS	Indian Standards
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
PU	Presidency University
SMF	Sealed Maintenance Free
STP	Sewage Treatment Plant
UPS	Uninterruptible Power Supply
V	Volt
WP	Watt Peaks

Executive Summary

1. Presidency University, Bangalore is a private university located in Itgalpur, Rajanakunte, Yelahanka, Bengaluru 560064 (10 kms from Yelahanka Town) 13.1682°N 77.5354°E. The University established in 2013 and commenced classes in 2015.The University is recognized by the University Grants Commission (UGC).

2. The institute offers a total of 51 courses in various disciplines such as Engineering, Law Management, Information Science, Commerce and Designing at the 38 undergraduate programs and 13 postgraduate programs. In all there are 11336 students studying these programs during the academic year 2020-21, of whom 10004 are UG students, 1332 are PG students.

3. The campus of Presidency University has a built up area of 137496. Sq.m, and 123171 sqm. It provides all necessary best in class facilities including a library, labs, and a fully Wi-Fi enabled campus. It has spacious classrooms, conference halls, auditoria, panel rooms, and sports facilities.

4. The college consumes energy in primarily 5 areas namely Lighting, Fans, AC , Projector and Pumps among others. The total connected load is 1186 KW. The college also has captive of four DG sets with two of 250 KVA and two of 500 Kva to provide backup power with an operation of 6—75 hours per month. UPS with a capacity 525.5KVA provides the required standby during the transition.

5. The total annual energy consumed per student is 57.44 kWh and per unit area is 4.44 Sqm, which is commendable.

6. A potential to install roof top Solar photo voltaic exists. A minimum of 700KWp may be installed, which would realise in 1million unis or ₹95 lakhs of energy per annum. The investment cost would be about ₹4.8 crores.

7. The analysis of loads indicate that nearly 78% savings in energy consumption by fans could be achieved by replacing with brush less DC fans. The expenditure required for replacement is ₹70.6 lakhs implying a payback period of ~7 years.

8. It is also recommended to install IoT enabled block level energy meters so as to continuously improve the savings.

1. Background

Presidency University is a private university and located at Itgalpur, Rajanakunte, Yelahanka, Bengaluru. It was established in 2015 and is affiliated to Bangalore North University.

The campus of Presidency University is spread over with a built up area of 137496 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.

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 never carried out energy audit in the past. An energy audit is a process for analysing energy consumption, functional requirements and identifying areas of intervention for energy minimization.

The current annual energy cost incurred by the University is around ₹ 45.78 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. The report documents the connected loads and respective energy utilised

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, No Load Losses, Power Factor Measurement 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-conditioners, 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

Energy audit of PU has been conducted by analysis of power consumption patterns over the year, total connected load, and utilization of power. All the functional areas of PU have been studied to understand connected loads, load utilization, 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
- Correlation with documentary evidence, meter readings etc
- Validation
- Identifying potential energy saving opportunities.
- Conclusion and Recommendations.

5. Salient features of the project

Table 1: Details of Presidency University

1	Name of Consumer:	Presidency University- Bangalore
2	Name of the contact person	Dr. Bahri H S – Deputy Director
3	Address of the consumer	AH Memorial Education Trust No 21/1, Dibbur Village, Hessaraghatta Hobli Bangalore North Taluk, Karnataka -560084
4	Transformer capacity	1300 kVA
5	Capacity of back generators	1500 kVA
6	Contract Demand	400 kVA
7	Demand Charges	₹210/KVA for 85% Of contract demand
8	Roof top solar power plant	NA
10	Annual Energy consumption	Jan-20 to Jan-21, 582460 Units
11	Annual Amount paid to BESCOM	₹1,02,73,351 /-
12	Type of connection	1HT2C2
13	Period of Audit	Jan 2020 – Jan 2021

6. Baseline data for the energy audit

Presidency University has made available the energy bills for the last calendar year. The electricity bills for the period between Jan 2020 to Aug 2021 was analysed to understand consumption patterns, yearly load variation patterns.

The graphs show an expected reduction in electricity bills when the restriction were in place and a rising trend when the normalcy was being returned. Sufficient data does not exist to predict a normal consumption.

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6.1. Energy consumption trend

The figures 1 and 2 show the low consumption and proportionate expenditure during the lockdown.

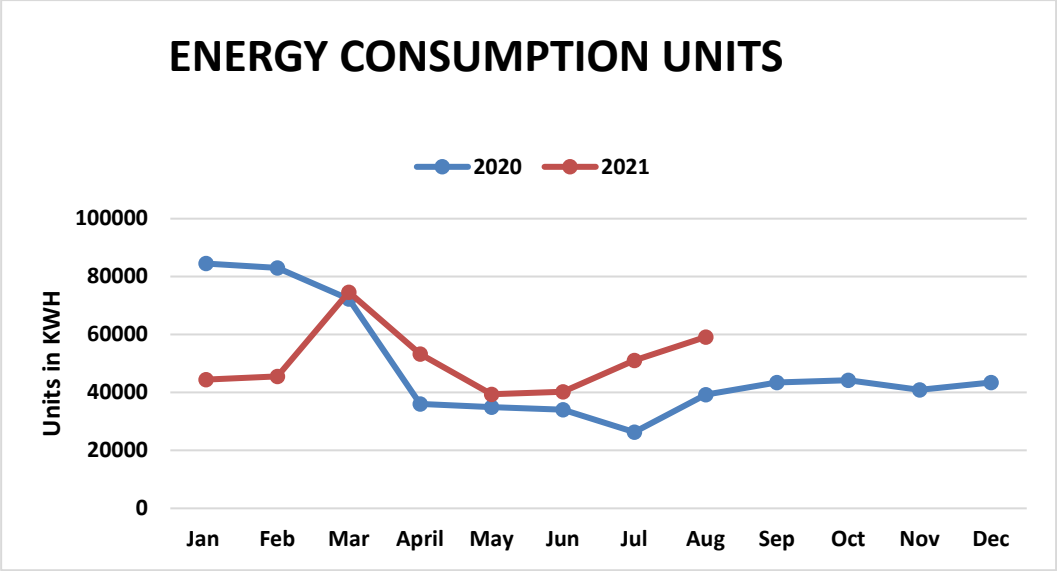

Figure 1: Year-wise monthly energy expenditure

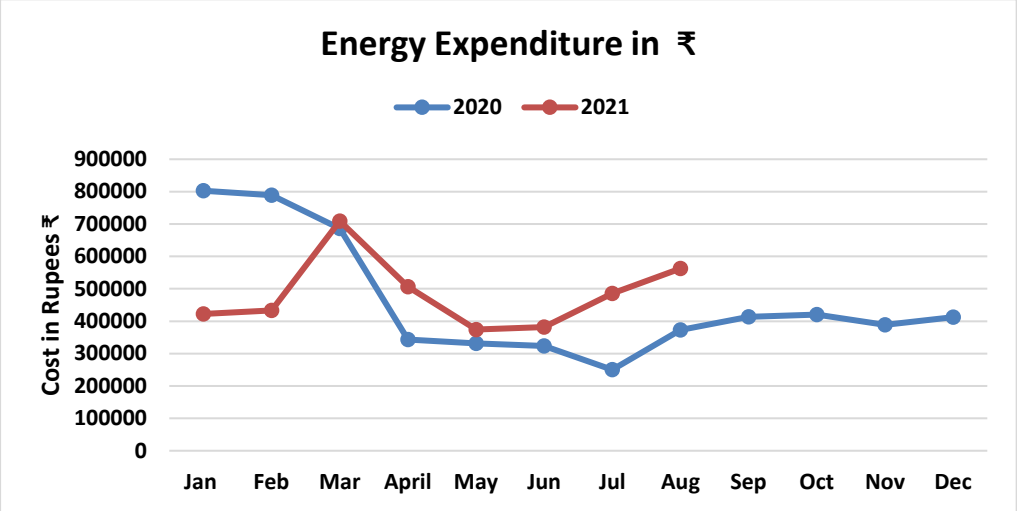

Figure 2: Year-wise monthly Energy Expenditure Pattern

It can be seen that the lowest consumption is about 36100KWH to 26320 KWH- in April 2020 to July 2020 respectively.

The administration can investigate this consumption as it is a large consumption for

a University under lockdown.

6.2. 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 1185 kW and load distribution is given below

Table 2: Segregated system with connected loads

Sl.No.	Particulars	Load (kW)
1	AC	702
2	Fans	177
3	Lights	211
4	Lifts	4
5	Projector	25
6	Pumps	68
7	Refrigerators	1
	Total Load kW	**1,185**

BESCOM bill of 2020 and 2021 has been referred for various analysis. Maximum power consumption has been observed in the month of January 2020 and minimum consumption in June. Consumption pattern depends of programs and activities of the institute.

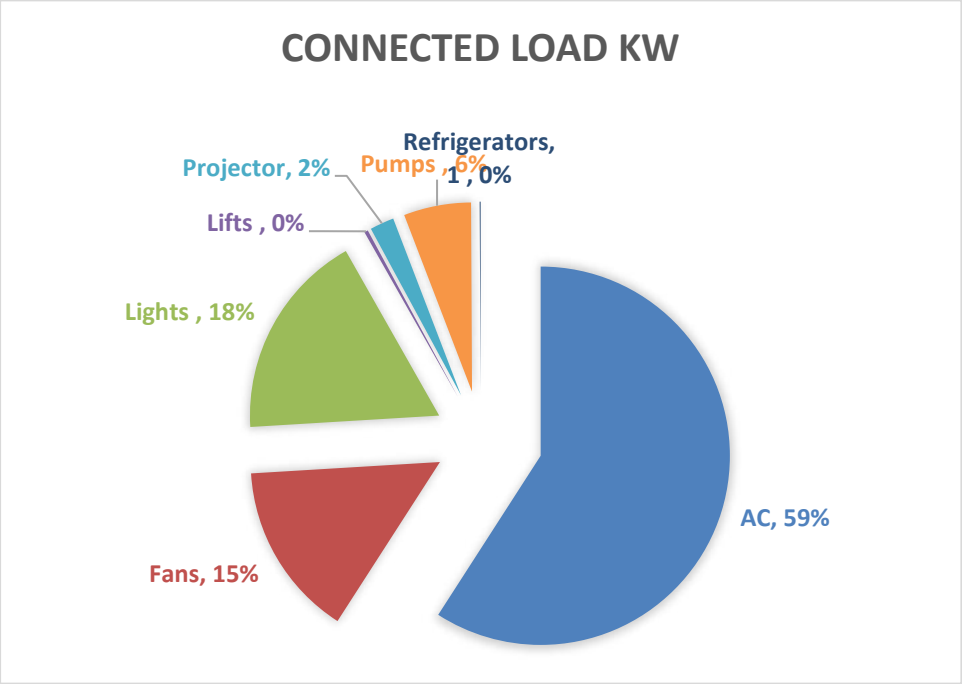

Figure 3: Connected Loads

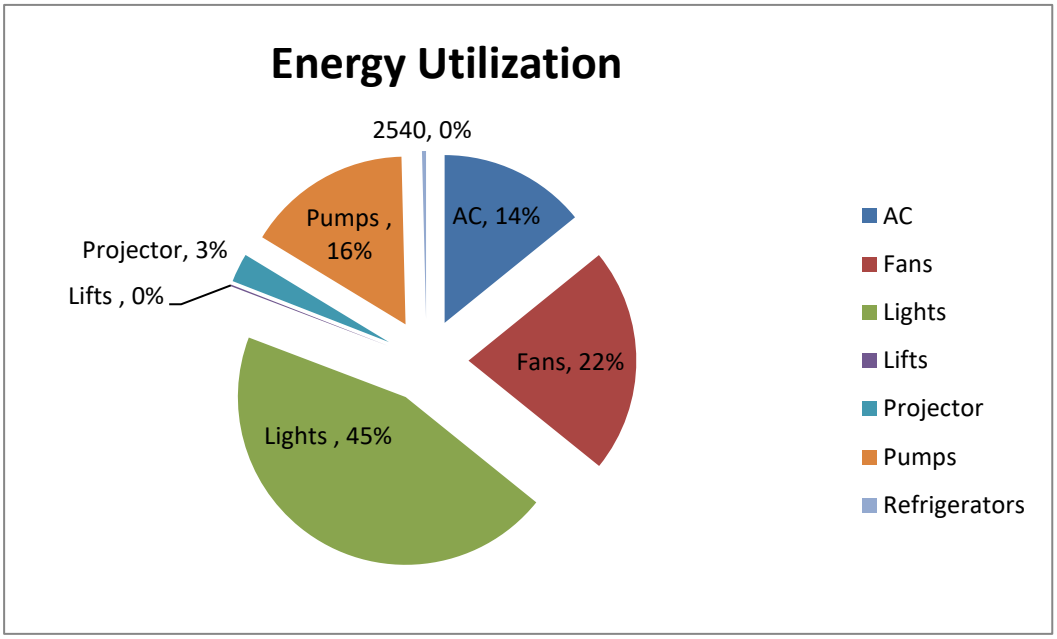

Figure 4: Energy Utilization

It can be observed that lighting account for the maximum energy, followed by AC, fans and pumps. The key variable loads that may be directly linked to full functioning of the university contribute to about 54000 kWh/ month. This would imply that leakages/ system losses of about 20000 kWh - 25000 kWh exists and need detailed investigation

7. Diesel Generator Sets

The Presidency University has installed four DG sets for power backup. The details are as under

Table 3: Details of 2 x 250 KVA DG set and their service areas

Sl No	Service areas	Major Connected loads KW
1.	MBA block	20.8
2.	COE	3.9
3.	MBA block and outside	38.7
4.	Workshop	33.8
5.	Fountain	1.1

6.	Central Admin	10.0
7.	Placement & Old admin	2.7
		110.9

It may be noted that the total essential loads is just under 25%of the installed capacity of the DG set.

Table 4: Details of 2 x 500 KVA DG set and their service areas

Sl No	Service Areas	Major Connected loads KW
	Admin G	26.7
	D block	226.4
	E block	91.7
	F block	85.2
	HJK block	98.1
	L block	150.8
	N block	86.8
	P block	48.7
	Q block	60.6
	R block	46.9
	S block	48.3
	U block	60.0
	Namaz	4.0
	Restrooms	86.9
	Total	1121.1

In the case of the 500KVA DG set, the combination seems adequate. However, considering the fact that the maximum demand has never exceeded 340KVA, it would be better to connect all in parallel to a ring local main grid an run only one DG set of 500KVA, or 250KVA as the case maybe. It would also be good to have a lower capacity of about 150KVA, so that the generator may be run at full load.

8. Roof Top Solar Photovoltaic

Currently there no Roof Top Solar provisions at the college campus. The Presidency University has ~138053 Sqm of roof area. Assuming even 5% of the roof is dedicated to SPV, there is a potential to install nearly 700 kWp of roof top grid connected SPV. This has a potential to generate about 2700 units every day or nearly 78000 kWh monthly. This can almost bring Presidency University to a net zero consumer.

9. Load Analysis

9.1 Lighting loads

Average monthly power utilization is between 23000 units to 26000 units. Lighting load with 6294 fixtures account to 45% of total power consumption or 210KW. 95% of the lighting are energy efficient LED fixtures and the balance are 36W Fluoroscent Tube Light. There is a potential to replace them with LED at the end of the useful period or earlier. This can result in a saving of nearly 1000 units per annum.

9.2 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
	Without Artificial Lighting	With Artificial Lighting	
Conference Room	50	200	300 - 500
Library	10	250	200 - 300
Reading Room	10	250	200 - 300
Classrooms	65	250	200 - 300
Entrance Lobby	40	200	100 - 300
Staff Room	20	65	200 - 300
Mess : Dining Space	60	150	100 - 300
Hostel: Room	25	150	100 - 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. The lighting level in the staff room are less than the recommended lux level, so alternatively task lighting may be provided to improve the lux level.

Figure 5: Task lighting

9.3 Decibel levels

The ambient sound levels were checked and were found to be within norms. The details are tabulated below.

Figure 6: Measurement of ambient sound level

Table 6: Ambient Sound levels (db) in functional areas

Location	Measured dB level		Recommended dB level
	Low	High	
Living Rooms, Classrooms, Lecture Halls, Conference Rooms	15	35	30 - 35
Offices, Courtrooms, Private Work Rooms, Library	25	45	40 - 45
Corridors, Open Offices, Bathrooms, Toilet Rooms, Reception, Lobbies, Shopping	30	55	45 - 55
Mess : Dining Space	40	60	45 - 55
Living Rooms, Classrooms, Lecture Halls, Conference Rooms	15	40	30 - 35

9.1 Fans: Energy Saving Potential

Detailed list of fans at various buildings in as per the detail given below. The total connected load is about 177KW

Table 7: Details of Fans

Sl No	Description	Power in W	Qty	Operating hours	Total KW	Total kWh
1	Wall mount fan 50W	50	36	2	1.8	3.6
2	Wall mount fan 55 W	55	95	2	5.225	10.45
3	Table fan 60W	60	32	2	1.92	3.84
4	Celling fan 70W	70	2368	3	165.76	497.28
5	Exhaust Fan 35W	35	73	8	2.555	20.44
6	Total		2604		177.26	535.61

Average monthly power utilization of fan load is about 11790 units. Fan load contributes 22 % of total power consumption.

An exercise has been carried out to check the feasibility of replacing with Brush less DC fans which are very energy efficient. The typical power at normal speed varies between 3W to 28W. Operating at medium speed is about 14W to 16W.

Table 8: Energy Saving Potential: Fans

Daily energy savings after substitution with BLDC kWH	**422**
Energy savings /day @ average unit Rate of ₹ 9.5	₹ 4009/-
Savings / Year	₹ 14,63,285/-
Proposed investment for Brushless DC Fans fixtures@ ₹2700/fan	₹ 70,30,800/-
Return on investment – Years	6.63

There is an energy saving potential of 80 % by installing brush less direct current fans. Payback period is around 75 Months.

9.2 UPS & Diesel Generator

Power backup in the form of 525.5 KVA UPS is implemented which is about 131% of the contract demand. There are about 27 UPS units ranging from 1KVA to 40KVA, with SMF battery AH ranging from 26AH to 150AH. These batteries do not require topping up of distilled water and spillage of acid. Neat and clean environment can be maintained.

10.Miscellaneous

10.1. Water consumption

Water is utilized by students, faculty, and other persons for meeting the domestic water requirements including drinking water. The water demand for the campus is estimated as 540 KLD as per the NBC 2016 which specifies 45 LPCD for non-boarding students and 135lpcd for boarding. The water demand is met through BWSSB and bore wells. The institution utilizes only 168 KLD at a per unit consumption of 22 lpcd.

However, the water usage are only estimates as no meters are provided at borewells or distribution end.

10.2. Sewage Treatment Plant

The fresh water utilised results in sewage generation. Although a STP of 450KLD is needed for a campus of 12000 pax (as per NBC 2016), a new STP with SBR technology is under implementation. It is in advanced stage and proposed to be commissioned shortly. It is recommended to utilize the treated water for toilet flushing and landscaping so as to reduce fresh water consumption.

10.3. Rain Water Harvesting

The total roof area in the campus is ~138000 Sq M. The average rainfall in Bengaluru is about 850mm. The annual roof top rainwater harvest potential is estimated to about 111 ML per annum. The open area would contribute nearly 31ML per annum. The Institution would need about 10ML of storage or recharge pit to comply with the BWSSB guidelines for RWH.

11.Conclusions and Recommendations

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

Table 9: Benchmarking of annual energy consumption

Sl No	Measure	Standard	PU values
	Energy/Student	210 kWh	57.44
	Energy/Sq.m built-up area	-	4.74

The following table summarizes the total savings that can be realized in three areas- Lighting and Fans.

Table 10: Summary of annual energy savings for Lightings

1	Annual Energy savings ₹	₹ 9,500/-
2	Proposed investment for kWh savings	₹ 18000/-
3	Payback period years	2

Table 11: Summary of annual energy savings for Fans

1	Annual Energy savings ₹	₹ 10,59,000/-
4	Proposed investment for kWh savings	₹ 70,38,200/-
5	Payback period years	6.64

It can be observed that nearly ₹0.1 lakhs and ₹10.6 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 ₹0.18 lakhs implying a payback period of 2 Years, while the fan replacement would require about ₹70.6 lakhs with a payback period of 7 years.

A potential to install roof top Solar photo voltaic exists. A minimum of 700KWp may be installed, which would realize in 1million unis or ₹95 lakhs of energy per annum. The investment cost would be about ₹4.8 crores

An analysis of the actual energy consumption during the lockdown would provide clue to nearly 20000KWH of electricity / month as the auditors feel it could be contributed by idle losses from the 1.3MVA transformer and other loads. Installation of block level energy meter would help monitor such wastage and continuously improve the savings.