Energy Audit Report – 2015

Submitted to

Kristu Jayanti College, Autonomous
Bengaluru

M/s. Paradigm Environmental Strategies Pvt. Ltd.
#150, 2nd Main, S.T. Bed Layout,
Koramangala 4th Block, Bangalore: 560034
Email ID: info@ecoparadigm.com Mobile: +91-9448077904

Document No: PES/2015-2016/KJC-EAR

Date of submission: 8th January 2016

Internal Document Control

Sl. No.	Document Number & Date	Prep	Chk	App	Remarks
1.	PES/2015-2016/KJC-EAR- 20160108	PKP	PKP	PKP	Draft

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
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 days scholars are 3549 including 840 residential students.

2. The campus of Kristu Jayanti College is spread over 9 acres with builtup area of 23510 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 that are housed in the main block along with the administrative sections. The college offers research centers in Social Work, Biotechnology, Commerce and Psychology.

3. KJC has instituted several measure to conserve water- A Rain water harvesting tank of 2.5 ML is established which is in compliance with the regulations. The overal consumption of freshwater is maintained at about 50 lpcd which is slightly more than the recommendations of IS 1172:1993. The wastewater is handled using a septic tanks.

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 330KW. The college also has one captive DG set of 125KVA to provide backup power with an operation of 6—75 hours per month. UPS with 45% of contract demand is also installed. A 50KW and 10KW solar photvoltaic is installed in the roof top. It has succesfully supplied an excess energy of 4177kWh for the year 2015.

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 89kWh and per unit area is 13.52 kWh which is appreciable.

6. The Analysis of loads indicate that nearly ₹7.6 lakhs and 3.54lakhs 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 ₹6.09 lakhs implying a payback period of 0.8 years, while the fan replacement would require about ₹22.3 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 4224 inclusive of 940 residential students.

The campus of Kristu Jayanti College is spread over 9 acres with a built up are aof 25289 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 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

The management of KJC is sensitive about the fact that the energy efficiency improvement of such campuses provides a benefit for the environment and impacts the Climate Change aspect of Bangalore City. Kristu Jayanti College proposes to initiate energy conservation efforts in their institution. This report outlines the methodology to be followed to minimise energy. It also details certain steps that may be incorporated to achieve the same. The purpose of this analysis is to provide the College insight into the energy savings potential that exists within facilities. Energy Efficiency changes and upgrades requires support from the Management of the college, students and faculty and operations personnel of the college, in order to maximize the savings and overall benefit.

Hence, 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

Since the earth summit, and the emergence of Agenda 21, as its pivotal and substantial outcome, energy as a sector and a component, got identified as the corner stone and balancing factor in the process of environment-development interaction, which decides the status and nature of sustainable development. It has also got accepted by the political leaderships of the world governments that to mold a development process, which is econo-ecologically sustainable, the management

of energy for achieving the maximum end-use benefits and efficiency which include increased use of renewable energy resources as development priority. Further, at a time when economic growth, employment opportunities and balance of payment scenarios are negatively affected due increase in energy price in the developing and third world countries, and carbon dioxide and other energy consumption induced green house gases are increasing globally, especially due to heavy energy consumption in the developed countries, comprehensive management of energy becomes a priority of all the countries.

India, the most affected country in terms of energy shortage and increasing energy price become one of the first countries in the developing world to adopt energy management measures in all sectors of the economy on a priority basis, including promotion and popularization of renewable energy technology and resources. With liberalization and globalization of economy, energy management aimed at enhancing total energy efficiency in all sectors of the economy will become a major factor in determining the comprehensive competitiveness of the economy.

Large campuses like industries, institutions etc., which are energy guzzlers could tighten their energy utilisation, which is a good proactive step. Hence, in India, the education regulators like AICTE, NAC and the education ministries of State and Central Government is also encouraging the educational institutions to undertake such energy audits and implement measures in energy management. Energy Audit is the first step, in that it indicates how an energy audit can fit into an energy management programme. Energy Management Programmes, Energy audits and the ensuing cost and energy saving opportunities identified in audits, are best implemented in the context of an energy management programme that operates, and is formally recognized, as an integral part of the ongoing management activities of the entity for which it applies. Hence, the KJC Management, has entrusted this activity to Ecoparadigm to explore the possibility of conducting an energy audit of its campus. Being the first such attempt, the scope has been limited to only undertake a preliminary audit.

The objective of the audit was as follows:

- To study the energy consumption pattern of the facility
- To identify the areas where potential for energy/cost saving exists
- To prepare proposals for energy/cost saving along with investment and payback periods.

Energy Audit is the key to a systematic approach for decision-making in the area of energy management. It attempts to balance the total energy

inputs with its use, and serves to identify all the energy streams in a facility. It quantifies energy usage according to its discrete functions. Industrial energy audit is an effective tool in defining and pursuing comprehensive energy management programme

As per the Energy Conservation Act, 2001, Energy Audit is defined as "the verification, monitoring and analysis of use of energy including submission of technical report containing recommendations for improving energy efficiency with cost benefit analysis and an action plan to reduce energy consumption".

3. Scope of work

a) Scope of work and methodology were as per the proposal agreed between KJC and Ecoparadigm. While undertaking data collection, field trials and their analysis, due care was always taken to avoid abnormal situations so as to generate normal/representative pattern of energy consumption at the facility. We focused our attention on energy management and optimization of energy efficiency of the systems, sub systems and equipment. The key to such performance evaluation lies in the sound knowledge of performance of equipment and system as a whole.

4. Approach and Methodology

4.1 Approach

The approach adopted here is to describe the complete energy audit methodology, which will set the stage for future detailed audit. Hence, in this report, an ideal approach is provided below:

Step 1: An important function of an energy audit is to evaluate the energy management programme and suggest ways in which it could be improved.

Action: Identify the energy management programme of the college

Step 2: An energy audit should provide much of the essential information to progress an energy management programme and action. It should summarise key energy use and cost indices, provide a breakdown of where energy is used and give a table of recommended actions.

Action: A detailed questionnaire/checklist to be prepared for the college

Step 3: An Action Plan to be prepared based on the inputs obtained from the energy audit. The energy audit aspects of the energy management process should include determining the level of detail (high, mid-range and detailed) that an energy auditor

will appraise when an audit is carried out, as well as the extent of any recommendations arising from the audit process.

4.2 Methodology

As this is a first attempt in the college of carrying out an Energy Audit, only a Preliminary energy audit, which is a relatively quick exercise was conducted. The steps involved the following:

a. Establish energy consumption in the organization
b. Estimate the scope for saving
c. Identify the most likely (and the easiest areas for attention)
d. Identify immediate (especially no-/low-cost) improvements/ savings
e. Set a reference point;
f. Identify areas for more detailed study/measurement
g. Preliminary energy audit uses existing, or easily obtained data

5. Salient features of the project

Table 1: Details of Kristu Jayanti College

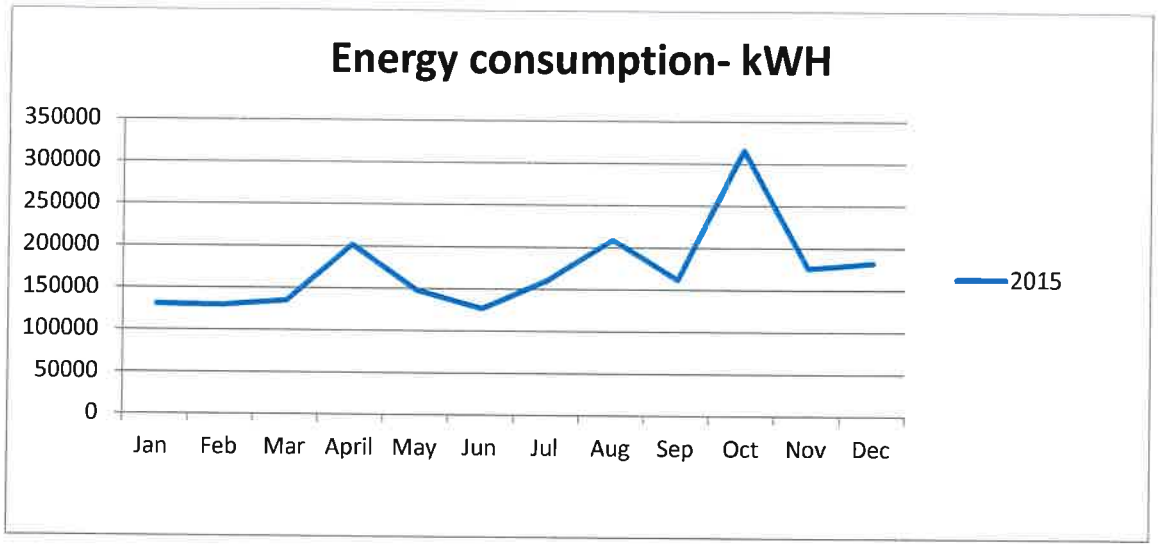
1	Name of Consumer:	M/s. Kristu Jayanti College- Bangalore
2	Name of the contact person	Mr. Edward – Dean
3	Address of the consumer	K Narayanapura , Kothanur(PO) ,Bangalore
4	Transformer capacity	500 kVA, 11kV / 433 V . ONAN,
5	Capacity of back generators	125 kVA
6	Contract Demand	200 kVA
7	Demand Charges	
8	Roof top solar power plant	50kWP and 10 kWP
9	Power factor correction	50 kVAR capacitor
10	Annual Energy consumption	Jan-15 to Dec-15, 2,65,041 Units
11	Annual Amount paid to BESCOM	₹ 20,78,538/-
12	Type of connection	HT2C2
13	Period of Audit	Jan- Dec 2015

6. Baseline data for the energy audit

Since the college has just started operation, there is no baseline data for comparison. The data is recorded to serve as baseline for the future audits.

6.1. Energy consumption trend.

Figure 1: Monthly energy consumption pattern



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 330 kW and load distribution is given below

Table 2: Seggregated system with connected loads

Sl.No	Particulars	2015
1	AC	173
2	Fans	56
3	Lights	63
4	Lifts	14
5	Pumps	13
6	Geysers	10
7	Fridges	1
	Total	330

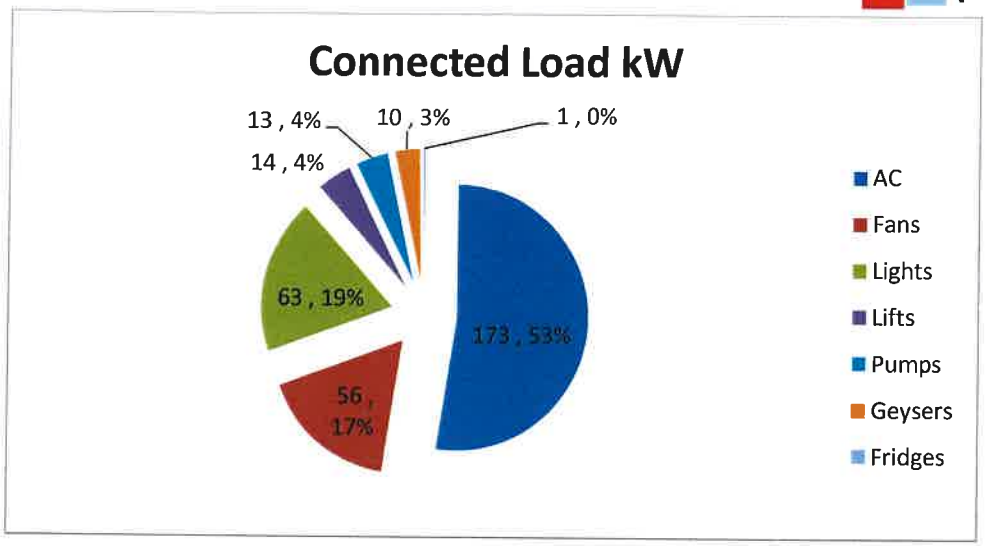


Figure 2: Connected load distribution

BESCOM bill of 2015 has been referred for various analysis. Maximum power consumption has been observed in the month of October and minimum consumption in June. 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

8. Diesel Generator Sets

There is a Diesel Generator sets of 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

One number 50KW and one number 10 KW grid connected solar photvoltaic power plant is installed in the campus. The total energy supplied to the grid after meeting the captive consumption is 4177 kWh.

Figure 3: Roof top SPV in campus

10. Power factor and Harmonics.

Capacitors installed for power factor correction is line with the current demand 50 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 Watt	Load in kW
1	Tube Lights Main Block	720	44	31.68
2	CFL Lights Main Block	0	22	0
3	LED Lights Main Block	100	22	2.2
4	Tube Lights PG Block	400	44	17.6

5	CFL Lights PG Block	152	22	3.35
6	LED Lights PG Block	90	22	1.98
7	Tube Lights Admin Block	0	44	0
8	CFL Lights Admin Block	0	22	0
9	LED Lights Admin Block	0	22	0
10	Tube Lights CMI Ashram	99	44	4.36
11	CFL Lights CMI Ashram	9	22	0.2
12	LED Lights CMI Ashram	27	22	0.6
13	Tube Lights Guest House	0	44	0
14	CFL Lights Guest House	0	22	0
15	LED Lights Guest House	0	22	0
16	Street Lights	18	31	0.56
	Total Power		2	62.53

Average monthly power utilization is between 9500 units to 12000 units. Lighting load contributes 19% 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	120 – 170	300 – 500
Library	65	200- 300
Workstation at library	65	200 -300
Classrooms	80-180	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 6: 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	720	32	253	6589	14	115.2	2995.2
2	Tube Lights PG Block	400	18	176	4576	8	80	2080
3	Tube Lights Admin Block	0	0	0	0	0	0	0
4	Tube Lights CMI Ashram	99	4	35	906	2.0	15.84	411.84
	Total	1219	0	464	12071	24	211	5487

Table 7: Cost saving analysis lighting load

Power cost / Month with Fluorescent tubes @ average unit Rate of ₹ 9.60	₹ 115886/-
Power cost / Month - ₹ with LED fixtures	₹ 52675/-
Savings / Month	₹ 63211/-
Savings / Year	₹ 758528/-
Proposed investment for LED fixtures.	₹ 609500/-
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 8: Details of Air Conditioning units

SL. No	Location of installation	Tonnage	Load in kW
1	ACs Main Block	14	
2	ACs PG Block	119	
3	ACs Admin Block	0	
4	ACs CMI Ashram	0	
5	ACs Guest House	0	
	Total Air conditioning load	133	**172.9**

Average monthly power utilization is between 11000 to 14000 units. Air-conditioning load contributes 52-54 % of total power consumption.

Energy Saving Potential

Energy saving potential of about 5 %, which amounts to 5700 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	523	
2	PG Block	243	
3	Admin Block	0	
4	CMI Ashram	50	
5	Guest House	0	
	Wall mounting fans	45	
	Total fan load	861	**55.96**

Average monthly power utilization of fan load is about 4924 units. Fan load contributes 17 % 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 5.7 years.

Table 10: Cost saving Analysis - Fans

Monthly Average power consumption in kWh with regular fans	4924 kWh
Monthly average power consumption with BLDC fans	1970 kWh
Total savings / Month – kWh	2955 kWh
Total savings / Year	35,459 kWh
Total investment for replacement of fans ₹	₹22,28,600/-
Cost savings/ year	₹. 3,90,053/-
Payback period	5.73 Years.

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	2016
1	Lift 15 pax	0
2	Lift 12 pax	0
3	Lift 10 pax	2
4	Lift 8 pax	0
5	Lift 6 pax	2
	Total numbers	4
	Total power @ 3.5 kW / lift	14

Average monthly power utilization of Lift load is about 302 units. Lift load contributes to 1 % 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 12: Details of Pumps installation

Sl. No	Particulars	Number	Power HP	Total Power KW	Operating hrs	Total energy
1	Submersible 90m, 550lpm	0	10	0	2	0
2	Submersible pumps 75m 450lpm	1	7.5	5.63	4	22.52
3	Submersible pumps 28m 80lpm	2	5	7.5	1.5	11.25
	Total			13.13		33.77

Total energy consumption is about 884 Units which is about 4% 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 90 KW UPS is implemented which is about 45% 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 243 KLD as per the IS 1172:1993 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 120KLD at a per unit consumption of 50 lpcd.

12.5.2. Sewage Treatment Plant

The fresh water utilised results in sewage generation. The projected demand of 243KLD would necessitate a STP of 206KLD. Since the actual usage is only 96KLD, the actual STP capacity required is only 104KLD. However, two septic tanks of 150KLD and 50KLD are installed within the premises. This indicates a gap in treatment capacity, which needs to be addressed quickly.

12.5.3. Rain Water Harvesting

The total built up area in the campus is 23510 Sqm. The average rainfall in Bengaluru is about 840mm. The roof top rainwater harvest potential is estimated to about 16.78ML per annum. The Institution has already implemented 2.5ML which is greater than the 0.75ML

ML RWH tank mandated by BWSSB.

13.Conclusions and Recommendations

The energy usage per Sqm and per student is tabulated below

Table 13: Benchmarking of annual energy consumption

Sl No	Measure	Standard	KJC values
	Energy/Student	210	**89.52**
	Energy/Sqm builtup area	-	**13.52**

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

Table 14: Executive Summary of Lightings

1	Annual Energy savings ₹	₹ 7,58,528/-
2	Proposed investment for kWh savings	₹ 6,09,500/-
3	Payback period years	0.8

Table 15: Executive Summary of Fans

1	Annual Energy savings ₹	₹3,90,053/-
4	Proposed investment for kWh savings	₹ 23,38,600/-
5	Payback period years	5.73

It can be observed that nearly ₹7.58 lakhs and 3.90lakhs 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 ₹6.09 lakhs implying a payback period of less than 8 months, while the fan replacement would require about ₹23.38 lakhs with a payback period of 5.7 years.