ENERGY & GREEN AUDIT REPORT

Academic Year – 2021 – 2022
Date of Audit – April 2021

Institute Name –
Lonavala Education Trust's,
Dr. B. N. Purandare Arts & Smt. S. G Gupta Commerce &
Smt. S.A. Mithaiwala Science College
At/post, Valvan, Lonavala, Pune
Maharashtra – 410403

Auditing Agency -
Enertek Solutions India Private Limited
615 – B, Nana Peth, Pune – 411 002
Contact no. +91 9421053996
harshad@enertecsolutions.com

Acknowledgement

We express our sincere thanks to the management of Dr. B.N. Purandare Arts and Smt.S.G. Gupta Commerce & Smt.S.A. Mithaiwala Science College for giving us the assignment of carrying out the detailed energy audit of their college premises. We sincerely appreciate the effort and support provided by the management team of Dr. B.N. Purandare Arts and Smt.S.G. Gupta Commerce & Smt.S.A. Mithaiwala Science College

We would like to applaud the good practises that are carried out in the college premises. Such practises are really laudable and can help the college run better.

We hope this report is as per your satisfaction and should be able to help you manage your energy better and obtain the said benefits in future after implementation of the projects.

Yours Sincerely
Energy Audit team

ENERGY AUDIT TEAM

Sr. No	Name of Members	Designation
1	Mr. Anand Dande	CEA- 29574
2	Mr. Harshad Batule	Technical Lead
3	Mr. Chaitanya Gadhave	Energy Engineer
4	Mr. Nihar Kamble	Energy Engineer
5	Mr. Nikhil Ukali	Energy Engineer

INDEX

Sr.No.	Particulars	Page Number
1	Executive Summary	3
2	Abbreviations	4
Chapter		
I	Study of Bill Analysis	5
II	Historical Data Analysis: Connected Load	11
III	Carbon Foot printing	17
IV	Green Audit for AY 2021	22
V	Water Layout	26
VI	Rooftop Solar PV Plant	27
VII	Waste Disposal & Vermi composting	30
VIII	Vendor List	33

Executive Summary

Sr.No.	Parameter	Energy Savings (kWh)	Cost saving (Rs.)	Investment (Rs.)	Payback period (Months)
1.	Replacement of T-5 Tube light 40 W to LED 20 W	3,936	17,712	16,400	12
2.	Replacement of 100W Fan to 28 W BLDC Fan	5,093	45,850	3,27,500	86
3.	Installation of rooftop Solar PV	27,813	2,20,557	9,00,000	48
Total		9,029	63,562	3,43,900	65

** Solar PV savings are not given as they are subjective of installation.

Lighting –

Existing lighting for classes and offices are of non-efficient T5 of 40 W and they are degraded by the period of usage. So, we can replace that efficient LED lights. Energy and cost Savings can be achieved through installation of tube lights.

BLDC Fans –

Institute can install BLDC Fans instead of conventional fan that can be save energy and subsequent effects of comfort cooling's can be achieved through this measure.

Green Audit -

Carbon dioxide generation of campus due to usage electricity and other modes like transport as very much catered by following means like usage of 10 kWp solar PV plant in the campus, usage of solar water heater for hostel premises for water heating, usage of small amount of rain water harvesting and Vermi-composting plant in the campus. Also, there are multiple number of trees in the college campus which are planted by college or naturally cultivated. So, there is very less chance of CO_2 emission in college facility.

Rooftop Solar PV plant -

Campus can opt for 15 kW solar PV plant on Science Building rooftop so they can self-sustain during day hours and which is maximum of load in campus. This can lead campus to the net zero campus which is new concept upbringing in the green buildings.

Abbreviations

Eff	-	Efficiency
Hr	-	Hour
K Cal	-	Kilo Calories
kWh	-	Kilo Watt Hour
MT	-	Metric Ton
Kg	-	Kilogram
H P	-	High Pressure
L P	-	Low Pressure
T_2	-	Temperature Final
T_1	-	Ambient Temperature
MW	-	Mega watt
TPH	-	Tones per hour
ΔT	-	Temperature Difference
MD	-	Maximum Demand
CD	-	Contract Demand
AMD	-	Actual maximum Demand
PC	-	Powder Coating
PT	-	Pre-Treatment Line
TOD	-	Time of Day tariff
VSD	-	Variable Speed Drive
DBT	-	Dry Bulb Temperature
WBT	-	Wet Bulb temperature
RH	-	Relative Humidity
TR	-	Tons of refrigeration
KW	-	Kilo Watts
KVA	-	Kilo Volt Ampere
KVAr	-	Kilo Volt Ampere Reactive
PF	-	Power Factor

Chapter I

Electricity Bill Analysis

In this chapter, we present the analysis of last year Electricity Bills

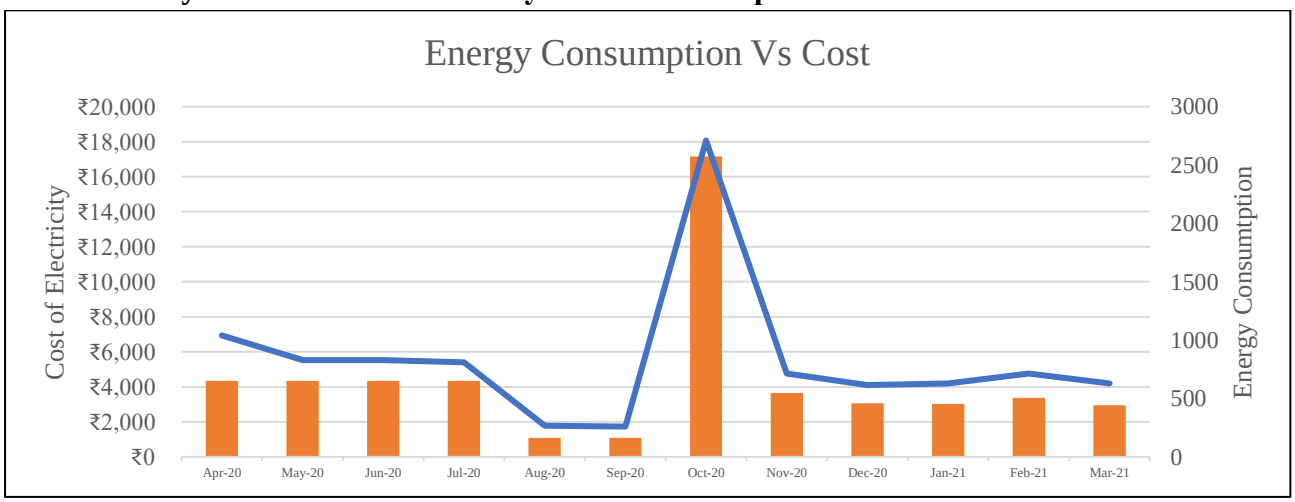
1.1 Commerce Building Meter - Consumer No. 181010038639

This consumer is one of the major contributors for billing. Monthly consumption for last few months and bill amount is as follows.

Table No. 1: Electrical Bill Analysis**:** 181010038639

Sr. No.	Month	Energy Consumption (kWh)	Amount (Rs.)
1	Apr-20	650	₹ 6,943
2	May-20	650	₹ 5,525
3	Jun-20	650	₹ 5,525
4	Jul-20	650	₹ 5,407
5	Aug-20	162	₹ 1,786
6	Sep-20	162	₹ 1,730
7	Oct-20	2,572	₹ 18,065
8	Nov-20	546	₹ 4,760
9	Dec-20	458	₹ 4,094
10	Jan-21	453	₹ 4,198
11	Feb-21	505	₹ 4,755
12	Mar-21	443	₹ 4,185
Total		7,901	₹ 50,282
Average		658	₹ 4,190
Max		2,572	₹ 18,065
Min		162	₹ 11,284

1.1.1 To study the variation of Monthly Units' Consumption:



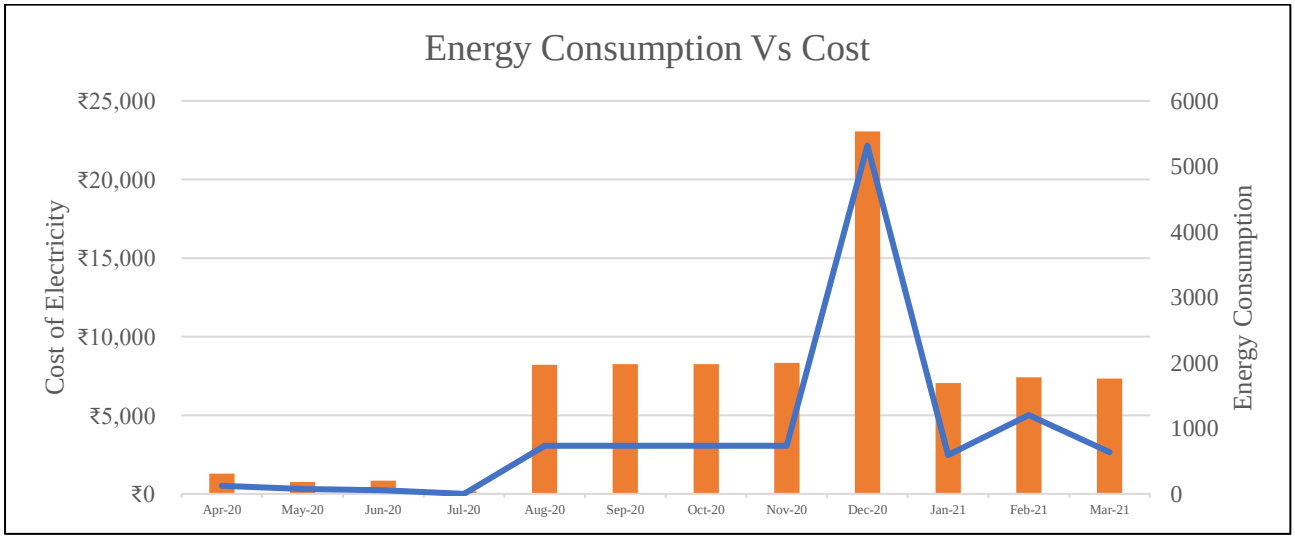
1.2 Arts Building Meter - Consumer No.181010102027

This consumer is one of the contributors for billing. Monthly consumption for last few months and bill amount is as follows.

Table No. 1: Electrical Bill Analysis- 2020-21:181010102027

Sr. No.	Month	Energy Consumption (kWh)	Amount (Rs.)
1	Apr-20	125	₹ 1,293
2	May-20	73	₹ 760
3	Jun-20	53	₹ 843
4	Jul-20	-	₹ 167
5	Aug-20	733	₹ 8,218
6	Sep-20	733	₹ 8,248
7	Oct-20	733	₹ 8,248
8	Nov-20	733	₹ 8,341
9	Dec-20	5,317	₹ 23,059
10	Jan-21	590	₹ 7,059
11	Feb-21	1,201	₹ 7,417
12	Mar-21	634	₹ 7,328
Total		10,925	₹ 80,981
Average		910	₹ 6,748
Max		5,317	₹ 23,059
Min		-	₹ 167

1.2.1 To study the variation of Monthly Units' Consumption:



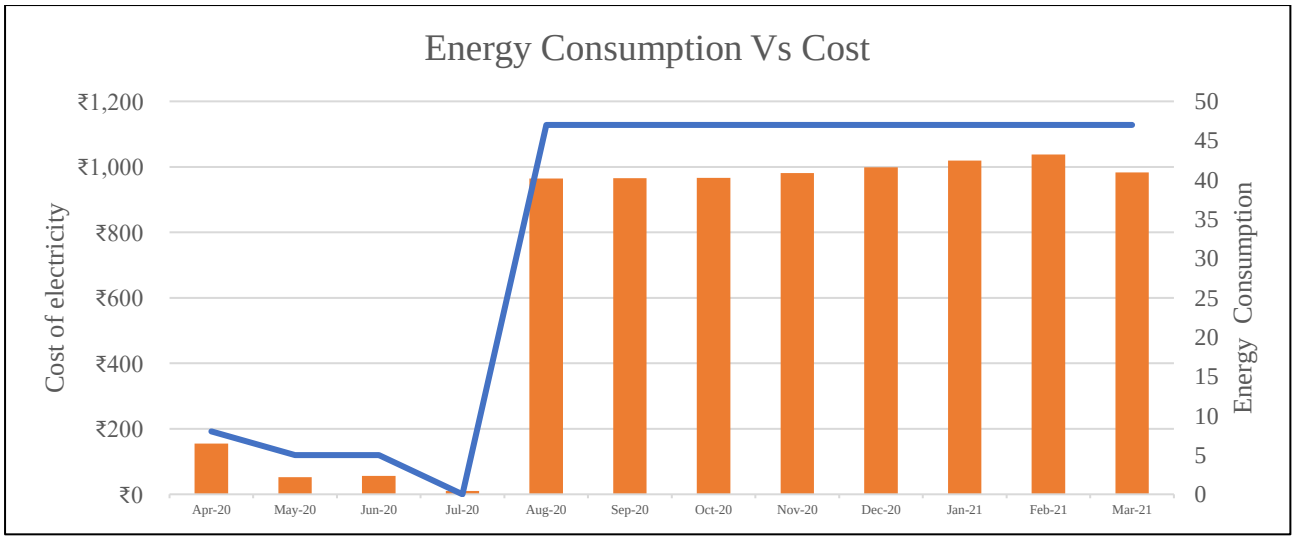
1.3 Junior Staff Meter - Consumer No. 181010101985

This consumer is one of the contributors for billing. Monthly consumption for last few months and bill amount is as follows.

Table No. 1: Electrical Bill Analysis- 2020-21:181010101985

Sr. No.	Month	Energy Consumption (kWh)	Amount (Rs.)
1	Apr-20	8	₹ 155
2	May-20	5	₹ 52
3	Jun-20	5	₹ 56
4	Jul-20	-	₹ 10
5	Aug-20	47	₹ 964
6	Sep-20	47	₹ 965
7	Oct-20	47	₹ 966
8	Nov-20	47	₹ 981
9	Dec-20	47	₹ 999
10	Jan-21	47	₹ 1,019
11	Feb-21	47	₹ 1,038
12	Mar-21	47	₹ 983
Total		394	₹ 8,189
Average		33	₹ 682
Max		47	₹ 1,038
Min		-	₹ 10

1.3.1 To study the variation of Monthly Units' Consumption:



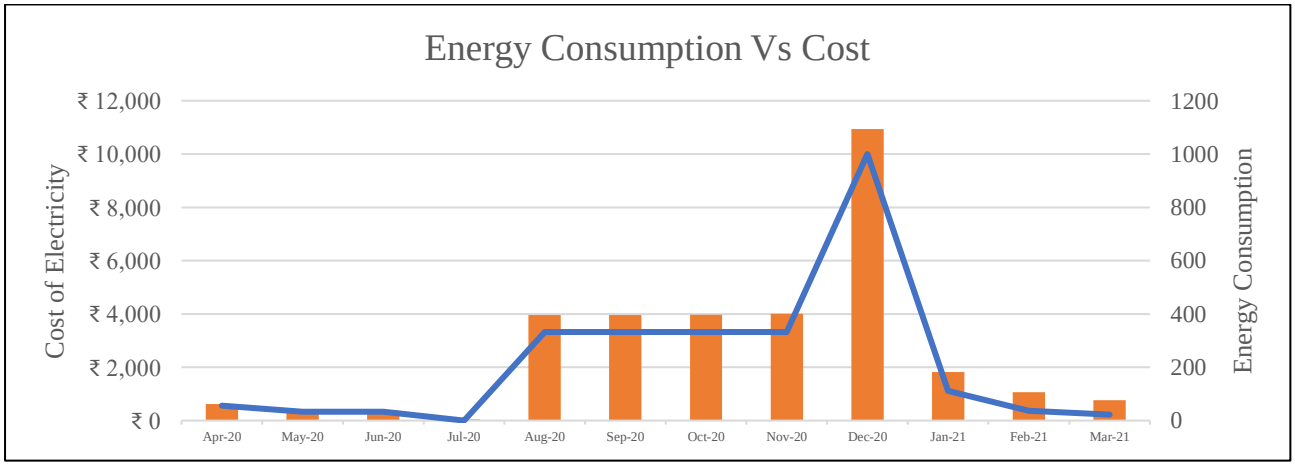
1.4 Science Building & Women's Hostel - Consumer No. 181010101969

This consumer is one of the contributors for billing. Monthly consumption for last few months and bill amount is as follows.

Table No. 1: Electrical Bill Analysis- 2020-21:181010101969

Sr. No.	Month	Energy Consumption (kWh)	Amount (Rs.)
1	Apr-20	56	₹ 622
2	May-20	33	₹ 344
3	Jun-20	33	₹ 363
4	Jul-20	0	₹ 44
5	Aug-20	332	₹ 3,957
6	Sep-20	332	₹ 3,965
7	Oct-20	332	₹ 3,967
8	Nov-20	332	₹ 4,013
9	Dec-20	1000	₹ 10,935
10	Jan-21	111	₹ 1,822
11	Feb-21	37	₹ 1,065
12	Mar-21	22	₹ 766
Total		2620	₹ 15,651
Average		218.33	₹ 1,304
Max		1000	₹ 4,013
Min		0	₹ 4,121

1.4.1 To study the variation of Monthly Units' Consumption:



1.5 Summary:

Sr. No	Consumer No	Annual Electricity Consumption (kWh)	Annual Bill (Rs.)
1	181010038639	7,901	₹ 66,973
2	181010102027	10,925	₹ 80,981
3	181010101969	394	₹ 8,188
4	181010101985	2620	₹ 31,863
	Total	21,840	₹ 1,88,005

1.6 Key Inference drawn:

From the above analysis, we present following important parameters:
Variation in Important Parameters Consumer number wise:

Sr. No	Consumer No	Parameter	Max	Min	Average
1	181010038639	Units Consumed in kWh	2,572	162	658
		Electricity Bill Amount	18,065	1,730	5581
2	181010102027	Units Consumed in kWh	5,317	53	993
		Electricity Bill Amount	23,059	167	6748
3	181010101969	Units Consumed in kWh	47	5	36
		Electricity Bill Amount	1,038	10	682
4	181010101985	Units Consumed in kWh	1,000	0	218
		Electricity Bill Amount	10,935	43.89	2655
		Total Average unit consumed in months KWh			**1820**

1.7 Built Up Area –

Sr. No.	Building Name	Area (Sqm)
1.	Science Building	330
2.	Arts Building 1	230
3.	Arts Building 2	345
4.	Commerce Building	414
5.	Women's Hostel	350
	Total	1,669

1.8 Benchmarking:

Now we compute the Electrical Energy Consumed per square feet of the College Building as under

Sr. No	Parameter	Value/Month	Unit
1	Energy Consumed	1819.99	kWh
2	College area	1,669	Sqm
3	**Unit consumed**	**1.10**	**kWh/Sqm**

Chapter II

Connected Load

In this chapter, we present the details of various Electrical loads as under for the different application -

2.1 Study of Floor wise connected load:

I) Commerce Building

Sr. No	Floor	Location	Tube light (40 W)	LED Floodlight (36 W)	LED Tube Light (20 W)	Bulb (9 W)	Fan (100 W)
1	Ground Floor	Classroom 6	4		1		6
2		Passage				3	
3		Classroom 5	4		1		7
4		YCM Office			2		1
5		Office			3	2	7
6		Trust Office			3	1	3
7		Principal office			3		3
8		Ranjan Hall	10			1	
9	First Floor	Exam Office	1				
10		Classroom 8	4				7
11		Classroom 9	5				7
12		Passage	2			1	
13		Classroom 10	7				6
14		Classroom 11	7	2			6
15		Canteen	6				5

II) Science Building

Sr. No	Floor	Location	Ceiling Light (8 W)	LED Tube Light (20 W)	Bulb (9 W)	Fan (100 W)	Flood light (30 W)
1	n d	Meeting Hall	20			8	2

2		Passage	3				
3		Knowledge Center	20			8	
4		Dept. of Math's		1			
5		Passage		1			
6	First Floor	Dept of Botany		1		1	
7		Botany Lab	8			4	
8		Lecture Room 1	8			4	
9		Passage	7				
10		Lecture Room 2	8			4	
11		Physics Lab	8			4	
12		Dept of Physics		1		1	
13		NAAC Cell		1		1	
14	Second Floor	Dept of Zoology		1		1	
15		Zoology Lab	8			4	
16		Lecture Room 3	8			4	
17		Passage	7				
18		Lecture Room 4	8			4	
19		Chemistry Lab	8			4	
20		Dept of Chemistry		1		1	

III) Arts Building

Sr. No	Floor	Location	Tube light (40 W)	LED Tube Light (20 W)	Bulb (9 W)	Fan (100 W)	Floodlight (30 W)	Flood light (18W)
1	Ground Floor	NSS Room	2			1		
2		Staff Room	3			3		
3		Changing Room	1			1		
4		Washroom			1			
5		Washroom			1			
6		Dept of English	4			2		
7		Staff room	5			3		
8		Passage			1			
9	First Floor	Passage					1	
10		Dept of Political Science		1		1		
11		Dept Of Economics	2	1		1		
12	Ground Floor	MA Arts 1	4			2		
13		MA Arts 2	4			2		
14		MA Arts 3	3			2		

15		MA Arts 4	4			2		
16		Passage			2			
17		Gymkhana		2	3		1	
18		Passage						7

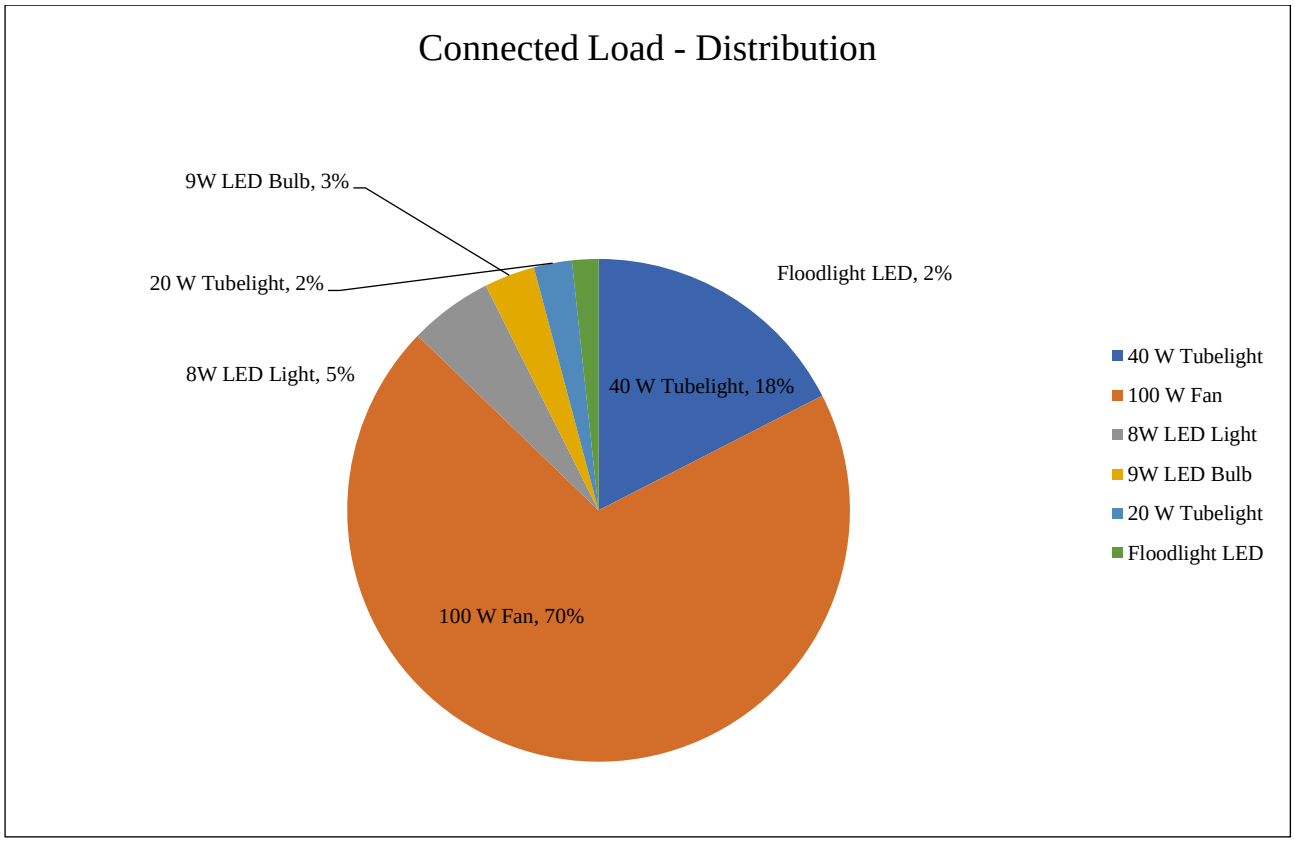
IV) Women's Hostel –

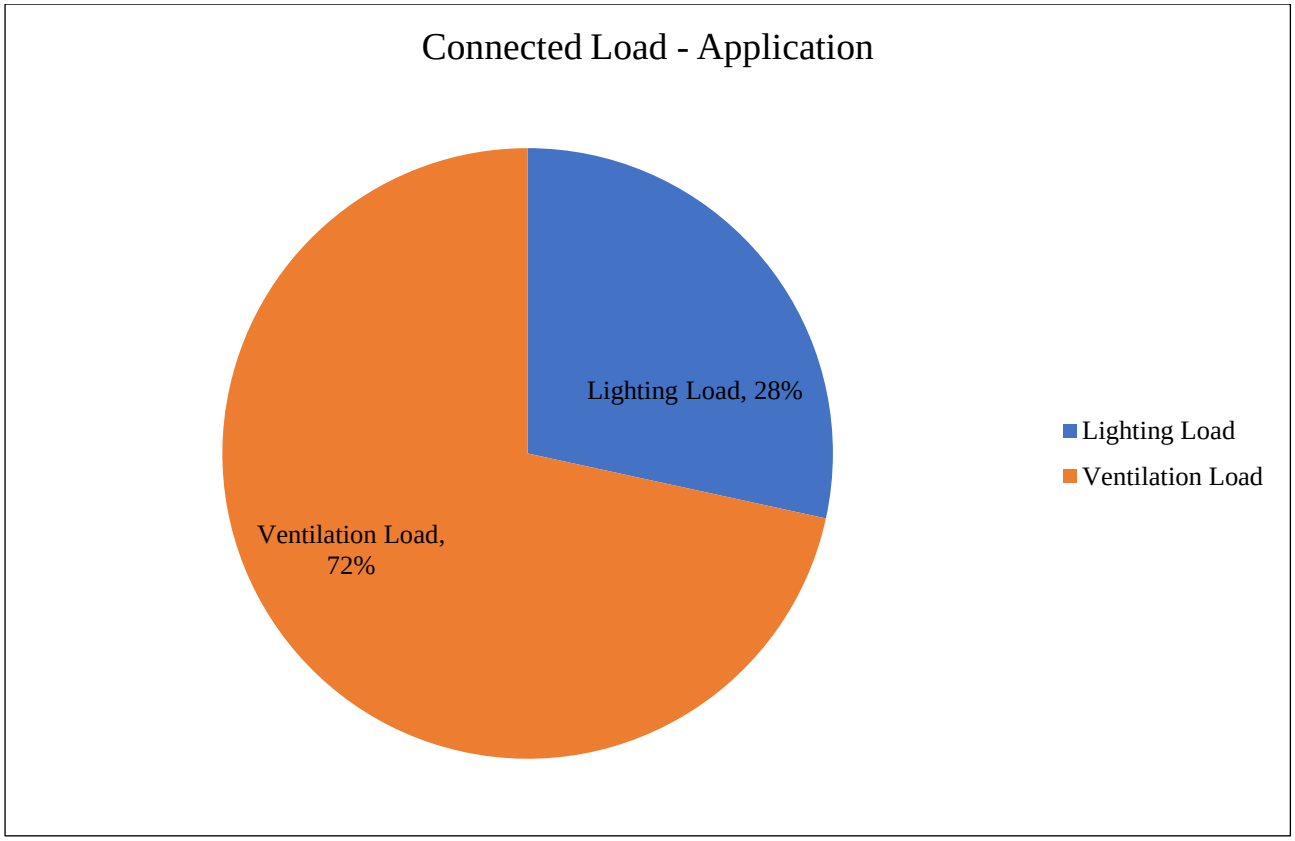
Sr. No	Floor	Location	Ceiling Light (8 W)	LED Tube Light (20 W)	Bulb (9 W)	Fan (100 W)	Flood light (18W)
1	Ground Floor	Passage	4				
2		Visitor Lounge	2				
3		Wardon Room			2		
4		Room No. 12			3		
5		Room No. 13			4		
6		Passage			7		1
7	First Floor	Room No. 14			4		
8		Room No. 15			4		
9		Computer Room			4		
10		Room No. 21			4		
11		Room No. 22			4		
12		Room No. 23			4		
13		Room No. 24			4		
14		Room No. 25			4		
15		Room No. 26			4		

2.2 Study of Fitting wise Connected Load:

No	Type of Fitting	Load/unit	Quantity	Load in kW
1	40 W Tube light	40	82	3.28
2	Fan 100 W	100	131	13.1
3	LED 8 W	8	127	1.01
4	LED 9 W	9	68	0.612
5	20 W Tube light LED	20	23	0.460
6	LED Floodlight	36	8	0.318
Total				**18.78**

PIE Chart for connected Load –





Energy Savings –

2.3.1 Replacement of existing non efficient T-5 tube light of 40 W to 20 W LED tube light

Product Type	Tube lights
Colour	White
Material	Plastic
Wattage	20 W
Lumen	2000 lumens
Description	Includes: LED Tube light, Wattage: 18-22 watts, Straight Linear Design, Warranty: 2 years on product from date of invoice, Input Voltage: AC 90-300 V, 50 Hz, 60 Hz, Long Life Span - Up to 50,000 Hours, Ingress Protection: IP20, Lower consumption and energy saving, No UV radiation and wide operating voltage, Size (mm): 26.5x1200 (L)

Savings Calculation: -

No of Tubes	Wattage of Tube light (W)	Total Operating (Hrs)	No of Days	Energy Consumption (kWh)	Proposed LED (W)	Energy Consumption (kWh)	Savings (kWh)	Cost Savings (Rs)	Investment (Rs)	Payback Period (Months)
82	40	6	300	5,904	20	2,952	2,952	25,416	16,400	8

2.3.2 Replacement of existing fans to efficient brushless Direct current fans

Proposed Fan: BLDC 28 W fan

Description:

Finish	Metallic
Sweep (mm)	1200
Power (W)	28
RPM	360
Air Delivery CMM (m^3/min)	240
Power factor	0.99
Service value (CMM/W)	8.6
MRP	2800

Savings Calculation:

No of Existing Fans	Wattage of Fan (W)	Total Operating (Hr)	No of Days	Energy Consumption (kWh)	BLDC Fan (W)	Energy Consumption (kWh)	Savings (kWh)	Cost Savings (Rs)	Investment (Rs)	Payback Period (Months)
131	100	6	90	7,074	28	1,981	5,093	45,850	3,27,500	86

Saving Summary:

Sr.No.	Parameter	Energy Savings (kWh)	Cost saving (Rs.)	Investment (Rs.)	Payback period (Months)
1.	Replacement of T-5 Tube light 40 W to LED 20 W	3,936	17,712	16,400	12
2.	Replacement of 100W Fan to 28 W BLDC Fan	5,093	45,850	3,27,500	86
	Total	9,029	63,562	3,43,900	65

Chapter III
Carbon Foot printing

A Carbon Foot print is defined as the Total Greenhouse Gas emissions, emitted due to various activities. In this we compute the emissions of Carbon-Di-Oxide, by usage of the various forms of Energy used by the College for performing its day-to-day activities. The college uses electrical energy for operating various electrical gadgets.

3.1 Basis for computation of CO2 Emissions:

The basis of Calculation for CO2 emissions due to Electrical Energy are as under 1 Unit (kWh) of Electrical Energy releases **0.8 Kg of CO2** into atmosphere

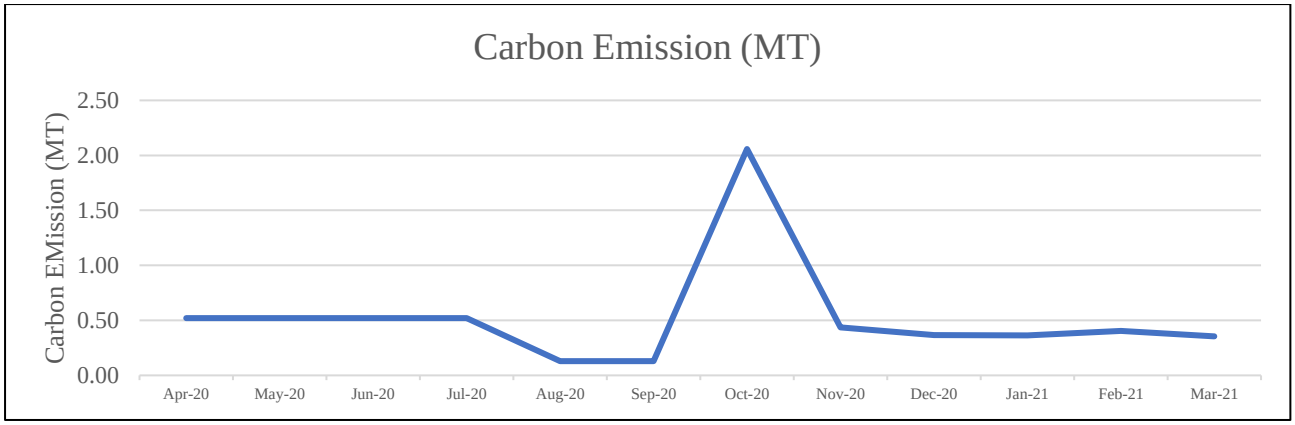
Based on the above Data we compute the CO2 emissions which are being released in to the atmosphere by the College due to its Day-to-Day operations.

3.2. Month wise Consumption of Electrical Energy:

We herewith furnish the details of electrical Energy consumption consumer number wise as under –

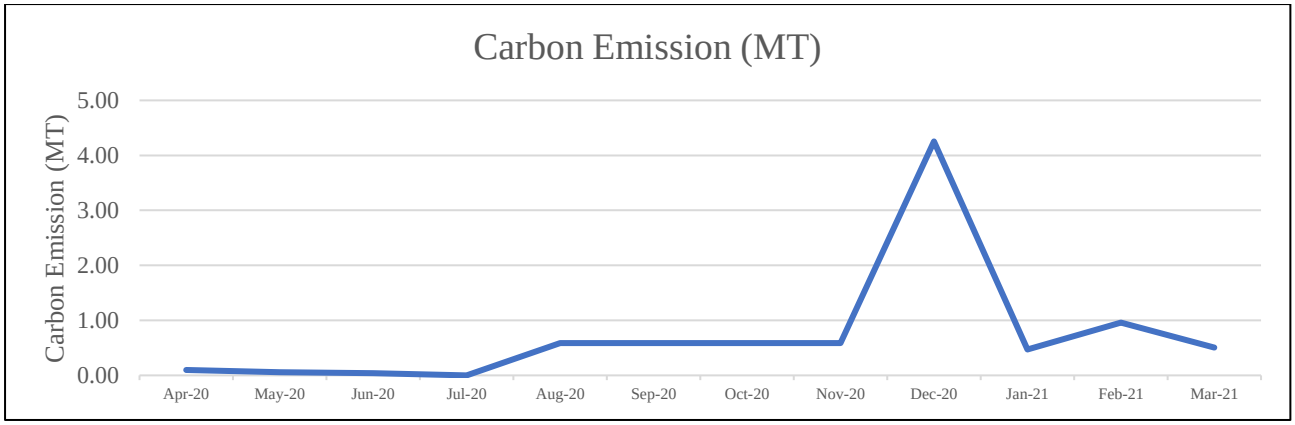
1. **Month wise CO2 Emissions: 181010038639**

Sr. No.	Month	Energy Consumption (kWh)	Carbon Emission (MT)
1	Apr-20	650	0.52
2	May-20	650	0.52
3	Jun-20	650	0.52
4	Jul-20	650	0.52
5	Aug-20	162	0.13
6	Sep-20	162	0.13
7	Oct-20	2,572	2.06
8	Nov-20	546	0.44
9	Dec-20	458	0.37
10	Jan-21	453	0.36
11	Feb-21	505	0.40
12	Mar-21	443	0.35
	Total	7,901	6.32
	Average	658	0.53
	Max	2,572	2.06
	Min	162	0.13



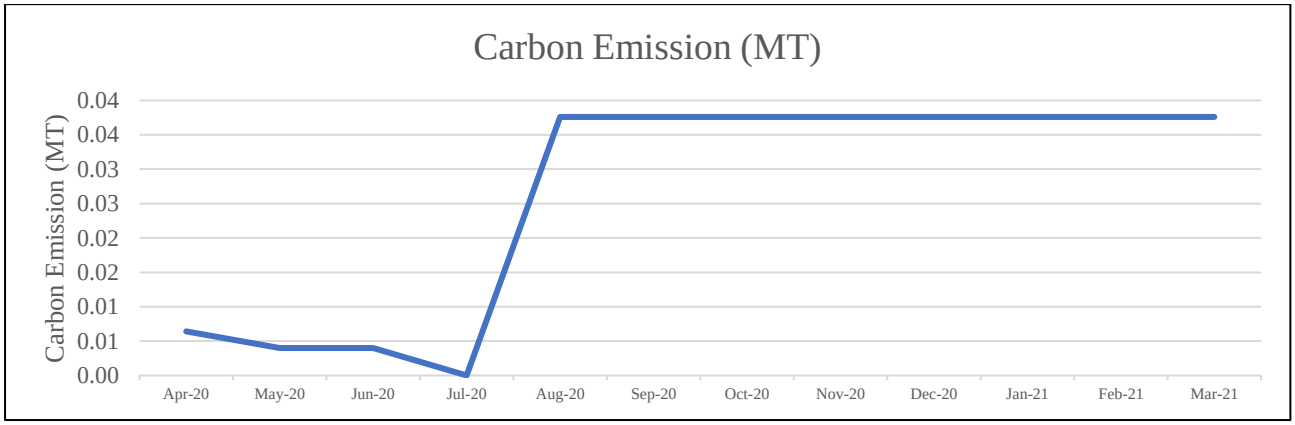
2. Month wise CO2 Emissions: 181010102027

Sr. No	Month	Energy Consumption (kWh)	Carbon Emission (MT)
1	Apr-20	125	0.10
2	May-20	73	0.06
3	Jun-20	53	0.04
4	Jul-20	0	0.00
5	Aug-20	733	0.59
6	Sep-20	733	0.59
7	Oct-20	733	0.59
8	Nov-20	733	0.59
9	Dec-20	5,317	4.25
10	Jan-21	590	0.47
11	Feb-21	1,201	0.96
12	Mar-21	634	0.51
	Total	10,925	8.74
	Average	910	0.73
	Max	5,317	4.25
	Min	0	0.00



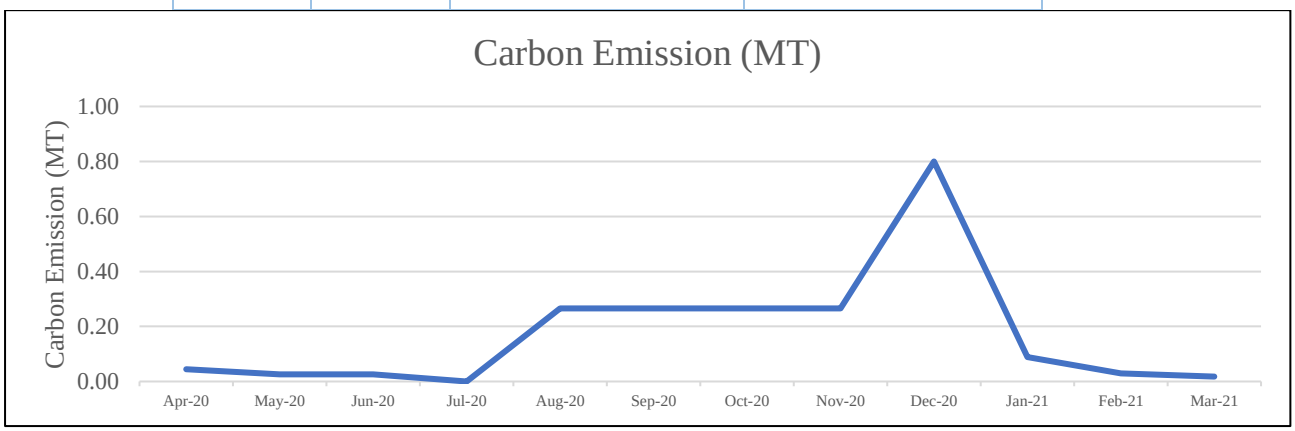
3. Month wise CO2 Emissions: 181010101985

Sr. No	Month	Energy Consumption (kWh)	Carbon Emission (MT)
1	Apr-20	8	0.01
2	May-20	5	0.00
3	Jun-20	5	0.00
4	Jul-20	0	0.00
5	Aug-20	47	0.04
6	Sep-20	47	0.04
7	Oct-20	47	0.04
8	Nov-20	47	0.04
9	Dec-20	47	0.04
10	Jan-21	47	0.04
11	Feb-21	47	0.04
12	Mar-21	47	0.04
	Total	394	0.32
	Average	33	0.03
	Max	47	0.04
	Min	0	0.00



4. Month wise CO2 Emissions: 181010101969

Sr. No	Month	Energy Consumption (kWh)	Carbon Emission (MT)
1	Apr-20	56	0.04
2	May-20	33	0.03
3	Jun-20	33	0.03
4	Jul-20	0	0.00
5	Aug-20	332	0.27
6	Sep-20	332	0.27
7	Oct-20	332	0.27
8	Nov-20	332	0.27
9	Dec-20	1000	0.80
10	Jan-21	111	0.09
11	Feb-21	37	0.03
12	Mar-21	22	0.02
	Total	2,620	2.10
	Average	218	0.17
	Max	1,000	0.80
	Min	0	0.00



3.6 Benchmarking:

Now we compute the CO2 emissions per Sq. ft basis as under:

Sr. No	Parameter	Value	Unit
1	CO_2 emissions	17.47	MT/annum
2	College area	17965	Sq ft
3	**CO_2 Emission Benchmark**	0.972	**Kg of CO2/Sq. ft**

Chapter – IV

GREEN AUDIT for the AY-2020-21

Dr. B. N. Purandare Arts & Smt. S. G Gupta Commerce & Smt. S.A. Mithaiwala Science College Lonavala is one the leading higher education Institutes in Lonavala, district Pune. It has been providing quality education to the students of Lonavala and premises. The college is spread over of 10 acres campus. It is also a college of highly greenery Maintenance College in Lonavala, Dist. Pune. They have a beautiful green campus very close to a Valvan Dam. We have prepared a green audit report after visiting the college campus by our team. This green audit report is based on the following major points.

1. Plantation in the campus
2. Energy audit and power savings
3. Carbon accounting
4. Use of Renewable energy options for saving the environment
5. Water audit
6. Waste disposal

1. Plantation in the campus

Plantation is playing very important role in the green audit and helping to save environment from damage. The campus plantation is very diverse and well maintained. After a daylong survey and records about the plantation in the campus is prepared which is per following table.

Sr. No	Local Name	Botanical Name	Quantity
1.	Umbar	Ficus Racemosa	1
2.	Ashoka	Polyalthia Longifolia	7
3.	Jambhul	Syzygium Cumini	4
4.	Oil Palm	Elaeis Oleifera	22
5.	Nilgiri	Eucalyptus	1
6.	Vad	Ficus Benghalensis	1
7.	Bauhinia Variegata	Bauhinia Variegata	1
8.	Casuarina Equisetifolia	Casuarina Equisetifolia	4
9.	Delonix Regia	Delonix Regia	1
10.	Saraca Indica	Saraca Indica	1

11.	Casia SP	Casia SP	5
12.	Bottle Palm	Bottle Palm	11
13	Cadamba	Neolamarckia Cadamba	3
14	Adulsa	Adhatoda Vasica	4
15	Shevga	Moringa Oleifera	1
16	Putrajivi	Putranjiva Roxburghii	1
17	Sanvari	Bombax Ceiba	1
18	Peltophorum Pterocarpum	Peltophorum Pterocarpum	2
19	Giripushpa1	Gliricidia	1
20	Amba	Mangifera Indica	1
21	Padal	Stereospermum	5
22	Naral	Cocus Nucifera	1
23	Nirgundi	Vitex Sp	5
24	Acatia Molegilifarmis	Acatia Molegilifarmis	2
25	Papai	Papaya	1
26	Pandhara Shirish	Albizia Procera	2
27	Ixora Coccinea	Ixora Coccinea	5

4.1 CALCULATION OF AMOUNT OF CO2 SEQUESTERED IN TREES PER YEAR

The carbon sequestration potential of the plant species present in green belt has been estimated and suitable plant with maximum sequestration of CO2 was recommended. Carbon sequestration is nothing but capturing atmospheric carbon dioxide or anthropogenic CO2 from large scale stationary sources like cement industry before it is released to the atmosphere. Once captured, the CO2 gas is put into long term storage. CO2 sequestration in plants has the potential to significantly reduce the level of carbon that occurs in the atmosphere. Terrestrial or biologic sequestration means using plants to capture CO2 from the atmosphere and then storing it as carbon in the stems and roots of the plants as well as in the soil. The green belts in industrial area acts as sink for capturing and storing carbon dioxide released from the industries.

Assessment of carbon sequestration ability of trees for adopting in greenbelt of cement industries

The carbon dioxide sequestered in plant species are determined based on following method:

1. Determine the total (green) weight of the tree
2. Determine the dry weight of the tree

3. Determine the weight of carbon in the tree
4. Determine the weight of carbon dioxide sequestered in the tree
5. Determine the weight of CO2 sequestered in the tree per year

4.2 Determination of Total (Green) Weight of the Tree

The algorithm to calculate the weight of a tree is:
For trees with D < 11: W = 0.25D2H
For trees with D >= 11: W = 0.15D2H
Where, W = Above-ground weight of the tree in pounds
D = Diameter of the trunk in inches
H = Height of the tree in feet
Depending on the species, the coefficient (e.g., 0.25) could change and the variables D2 and H could be raised to exponents just above or below 1. However, these two equations could be seen as an ―average‖ of all the species' equations. The root system weighs about 20% as much as the above-ground weight of the tree. Therefore, to determine the total green weight of the tree, multiply the above-ground weight of the tree by 120%.

4.3 Determination of Dry Weight of the Tree

Taking all species in into account, the average tree is 72.5% dry matter and 27.5% moisture. Therefore, to determine the dry weight of the tree, multiply the weight of the tree by 72.5%.

4.4 Determine the weight of carbon in the tree

The average carbon content is generally 50% of the tree's total volume. Therefore, to determine the weight of carbon in the tree, multiply the dry weight of the tree by 50%.

Determine the weight of carbon dioxide sequestered in the tree –

CO2 is composed of one molecule of Carbon and 2 molecules of Oxygen.
The atomic weight of Carbon is 12.001115.
The atomic weight of Oxygen is 15.9994.
The weight of CO2 is C+2*O=43.999915

The ratio of CO2 to C is 43.999915/12.001115=3.6663.
Therefore, to determine the weight of carbon dioxide sequestered in the tree, multiply the weight of carbon in the tree by 3.6663. Determine the weight of CO2 sequestered in the tree per year.
Divided the weight of carbon dioxide sequestered in the tree by the age of the tree.

Sample Measurements –

Sr.No.	Name of tree	Circumference	Diameter (inch)	Height (Feet)	Weight of tree	Dry weight of tree	Carbon content	CO2 Sequestration
1	Umbar	840	11	49	819	614.1	307	1125
2	Vad	1080	14	49	1354	1015.2	508	1859
3	Jambhul	1250	16	49	1813	1359.9	680	2491
4	Amba	840	11	49	819	614.1	307	1125
5	Nirgundi	1050	13	49	1279	959.6	480	1757
6	Jambhul	1140	14	49	1508	1131.1	566	2072
7	Nilgiri	800	10	49	743	557.0	279	1020
8	Jambhul	1150	14	49	1535	1151.1	576	2108

9	Nilgiri	1200	15	49	1671	1253.3	627	2295
10	Cadamba	900	11	49	940	705.0	352	1291
							Total	17144

Existing Plantation in college –

Chapter V

Water Layout

College has multiple buildings and tanks for water usage. Staff, students and other persons in the campus are roughly 1000 nos. This in total varies with considering current condition. Roughly a 20 litres /person is daily usage of water per day. College has a source of raw water from municipal corporation from two supplies at different locations.

Water flow –

Supply from Municipal Corporation Tap water goes into the storage tank of different buildings and then it is being distributed by means of gravity to different Locations. This storage tank is at high elevation so there is no need of any additional pumping requirement.

Various tanks in college premises –

Sr. No.	Tank Name	Capacity (Litres)
1.	Arts College Storage Tank	2,500
2.	Gents & Ladies Washroom Tank	5,000
3.	Junior Staff Room Tank	1,000
4.	Women's Hostel	10,000
5.	YCM Vice Principal Office & Admin Tank	5,000
6.	Principal Office & Trust Office	2,000
	Total	25,500

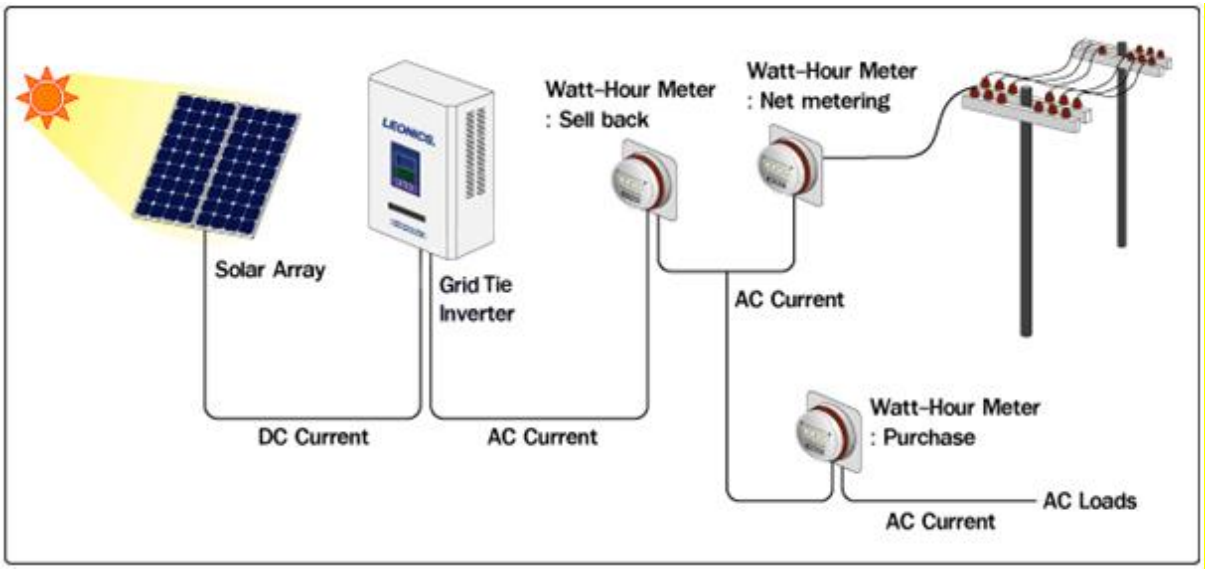
Daily water consumption is supplied by the municipal corporation, in rainy season there is tremendous rainfall due to surrounding nature. This supply is mainly from two main connections of municipal corporation.

Chapter VI

Rooftop Solar PV

The college Should opt for rooftop solar photovoltaics plant. This is a clean and green source of energy that can be directly utilised as a substitute to the Grid Power. In this section we shall be seeing the benefits and proposal for Solar PV system – On Grid Type

In this system, there is no battery backup required, the energy generated is directly utilised by the load and the excess units are fed back into the grid with a net meter. At the end of the month the difference of the two will be your actual billed units. This system is more cost effective than a Battery type/ Islanding type/ Solar PV off grid system.



Benefits of solar: -

- Electricity produced by solar cells is clean and silent. Because they do not use fuel other than sunshine, PV systems do not release any harmful air or water pollution into the environment, deplete natural resources, or endanger animal or human health.
- Photovoltaic systems are quiet and visually unobtrusive.
- Small-scale solar plants can take advantage of unused space on rooftops of existing buildings.
- Solar energy is a locally available renewable resource. It does not need to be imported from other regions of the country or across the world. This reduces environmental impacts associated with transportation and also reduces our dependence on imported oil. And, unlike fuels that are mined and harvested, when we use solar energy to produce electricity we do not deplete or alter the resource.

Total solar PV capacity that can be connected on roof is 15 kW depending on actual space available on the roof of science building which is facing south direction. Area available on roof is 165 sqm for solar installation.

Considering 15 kW System-

- Units generated per day = 76 kWh
- Annual Generation Possible = 27,813 kWh
- Area required = 165 sqm
- Saving = 2,21,113 INR per year
- Investment = 9,00,000 INR plus taxes
- Depreciation applicable
- Possible Payback – 4.07 yrs.

Note: - Figures mentioned here are based on thumb rule, Quotation will be given that will cover the necessary details on request.
According to peak, Shine hours and global irradiance available at location = 5.08 kWh/kWp Generation Considered

Solar Payback & estimated generation

Year	Energy kWh/Anum	Energy (kWh) rate	Cost saving
1	27,813	₹ 7.93	₹ 2,20,557
2	27,535	₹ 8.09	₹ 2,22,719
3	27,260	₹ 8.25	₹ 2,24,901
4	26,987	₹ 8.42	₹ 2,27,105
5	26,717	₹ 8.58	₹ 2,29,331
6	26,450	₹ 8.76	₹ 2,31,578
7	26,185	₹ 8.93	₹ 2,33,848
8	25,924	₹ 9.11	₹ 2,36,139
9	25,664	₹ 9.29	₹ 2,38,454
10	25,408	₹ 9.48	₹ 2,40,790
11	25,154	₹ 9.67	₹ 2,43,150
12	24,902	₹ 9.86	₹ 2,45,533
13	24,653	₹ 10.06	₹ 2,47,939
14	24,406	₹ 10.26	₹ 2,50,369
15	24,162	₹ 10.46	₹ 2,52,823
16	23,921	₹ 10.67	₹ 2,55,300
17	23,682	₹ 10.89	₹ 2,57,802
18	23,445	₹ 11.10	₹ 2,60,329
19	23,210	₹ 11.33	₹ 2,62,880
20	22,978	₹ 11.55	₹ 2,65,456
21	22,748	₹ 11.78	₹ 2,68,058
22	22,521	₹ 12.02	₹ 2,70,685
23	22,296	₹ 12.26	₹ 2,73,337
24	22,073	₹ 12.50	₹ 2,76,016
25	21,852	₹ 12.75	₹ 2,78,721
Total	6,17,945		₹ 62,13,822

- *Note Considering 1% Degradation of Solar Panels and System per annum*

  2% increase considered in Electricity cost per annum

Saving Summary:

Sr.No.	Parameter	Energy Savings (kWh)	Cost saving (Rs.)	Investment (Rs.)	Payback period (Months)
1.	Installation of rooftop Solar PV	27,813	2,20,557	9,00,000	48

Chapter VII

Waste Disposal and Vermi- Composting

Vermiculture Composting Culture –

Vermicomposting is basically a managed process of worms digesting organic matter to transform the material into a beneficial soil amendment. The institute has been started Vermi culture composting culture in house on 30 Sq. meter land. The main purpose of this is to reduce disposable waste in the college campus and after complete process of Vermi composting it is used as manure for plantation and greenery in the campus. It is also used for the demonstration and awareness in farmers to implement organic farming and its importance.

The main benefits of the process are to reduce the waste in the environment and utilized for some useful purpose and also it is cost savings process.

The earthworms being voracious eaters consume the biodegradable matter and give out a part of the matter as excreta or Vermi-castings. The Vermi-casting containing nutrients is a rich manure for the plants. Vermicompost, apart from supplying nutrients and growth enhancing hormones to plants, improves the soil structure leading to increase in water and nutrient holding capacities of soil. Fruits, flowers and vegetables and other plant products grown using vermicompost are reported to have better keeping quality. A growing number of individuals and institutions are taking interest in the production.

Process:

The process of composting crop residues / Agri wastes using earthworms comprise spreading the agricultural wastes and cow dung in gradually built-up shallow layers. The pits are kept shallow to avoid heat built-up that could kill earthworms. To enable earthworms to transform the material relatively faster a temperature of around 300C is maintained. The final product generated by this process is called vermicompost which essentially consist of the casts made by earthworms eating the raw organic materials. The process consists of constructing brick lined beds generally of 0.9 to 1.5 m width and 0.25 to 0.3 m height are constructed inside a shed open from all sides. For commercial production, the beds can be prepared with 15 m length, 1.5 m width and 0.6 m height spread equally below and above the ground. While the length of the beds can be made as per convenience, the width and height cannot be increased as an increased width affects the ease of operation and an increased height on conversion rate due to heat built up. Cow dung and farm waste can be placed in layers to make a heap of about 0.6 to 0.9 m height. Earthworms are introduced in between the layers @ 350 worms per m3 of bed volume that weighs nearly 1 Kg. The beds are maintained at about 40-50% moisture content and a temperature of 20–300 C by sprinkling water over the beds. When the commercial scale production is aimed at, in addition to the cost of production, considerable amount has to be invested initially on capital items. The capital cost may work out to about Rs. 5000 to 6000 for every tonne of vermicompost production capacity. The high unit capital cost is due to the fact that large units require considerable expenditure on preparation of Vermi beds, shed to provide shelter to these beds and machinery. However, these expenditures are incurred only once. Under the operational cost, transportation of raw materials as also the finished product are the key activities. When the source organic wastes and dung are away from the production facility and the finished product requires transportation to far off places before being marketed, the operational cost would increase.

However, in most of the cases, the activity is viable and bankable. Following are the items required to be considered while setting up a unit for production of Vermi-compost.

Components of a Commercial Unit –

Commercial units have to be developed based on availability of cow dung locally. If some big dairy is functioning then such unit will be an associated activity.

Commercial units must not be designed based on imported cow dung.

1. Sheds

For a Vermi-composting unit, whether small or big, this is an essential item and is required for securing the Vermi beds. They could be of attached roof supported by bamboo rafters or steel trusses. Locally available roofing materials or HDPE sheet may also be used in roofing to keep the capital investment at reasonably lower level. If the size is so chosen as to prevent wetting of beds due to rain on a windy day, they could be open sheds. While designing the sheds adequate room/pathways has to be left around the beds for easy movement of the labourers attending to the filling and harvesting the beds.

2. Vermi-beds

Normally the beds have 0.3 to 0.6 m height depending on the provision for drainage of excess water. Care should be taken to make the bed with uniform height over the entire width to avoid low production owing to low bed volumes. The bed width should not be more that 1.5 m to allow
easy access to the centre of the bed.

3. **Fencing and Roads/Paths**

The site area needs development for construction of structures and development of roads and pathways for easy movement of hand-drawn trolleys/wheel barrows for conveying the raw material and
the finished products to and from the Vermisheds. The entire area has to be fenced to prevent trespass by animals and other unwanted elements. These could be estimated based on the length of the periphery of the farm and the length and type of roads/paths required. The costs on fencing and formation of roads should be kept low as these investments are essential for a production unit, yet would not lead to increase in production.

4**. Water Supply System**

As the beds have to be kept moist always with about 50% moisture content, there is a need to plan fora water source, lifting mechanism and a system of conveying and applying the water to the Vermi-beds. Drippers with round the clock flow arrangement would be quite handy for continuous supply and saving on water. Such a water supply system requires considerable initial investment. However, it reduces the operational cost on hand watering and proves economical in the long run. The cost of these items would depend on the capacity of the unit and the type of water supply chosen.

5. Transportation

For any Vermi-composting unit transport arrangement is a must. When the source of raw material is away from the production unit, an off-site transport becomes major item of investment. A large sized unit with about 1000 tonnes per annum capacity may require a three-tonne capacity mini-truck. With small units particularly with the availability of raw material near the site, expending on transport facility may become infructuous. On-site transport facilities like manually drawn trolleys to convey raw material and finished products

between the storage point and the Vermi-compost sheds could also be included in the project cost.

Existing Waste disposal – As observed there is dig in campus in which this Vermi-composting protect can be done**.** By following all above mentioned process we can reduce disposable waste in the college campus and after complete process of Vermi composting it is used as manure for plantation and greenery in the campus. It is also used for the demonstration and awareness in farmers to implement organic farming and its importance.
But there needs to be separation of wastes like organic waste, plastic waste and paper waste.

Existing waste disposal bed

Chapter – VIII

Vendor List

1. APFC panels & LT panels –
   Enertek Solutions India Private Limited
   Mr. Anand Dande - +91 9766043482

2. BLDC fans
   Enertek Solutions India Pvt. Ltd.
   Mr. Harshad Batule - +91 9421053996

3. Energy Efficient lights
   Enertek Solutions India Pvt. Ltd.
   Mr. Harshad Batule - +91 9421053996

4. Pumping System –
   Enertek Solutions India Private Limited
   Mr. Anand Dande – +91 9766043482

5. Solar Water Heater System
   Constro-Enegry solutions LLP
   Mr. Deepak Babar – +91 9850033677

6. Solar PV System
   Enertek Solutions India Private Limited
   Mr. Harshad Batule - +919421053996

7. Paper waste management
   Mr. Onkar Dahiwal - +91 7276372701