Shri Shivaji Education Society Amravati's

SCIENCE COLLEGE

Congress Nagar, Nagpur-440012

Energy

AUDIT REPORT

2019-2024

Prepared by

Nutan Urja Solutions
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Report On

Energy Audit

At

Shri Shivaji Education Society Amravati's

Science College,

Nagpur

(Year 2023-24)

Prepared by

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Contents

Acknowledgement

We at Nutan Urja Solutions, Pune, express our sincere gratitude to the management of Shri Shivaji Education Society Amravati's Science College, Nagpur for awarding us the assignment of Energy Audit of their college premises.

We are also thankful to various Head of Departments & other Staff members for helping us during the field measurements.

We hope that the recommendations stated in this report will be useful and worthy of discussions to take things forward to help implementation of energy conservation measures through energy savings. While we have made every attempt to adhere to high quality standards, in both data collection and analysis through the report, we would welcome your suggestions so as to improve upon this report further.

Executive Summary

After the Field measurements & analysis, we present herewith important observations made and various measures to reduce the Energy Consumption & mitigate the CO_2 emissions. College consumes Energy in the form of Electrical Energy used for various gadgets, Office & other facilities.

1. Present Energy Consumption

In the following Table, we present the details of Energy Consumption.

Table no 2.1: Details of energy consumption

Sr no	Parameter	Energy consumed, (kWh)	CO2 Emission (MT)
1	Maximum	569	0.46
2	Minimum	164	0.13
3	Average	236	0.19
4	Total	2,829	2.26

2. Energy Conservation Projects already installed

1. Usage of STAR Rated ACs at new installations
2. Usage of LED lights at some indoor locations
3. Usage of LED Lights for outdoor lighting.

3. Key Observations

1. Usage of LED lights.
2. Usage of star rated equipment.
3. Maintained a good power factor.

4. Percentage of Usage of Alternate Energy

The College has installed a Roof Top Solar PV Plant. The percentage of usage of Alternate Energy to Annual Energy Requirement is 97 %.

5. Percentage of Usage of LED Lighting

The College has various Types of Light fittings. The percentage of Annual LED Lighting Usage to Annual Lighting requirement works out to be 62 %.

6. Recommendations

Table no 1: Recommendations for energy savings

No	Recommendation	Annual Saving potential, kWh/Annum	Annual Monetary Gain, Rs.	Investment Required, Rs.	Payback period, Months
1	Replacement of 92 Nos T-8 fittings with 20W LED fittings	1,840	20,240	58,972	35
2	Replacement of 411 Nos Old Ceiling Fans with STAR rating fans	20,550	2,26,050	8,93,514	47
	Total	22,390	2,46,290	9,52,486	46

7 Notes & Assumptions

1. Daily working hours-10 Nos
2. Annual working Days-300 Nos
3. Average Rate of Electrical Energy : **Rs 11/- per kWh**

Abbreviations

CFL	:	Compact Fluorescent Lamp
FTL	:	Fluorescent Tube Light
LED	:	Light Emitting Diode
V	:	Voltage
I	:	Current
kW	:	Kilo- Watt
kWh	:	kilo-Watt Hour
kVA	:	Active Power

1. Introduction

Shri Shivaji Education Society Amravati's Science College is located in Nagpur. With its competent galaxy of faculty members, the college has been rendering sincere services in the field of higher education since 1967. This is a single faculty college degree level and offers PG courses with recognized centers of Higher Learning and Research in Microbiology, Chemistry, Computer Science, Physics and Mathematics.

1.1 Objectives

1. To study present level of Energy Consumption
2. To Study Electrical Consumption
3. To assess the various equipment/facilities from Energy efficiency aspect
4. To study various measures to reduce the Energy Consumption

1.2 Audit Methodology:

1. Study of connected load
2. Study of various Electrical parameters
3. To prepare the Report with various Encon measures with payback analysis

1.3 General Details of College

Table No-1.1: Details of college

No	Head	Particulars
1	Name of Institution	Shri Shivaji Education Society Amravati's Science College, Nagpur
2	Address	Shri Shivaji Education Society Amravati's Science College, Nagpur, Congress Nagar, Nagpur
3	Affiliation	R. T. M. Nagpur University, Nagpur

2. Study of connected load

In this chapter, we present details of various connected electrical equipment and electrical load.

Table No-2.1: Location wise study of Electrical fittings in various buildings

No	Location	FTL (40W)	CFL	LED tube (20W)	LED bulb (12W)	Computers (65W)	Fans	1.5 Tr Star rated AC
1	Office		14	2		11	9	
2	Cabin			1	8	2	4	1
3	Meeting Hall		30		2		6	3
4	Cabin Porch				3		2	
5	Porch			1	5			
6	Exam Room			2			1	
7	Store Room	1		1				
8	Micro Biology	12		18		4	15	3
9	Biotech	9	52	5		4	17	3
10	Zoology			20		3	11	
11	Statistics	4		2	8	2	12	
12	Jr. Electronics	5		4		3	9	1
13	Electronics	11		2			9	1
14	Mathematics	2		1	6	5	4	1
15	B 1	3		1			4	
16	Physical Dept.	2		5		1	2	
17	Jr. Chemistry	2		4			4	
18	English Dept.	1	1	2	6	6	6	1
19	Computer Dept.	1		66	3	132	14	16
20	Research Lab				4	9		1
21	B 2			1			4	
22	B 3	1					4	
23	B 4	1					2	

24	Jr. Physics			3			5	
25	Jr. Biology			3			4	
26	Fisheries Jr.	1		1			2	
27	3rd Floor Pasage	3	1	4				
28	B 7	2					4	
29	B 6	1					4	
30	B 9	4		3			9	
31	BCA		28		360	51	8	4
32	BCA Lab 2					29	7	3
33	B 12				11		7	
34	B 13	1		3			5	
35	Conference Hall							
36	B Block Stairs			8				
37	B Block Bath		6					
38	B Block Pasage				72		2	
39	B Block Porch			4			4	
40	301 to 313		14	15			14	
41	201 to 212			20			20	
42	101to 119			20			20	
43	Mess	3	7	3			8	
44	Warden Room			5		1	5	
45	Guest House		4	4	8		6	3
46	Gym	8					7	
47	Hostel Porch & Stairs		32	2			1	
48	First Floor Bath	2	10					
49	Second Floor Bath	2	14					
50	Botany			6		3	5	1
51	Botany PG Lab			4			4	
52	Botany Laboratory			10			6	
53	Chemistry			56		7	30	1
54	Library	2			104	37	40	
55	IQAC	1		2		2	2	1

56	Guard Room			1			1	
57	College Parking	5						
58	Jr. Office	2				2	2	1
59	Physics Dept.			43		18	40	1
	Total	**92**	**213**	**358**	**600**	**332**	**411**	**46**

Apart from above load, the college has pumps, street lights. Individual fitting wise load is as under.

Table No 2.2: Equipment wise Connected Load

No	Equipment	Qty	Load, W/Unit	Load, kW
1	F T L-40 W	92	40	3.7
2	CFL	213	24	5.1
3	LED Tube-20W	358	20	7.2
4	LED bulb	600	12	7.2
5	Computers	332	65	21.6
6	Ceiling Fan	411	65	26.7
7	AC (1.5Tr)	46	1838	84.5
8	LED focus Street light	4	35	0.1
9	Pumps (2 nos 2HP)			3.0
	Total			**114.4**

Data can be represented in terms of PIE chart as under,

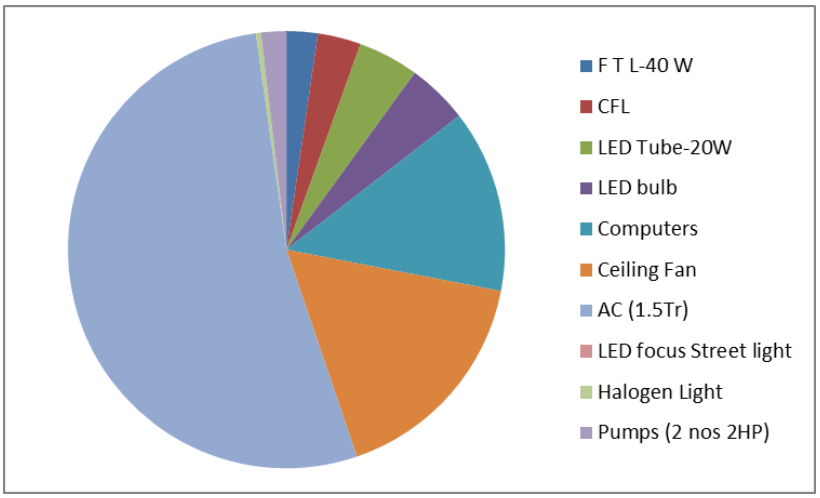

Figure 2.1: Distribution of connected load.

3. Study of Electrical Energy Consumption

In this chapter, electricity bills are studied for the analysis of electrical energy consumption.

Table no 3.1: Summary of electricity bills

No	Month	Energy (kWh)	Bill Amount (Rs)
1	Jun-24	216	24408
2	May-24	242	27346
3	Apr-24	248	28010
4	Mar-24	236	27789
5	Feb-24	181	26703
6	Jan-24	173	26528
7	Dec-23	181	26331
8	Nov-23	164	26895
9	Oct-23	193	34515
10	Sep-23	569	27786
11	Aug-23	248	26486
12	Jul-23	178	26747
	Total	**2,829**	**3,29,544**

Variation in energy consumption is as follows,

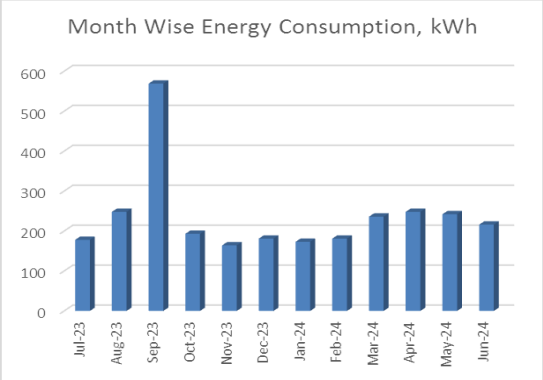

Figure 3.1: Month wise energy consumption

Monthly variation in electricity bill is as follows,

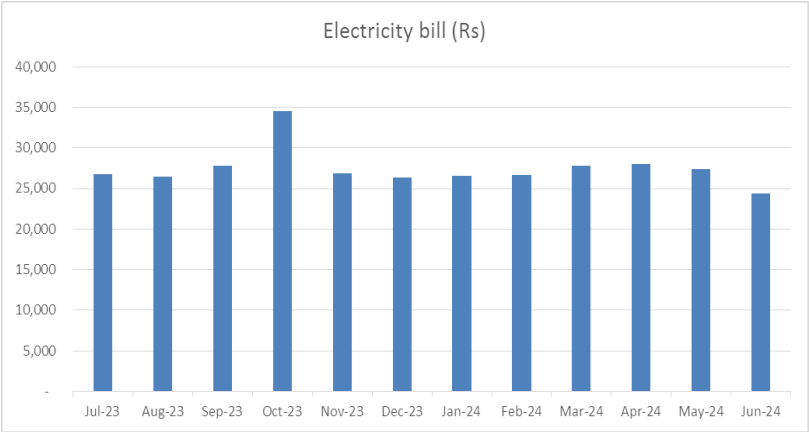

Figure 3.2: Month wise electricity bill

Key observations of electricity bill are as follows,

Table no 3.2: Key observations

Sr no	Parameter	Energy consumed, (kWh)	CO2 Emission (MT)
1	Maximum	569	0.46
2	Minimum	164	0.13
3	Average	236	0.19
4	Total	2,829	2.26

4. Carbon Foot printing

1. A Carbon Foot print is defined as the Total Greenhouse Gas emissions (CO_2 emissions), emitted due to various activities. In this we compute the emissions of Carbon-Di-Oxide, by usage of the various form of Electrical Energy used by the College for performing its day to day activities

2. Basis for computation of CO_2 Emissions:

The basis of Calculation for CO_2 emissions due to Electrical Energy is as under

- 1 Unit (kWh) of Electrical Energy releases **0.8 Kg of CO_2** into atmosphere.

Based on the above Data we compute the CO_2 emissions which are being released in to the atmosphere by the College due to its Day to Day operations

We herewith furnish the details of various forms of Energy consumption as under

Table 4.1: Month wise Consumption of Electrical Energy & CO2 Emissions

No	Month	Energy Consumed, kWh	CO2 Emissions, MT
1	Jun-24	216	0.17
2	May-24	242	0.19
3	Apr-24	248	0.20
4	Mar-24	236	0.19
5	Feb-24	181	0.14
6	Jan-24	173	0.14
7	Dec-23	181	0.14
8	Nov-23	164	0.13
9	Oct-23	193	0.15
10	Sep-23	569	0.46
11	Aug-23	248	0.20
12	Jul-23	178	0.14
	Total	**2,829**	**2.26**

In the following Chart we present the CO2 emissions due to usage of Electrical Energy.

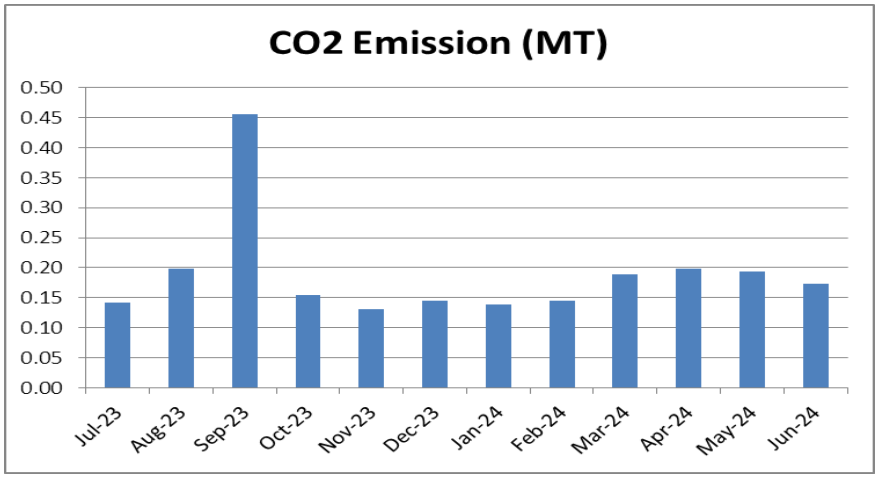

Figure 4.1: Month wise CO2 Emission

5. Study of utilities

5.1 Study of Lighting

In the facility, the lighting system can be divided mainly in to parts, indoor lighting and outdoor lighting. There are 92 FTL fittings with Electronic/ magnetic chokes , 213 nos of CFLs, 358 nos of LED tubes, 600 nos of LED bulbs. It is recommended to install the 20 W LED Tube light fittings in place of these old T-8 fittings.

5.2 Air-conditioners

In the facility, there are about 46 Nos. of 1.5 Tr Air-conditioners.

5.3 Ceiling Fans

At building facility, there are about 411 Nos Old Ceiling Fans, which consumed about 65 W of Electrical Energy. It is recommended to replace these old Fans with BEE STAR Rated Ceiling Fans.

5.4 Water Pumps

There are in total Water pumps with 2HP and21HP capacities respectively.

6. Study of usage of alternate energy

In this Chapter, we compute the percentage of Usage of Alternate/Renewable Energy to Annual Energy Requirement of the College. The College has installed Roof Top Solar PV System. The Installed Capacity of Solar PV Plant is **64 kWp**. The college has also installed 10,000 liters capacity Solar Thermal Hot Water system on hostel campus.

Table 6.1: Computation of % Usage of Alternate Energy to Annual Energy Requirement

No	Particulars	Value	Unit
1	Annual Energy Purchased from MSEDCL	2,829	kWh/Annum
2	Energy Generated by Roof Top Solar PV System	96000	kWh/Annum
3	Total Energy Requirement of College	98,829	kWh/Annum
4	% of Usage of Alternate Energy to Annual Energy Requirement	97	**%**

Photograph of Solar PV plant

7. Study of usage of LED lighting

In this chapter we study the lighting system of college and compute the percentage of total load catered by LED lighting.

Table 7.1: Total lighting load

No	Particulars	Qty	Load, W/Unit	Load, kW
1	F T L-40 W	92	40	3.7
2	CFL	213	24	5.1
	LED lighting load			
1	LED tube	358	20	7.2
2	LED bulbs	600	12	7.2
3	LED street lights	4	35	0.1
	Total LED lighting load			14.5
	Total Lighting load			23.3

It can be seen that out of total lighting load 62% load is LED lighting load.

8. Energy conservation proposals

8.1 Replacement of Old T-8 FTLs with 20 W LED fittings

In the facility, there are about 92 Nos, T-8, FTL fittings with Electronic/magnetic chokes. It is recommended to install the 20 W LED Tube light fittings in place of these old T-8 fittings. In the following Table, we present the savings, investment required & payback analysis.

No	Particulars	Value	Unit
1	Present Qty of T-8 fittings	92	Nos
2	Energy Demand of T-8 fitting	40	W/Unit
3	Energy Demand of 20 W LED fittin	20	W/Unit
4	Reduction in demad	20	W/Unit
5	Average Daily Usage period	4	Hrs/Day
6	Daily saving in Energy	7.36	kWh/Day
7	Annual Working Days	250	Nos
8	Annual Energy Saving possible	1840	kWh/Annum
9	Rate of Electrical Energy	11	Rs/kWh
10	Annual Monetary saving	20240	Rs/Annum
11	Cost of 20 W LED Tube	641	Rs/Unit
12	Investment required	58972	Rs lump sum
13	Simple Payback period	35	Months

8.2 Replacement of old fans with STAR Rated fans

During the Audit, it was observed that there are 411 no of fans. It is recommended to replace these old fans with STAR Rated fans.

In the following Table, we present the savings, investment required & payback analysis.

No	Particulars	Value	Unit
1	Present Qty of Old Ceiling Fan fittings	411	Nos
2	Energy Demand of Old Ceiling Fan fitting	65	W/Unit
3	Energy Demand of STAR Rated Fan	40	W/Unit
4	Reduction in demad	25	W/Unit
5	Average Daily Usage period	8	Hrs/Day
6	Daily saving in Energy	82.2	kWh/Day
7	Annual Working Days	250	Nos
8	Annual Energy Saving possible	20550	kWh/Annum
9	Rate of Electrical Energy	11	Rs/kWh
10	Annual Monetary saving	226050	Rs/Annum
11	Cost of STAR Rated Ceiling Fan	2174	Rs/unit
12	Investment required	893514	Rs lump sum
13	Simple Payback period	47	Months

8.3 Summary of Savings

No	Recommendation	Annual Saving potential, kWh/Annum	Annual Monetary Gain, Rs.	Investment Required, Rs.	Payback period, Months
1	Replacement of 92 Nos T-8 fittings with 20W LED fittings	1,840	20,240	58,972	35
2	Replacement of 411 Nos Old Ceiling Fans with STAR rating fans	20,550	2,26,050	8,93,514	47
	Total	**22,390**	**2,46,290**	**9,52,486**	**46**

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Sr no	Parameter	Energy consumed, (kWh)	CO2 Emission (MT)
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2	Minimum	234	0.19
3	Average	3,398	2.72
4	Total	40,780	32.62

2. Energy Conservation Projects already installed

1. Usage of STAR Rated ACs at new installations
2. Usage of LED lights at some indoor locations
3. Usage of LED Lights for outdoor lighting.

3. Key Observations

1. Usage of LED lights.
2. Usage of star rated equipment.
3. Maintained a good power factor.

4. Percentage of Usage of Alternate Energy

The College has installed a Roof Top Solar PV Plant. The percentage of usage of Alternate Energy to Annual Energy Requirement is 72 %.

5. Percentage of Usage of LED Lighting

The College has various Types of Light fittings. The percentage of Annual LED Lighting Usage to Annual Lighting requirement works out to be 62 %.

Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

6. Recommendations

Table no 1: Recommendations for energy savings

No	Recommendation	Annual Saving potential, kWh/Annum	Annual Monetary Gain, Rs.	Investment Required, Rs.	Payback period, Months
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7 Notes & Assumptions

1. Daily working hours-10 Nos
2. Annual working Days-300 Nos
3. Average Rate of Electrical Energy : **Rs 11/- per kWh**

Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

Abbreviations

CFL	:	Compact Fluorescent Lamp
FTL	:	Fluorescent Tube Light
LED	:	Light Emitting Diode
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I	:	Current
kW	:	Kilo- Watt
kWh	:	kilo-Watt Hour
kVA	:	Active Power

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1. Study of connected load
2. Study of various Electrical parameters
3. To prepare the Report with various Encon measures with payback analysis

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Table No-1.1: Details of college

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1	Name of Institution	Shri Shivaji Education Society Amravati's Science College, Nagpur
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Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

2. Study of connected load

In this chapter, we present details of various connected electrical equipment and electrical load.

Table No-2.1: Location wise study of Electrical fittings in various buildings

No	Location	FTL (40W)	CFL	LED tube (20W)	LED bulb (12W)	Computers (65W)	Fans	1.5 Tr Star rated AC
1	Office		14	2		11	9	
2	Cabin			1	8	2	4	1
3	Meeting Hall		30		2		6	3
4	Cabin Porch				3		2	
5	Porch			1	5			
6	Exam Room			2			1	
7	Store Room	1		1				
8	Micro Biology	12		18		4	15	3
9	Biotech	9	52	5		4	17	3
10	Zoology			20		3	11	
11	Statistics	4		2	8	2	12	
12	Jr. Electronics	5		4		3	9	1
13	Electronics	11		2			9	1
14	Mathematics	2		1	6	5	4	1
15	B 1	3		1			4	
16	Physical Dept.	2		5		1	2	
17	Jr. Chemistry	2		4			4	
18	English Dept.	1	1	2	6	6	6	1
19	Computer Dept.	1		66	3	132	14	16
20	Research Lab				4	9		1
21	B 2			1			4	
22	B 3	1					4	
23	B 4	1					2	

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24	Jr. Physics			3			5	
25	Jr. Biology			3			4	
26	Fisheries Jr.	1		1			2	
27	3rd Floor Pasage	3	1	4				
28	B 7	2					4	
29	B 6	1					4	
30	B 9	4		3			9	
31	BCA		28		360	51	8	4
32	BCA Lab 2					29	7	3
33	B 12				11		7	
34	B 13	1		3			5	
35	Conference Hall							
36	B Block Stairs			8				
37	B Block Bath		6					
38	B Block Pasage				72		2	
39	B Block Porch			4			4	
40	301 to 313		14	15			14	
41	201 to 212			20			20	
42	101to 119			20			20	
43	Mess	3	7	3			8	
44	Warden Room			5		1	5	
45	Guest House		4	4	8		6	3
46	Gym	8					7	
47	Hostel Porch & Stairs		32	2			1	
48	First Floor Bath	2	10					
49	Second Floor Bath	2	14					
50	Botany			6		3	5	1
51	Botany PG Lab			4			4	
52	Botany Laboratory			10			6	
53	Chemistry			56		7	30	1
54	Library	2			104	37	40	
55	IQAC	1		2		2	2	1

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56	Guard Room			1			1	
57	College Parking	5						
58	Jr. Office	2				2	2	1
59	Physics Dept.			43		18	40	1
	Total	**92**	**213**	**358**	**600**	**332**	**411**	**46**

Apart from above load, the college has pumps, street lights. Individual fitting wise load is as under.

Table No 2.2: Equipment wise Connected Load

No	Equipment	Qty	Load, W/Unit	Load, kW
1	F T L-40 W	92	40	3.7
2	CFL	213	24	5.1
3	LED Tube-20W	358	20	7.2
4	LED bulb	600	12	7.2
5	Computers	332	65	21.6
6	Ceiling Fan	411	65	26.7
7	AC (1.5Tr)	46	1838	84.5
8	LED focus Street light	4	35	0.1
9	Pumps (2 nos 2HP)			3.0
	Total			**114.4**

Data can be represented in terms of PIE chart as under,

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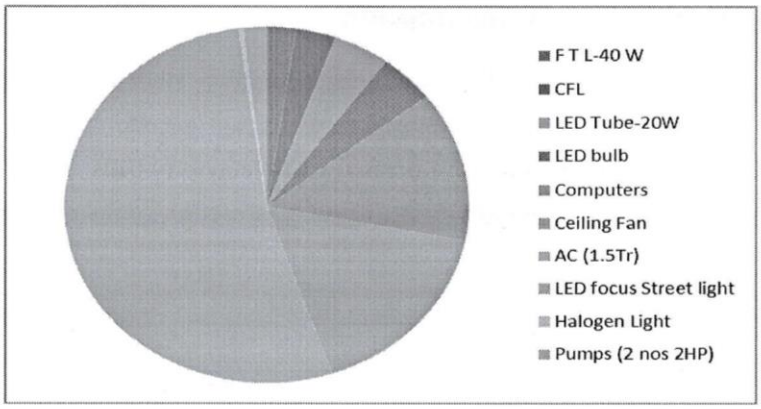

Figure 2.1: Distribution of connected load.

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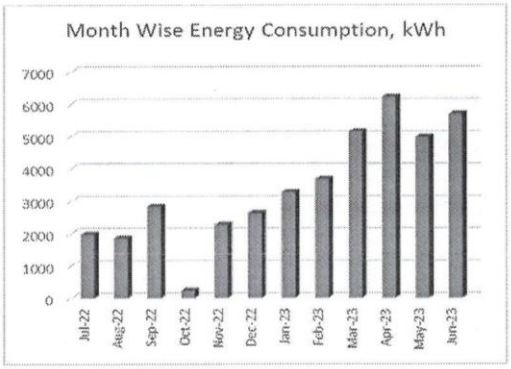
3. Study of Electrical Energy Consumption

In this chapter, electricity bills are studied for the analysis of electrical energy consumption.

Table no 3.1: Summary of electricity bills

No	Month	Energy (kWh)	Bill Amount (Rs)
1	Jun-23	5691	97129
2	May-23	4972	87970
3	Apr-23	6217	104880
4	Mar-23	5145	84930
5	Feb-23	3675	63598
6	Jan-23	3278	58717
7	Dec-22	2632	38121
8	Nov-22	2274	34958
9	Oct-22	234	36497
10	Sep-22	2838	39972
11	Aug-22	1852	36150
12	Jul-22	1972	33179
	Total	**40,780**	**7,16,101**

Variation in energy consumption is as follows,



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Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

Figure 3.1: Month wise energy consumption

Monthly variation in electricity bill is as follows,

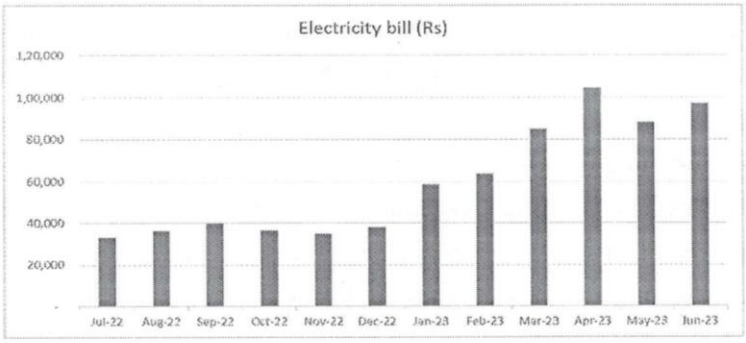

Figure 3.2: Month wise electricity bill

Key observations of electricity bill are as follows,

Table no 3.2: Key observations

Sr no	Parameter	Energy consumed, (kWh)	CO2 Emission (MT)
1	Maximum	6,217	4.97
2	Minimum	234	0.19
3	Average	3,398	2.72
4	Total	40,780	32.62

Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

4. Carbon Foot printing

1. A Carbon Foot print is defined as the Total Greenhouse Gas emissions (CO_2 emissions), emitted due to various activities. In this we compute the emissions of Carbon-Di-Oxide, by usage of the various form of Electrical Energy used by the College for performing its day to day activities

2. Basis for computation of CO_2 Emissions:

The basis of Calculation for CO_2 emissions due to Electrical Energy is as under

- 1 Unit (kWh) of Electrical Energy releases **0.8 Kg of CO_2** into atmosphere.

Based on the above Data we compute the CO_2 emissions which are being released in to the atmosphere by the College due to its Day to Day operations

We herewith furnish the details of various forms of Energy consumption as under

Table 4.1: Month wise Consumption of Electrical Energy & CO2 Emissions

No	Month	Energy Consumed, kWh	CO2 Emissions, MT
1	Jun-23	5,691	4.55
2	May-23	4,972	3.98
3	Apr-23	6,217	4.97
4	Mar-23	5,145	4.12
5	Feb-23	3,675	2.94
6	Jan-23	3,278	2.62
7	Dec-22	2,632	2.11
8	Nov-22	2,274	1.82
9	Oct-22	234	0.19
10	Sep-22	2,838	2.27
11	Aug-22	1,852	1.48
12	Jul-22	1,972	1.58
	Total	**40,780**	**32.62**

In the following Chart we present the CO2 emissions due to usage of Electrical Energy.

Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

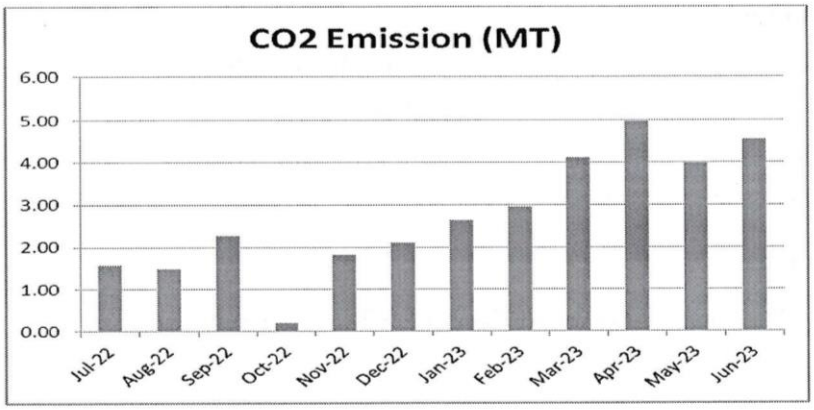

Figure 4.1: Month wise CO2 Emission

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Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

5. Study of utilities

5.1 Study of Lighting

In the facility, the lighting system can be divided mainly in to parts, indoor lighting and outdoor lighting. There are 92 FTL fittings with Electronic/ magnetic chokes , 213 nos of CFLs, 358 nos of LED tubes, 600 nos of LED bulbs. It is recommended to install the 20 W LED Tube light fittings in place of these old T-8 fittings.

5.2 Air-conditioners

In the facility, there are about 46 Nos. of 1.5 Tr Air-conditioners.

5.3 Ceiling Fans

At building facility, there are about 411 Nos Old Ceiling Fans, which consumed about 65 W of Electrical Energy. It is recommended to replace these old Fans with BEE STAR Rated Ceiling Fans.

5.4 Water Pumps

There are in total Water pumps with 2HP and21HP capacities respectively.

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Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

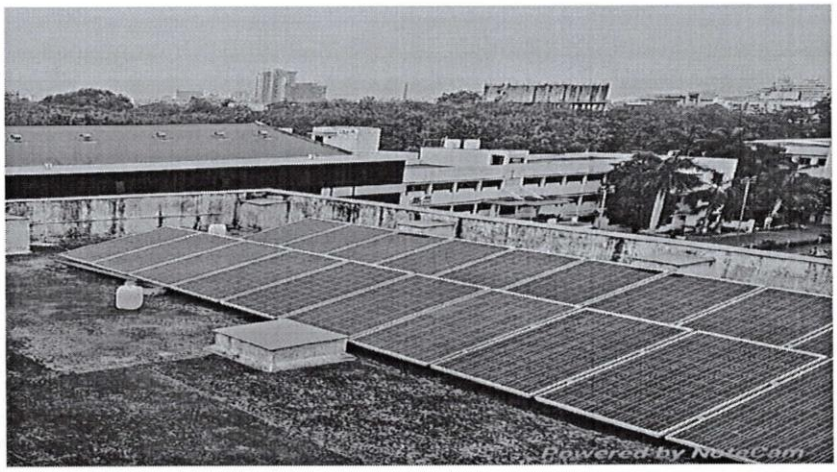
6. Study of usage of alternate energy

In this Chapter, we compute the percentage of Usage of Alternate/Renewable Energy to Annual Energy Requirement of the College. The College has installed Roof Top Solar PV System. The Installed Capacity of Solar PV Plant is **64 kWp**. The college has also installed 10,000 liters capacity Solar Thermal Hot Water system on hostel campus.

Table 6.1: Computation of % Usage of Alternate Energy to Annual Energy Requirement

No	Particulars	Value	Unit
1	Annual Energy Purchased from MSEDCL	40,780	kWh/Annum
2	Energy Generated by Roof Top Solar PV System	96000	kWh/Annum
3	Total Energy Requirement of College	136,780	kWh/Annum
4	% of Usage of Alternate Energy to Annual Energy Requirement	70	%

Photograph of Solar PV plant



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7. Study of usage of LED lighting

In this chapter we study the lighting system of college and compute the percentage of total load catered by LED lighting.

Table 7.1: Total lighting load

No	Particulars	Qty	Load, W/Unit	Load, kW
1	F T L-40 W	92	40	3.7
2	CFL	213	24	5.1
	LED lighting load			
1	LED tube	358	20	7.2
2	LED bulbs	600	12	7.2
3	LED street lights	4	35	0.1
	Total LED lighting load			14.5
	Total Lighting load			23.3

It can be seen that out of total lighting load 62% load is LED lighting load.

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Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

8. Energy conservation proposals

8.1 Replacement of Old T-8 FTLs with 20 W LED fittings

In the facility, there are about 92 Nos, T-8, FTL fittings with Electronic/magnetic chokes. It is recommended to install the 20 W LED Tube light fittings in place of these old T-8 fittings. In the following Table, we present the savings, investment required & payback analysis.

No	Particulars	Value	Unit
1	Present Qty of T-8 fittings	92	Nos
2	Energy Demand of T-8 fitting	40	W/Unit
3	Energy Demand of 20 W LED fittin	20	W/Unit
4	Reduction in demad	20	W/Unit
5	Average Daily Usage period	4	Hrs/Day
6	Daily saving in Energy	7.36	kWh/Day
7	Annual Working Days	250	Nos
8	Annual Energy Saving possible	1840	kWh/Annum
9	Rate of Electrical Energy	11	Rs/kWh
10	Annual Monetary saving	20240	Rs/Annum
11	Cost of 20 W LED Tube	641	Rs/Unit
12	Investment required	58972	Rs lump sum
13	Simple Payback period	35	Months

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Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

8.2 Replacement of old fans with STAR Rated fans

During the Audit, it was observed that there are 411 no of fans. It is recommended to replace these old fans with STAR Rated fans.

In the following Table, we present the savings, investment required & payback analysis.

No	Particulars	Value	Unit
1	Present Qty of Old Ceiling Fan fittings	411	Nos
2	Energy Demand of Old Ceiling Fan fitting	65	W/Unit
3	Energy Demand of STAR Rated Fan	40	W/Unit
4	Reduction in demad	25	W/Unit
5	Average Daily Usage period	8	Hrs/Day
6	Daily saving in Energy	82.2	kWh/Day
7	Annual Working Days	250	Nos
8	Annual Energy Saving possible	20550	kWh/Annum
9	Rate of Electrical Energy	11	Rs/kWh
10	Annual Monetary saving	226050	Rs/Annum
11	Cost of STAR Rated Ceiling Fan	2174	Rs/unit
12	Investment required	893514	Rs lump sum
13	Simple Payback period	47	Months

Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

8.3 Summary of Savings

No	Recommendation	Annual Saving potential, kWh/Annum	Annual Monetary Gain, Rs.	Investment Required, Rs.	Payback period, Months
1	Replacement of 92 Nos T-8 fittings with 20W LED fittings	1,840	20,240	58,972	35
2	Replacement of 411 Nos Old Ceiling Fans with STAR rating fans	20,550	2,26,050	8,93,514	47
	Total	**22,390**	**2,46,290**	**9,52,486**	**46**

Report
On
Energy Audit
At
Shri Shivaji Education Society Amravati's
Science College,
Nagpur
(Year 2021-22)

Prepared by
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Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

Contents

Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

Acknowledgement

We at Nutan Urja Solutions, Pune, express our sincere gratitude to the management of Shri Shivaji Education Society Amravati's Science College, Nagpur for awarding us the assignment of Energy Audit of their college premises.

We are also thankful to various Head of Departments & other Staff members for helping us during the field measurements.

We hope that the recommendations stated in this report will be useful and worthy of discussions to take things forward to help implementation of energy conservation measures through energy savings. While we have made every attempt to adhere to high quality standards, in both data collection and analysis through the report, we would welcome your suggestions so as to improve upon this report further.

Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

Executive Summary

After the Field measurements & analysis, we present herewith important observations made and various measures to reduce the Energy Consumption & mitigate the CO_2 emissions. College consumes Energy in the form of Electrical Energy used for various gadgets, Office & other facilities.

1. Present Energy Consumption

In the following Table, we present the details of Energy Consumption.

Table no 2.1: Details of energy consumption

Sr no	Parameter	Energy consumed, (kWh)	CO2 Emission (MT)
1	Maximum	9,278	7.42
2	Minimum	248	0.20
3	Average	3,184	2.55
4	Total	38,202	30.56

2. Energy Conservation Projects already installed

1. Usage of STAR Rated ACs at new installations
2. Usage of LED lights at some indoor locations
3. Usage of LED Lights for outdoor lighting.

3. Key Observations

1. Usage of LED lights.
2. Usage of star rated equipment.
3. Maintained a good power factor.

4. Percentage of Usage of Alternate Energy

The College has installed a Roof Top Solar PV Plant. The percentage of usage of Alternate Energy to Annual Energy Requirement is 72 %.

5. Percentage of Usage of LED Lighting

The College has various Types of Light fittings. The percentage of Annual LED Lighting Usage to Annual Lighting requirement works out to be 62 %.

Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

6. Recommendations

Table no 1: Recommendations for energy savings

No	Recommendation	Annual Saving potential, kWh/Annum	Annual Monetary Gain, Rs.	Investment Required, Rs.	Payback period, Months
1	Replacement of 92 Nos T-8 fittings with 20W LED fittings	1,840	20,240	58,972	35
2	Replacement of 411 Nos Old Ceiling Fans with STAR rating fans	20,550	2,26,050	8,93,514	47
	Total	22,390	2,46,290	9,52,486	46

7 Notes & Assumptions

1. Daily working hours-10 Nos
2. Annual working Days-300 Nos
3. Average Rate of Electrical Energy : **Rs 11/- per kWh**

Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

Abbreviations

CFL	:	Compact Fluorescent Lamp
FTL	:	Fluorescent Tube Light
LED	:	Light Emitting Diode
V	:	Voltage
I	:	Current
kW	:	Kilo- Watt
kWh	:	kilo-Watt Hour
kVA	:	Active Power

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Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

1. Introduction

Shri Shivaji Education Society Amravati's Science College is located in Nagpur. With its competent galaxy of faculty members, the college has been rendering sincere services in the field of higher education since 1967. This is a single faculty college degree level and offers PG courses with recognized centers of Higher Learning and Research in Microbiology, Chemistry, Computer Science, Physics and Mathematics.

1.1 Objectives

1. To study present level of Energy Consumption
2. To Study Electrical Consumption
3. To assess the various equipment/facilities from Energy efficiency aspect
4. To study various measures to reduce the Energy Consumption

1.2 Audit Methodology:

1. Study of connected load
2. Study of various Electrical parameters
3. To prepare the Report with various Encon measures with payback analysis

1.3 General Details of College

Table No-1.1: Details of college

No	Head	Particulars
1	Name of Institution	Shri Shivaji Education Society Amravati's Science College, Nagpur
2	Address	Shri Shivaji Education Society Amravati's Science College, Nagpur, Congress Nagar, Nagpur
3	Affiliation	R. T. M. Nagpur University, Nagpur

Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

2. Study of connected load

In this chapter, we present details of various connected electrical equipment and electrical load.

Table No-2.1: Location wise study of Electrical fittings in various buildings

No	Location	FTL (40W)	CFL	LED tube (20W)	LED bulb (12W)	Computers (65W)	Fans	1.5 Tr Star rated AC
1	Office		14	2		11	9	
2	Cabin			1	8	2	4	1
3	Meeting Hall		30		2		6	3
4	Cabin Porch				3		2	
5	Porch			1	5			
6	Exam Room			2			1	
7	Store Room	1		1				
8	Micro Biology	12		18		4	15	3
9	Biotech	9	52	5		4	17	3
10	Zoology			20		3	11	
11	Statistics	4		2	8	2	12	
12	Jr. Electronics	5		4		3	9	1
13	Electronics	11		2			9	1
14	Mathematics	2		1	6	5	4	1
15	B 1	3		1			4	
16	Physical Dept.	2		5		1	2	
17	Jr. Chemistry	2		4			4	
18	English Dept.	1	1	2	6	6	6	1
19	Computer Dept.	1		66	3	132	14	16
20	Research Lab				4	9		1
21	B 2			1			4	
22	B 3	1					4	
23	B 4	1					2	

Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

24	Jr. Physics			3			5	
25	Jr. Biology			3			4	
26	Fisheries Jr.	1		1			2	
27	3rd Floor Pasage	3	1	4				
28	B 7	2					4	
29	B 6	1					4	
30	B 9	4		3			9	
31	BCA		28		360	51	8	4
32	BCA Lab 2					29	7	3
33	B 12				11		7	
34	B 13	1		3			5	
35	Conference Hall							
36	B Block Stairs			8				
37	B Block Bath		6					
38	B Block Pasage				72		2	
39	B Block Porch			4			4	
40	301 to 313		14	15			14	
41	201 to 212			20			20	
42	101to 119			20			20	
43	Mess	3	7	3			8	
44	Warden Room			5		1	5	
45	Guest House		4	4	8		6	3
46	Gym	8					7	
47	Hostel Porch & Stairs		32	2			1	
48	First Floor Bath	2	10					
49	Second Floor Bath	2	14					
50	Botany			6		3	5	1
51	Botany PG Lab			4			4	
52	Botany Laboratory			10			6	
53	Chemistry			56		7	30	1
54	Library	2			104	37	40	
55	IQAC	1		2		2	2	1

Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

56	Guard Room			1			1	
57	College Parking	5						
58	Jr. Office	2				2	2	1
59	Physics Dept.			43		18	40	1
	Total	**92**	**213**	**358**	**600**	**332**	**411**	**46**

Apart from above load, the college has pumps, street lights. Individual fitting wise load is as under.

Table No 2.2: Equipment wise Connected Load

No	Equipment	Qty	Load, W/Unit	Load, kW
1	F T L-40 W	92	40	3.7
2	CFL	213	24	5.1
3	LED Tube-20W	358	20	7.2
4	LED bulb	600	12	7.2
5	Computers	332	65	21.6
6	Ceiling Fan	411	65	26.7
7	AC (1.5Tr)	46	1838	84.5
8	LED focus Street light	4	35	0.1
9	Pumps (2 nos 2HP)			3.0
	Total			**114.4**

Data can be represented in terms of PIE chart as under,

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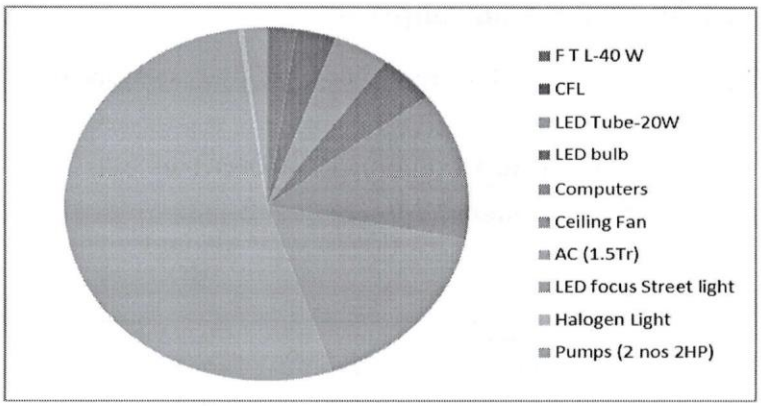

Figure 2.1: Distribution of connected load.

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3. Study of Electrical Energy Consumption

In this chapter, electricity bills are studied for the analysis of electrical energy consumption.

Table no 3.1: Summary of electricity bills

No	Month	Energy (kWh)	Bill Amount (Rs)
1	Jun-22	266	79283
2	May-22	248	57910
3	Apr-22	9278	136134
4	Mar-22	7047	103173
5	Feb-22	2010	54384
6	Jan-22	2404	57672
7	Dec-21	2747	60835
8	Nov-21	2478	58659
9	Oct-21	4069	86861
10	Sep-21	3625	73992
11	Aug-21	1961	58292
12	Jul-21	2069	55366
	Total	38,202	8,82,561

Variation in energy consumption is as follows,

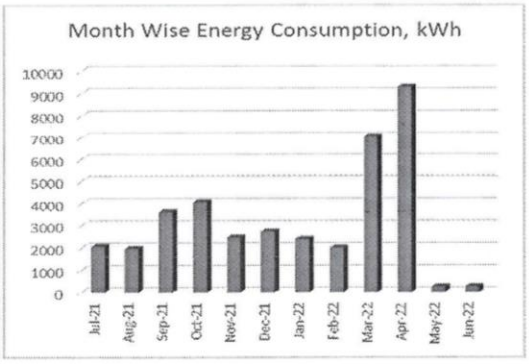

Figure 3.1: Month wise energy consumption

Monthly variation in electricity bill is as follows,

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Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

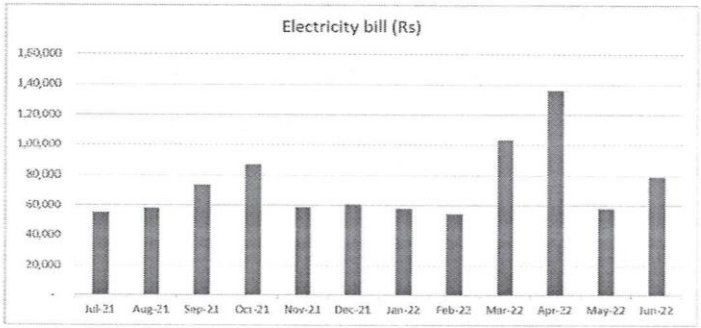

Figure 3.2: Month wise electricity bill

Key observations of electricity bill are as follows,

Table no 3.2: Key observations

Sr no	Parameter	Energy consumed, (kWh)	CO2 Emission (MT)
1	Maximum	9,278	7.42
2	Minimum	248	0.20
3	Average	3,184	2.55
4	Total	38,202	30.56

Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

4. Carbon Foot printing

1. A Carbon Foot print is defined as the Total Greenhouse Gas emissions (CO_2 emissions), emitted due to various activities. In this we compute the emissions of Carbon-Di-Oxide, by usage of the various form of Electrical Energy used by the College for performing its day to day activities

2. Basis for computation of CO_2 Emissions:

The basis of Calculation for CO_2 emissions due to Electrical Energy is as under

- 1 Unit (kWh) of Electrical Energy releases **0.8 Kg of CO_2** into atmosphere.

Based on the above Data we compute the CO_2 emissions which are being released in to the atmosphere by the College due to its Day to Day operations

We herewith furnish the details of various forms of Energy consumption as under

Table 4.1: Month wise Consumption of Electrical Energy & CO2 Emissions

No	Month	Energy Consumed, kWh	CO2 Emissions, MT
1	Jun-22	266	0.21
2	May-22	248	0.20
3	Apr-22	9,278	7.42
4	Mar-22	7,047	5.64
5	Feb-22	2,010	1.61
6	Jan-22	2,404	1.92
7	Dec-21	2,747	2.20
8	Nov-21	2,478	1.98
9	Oct-21	4,069	3.26
10	Sep-21	3,625	2.90
11	Aug-21	1,961	1.57
12	Jul-21	2,069	1.66
	Total	**38,202**	**30.56**

In the following Chart we present the CO2 emissions due to usage of Electrical Energy.

Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

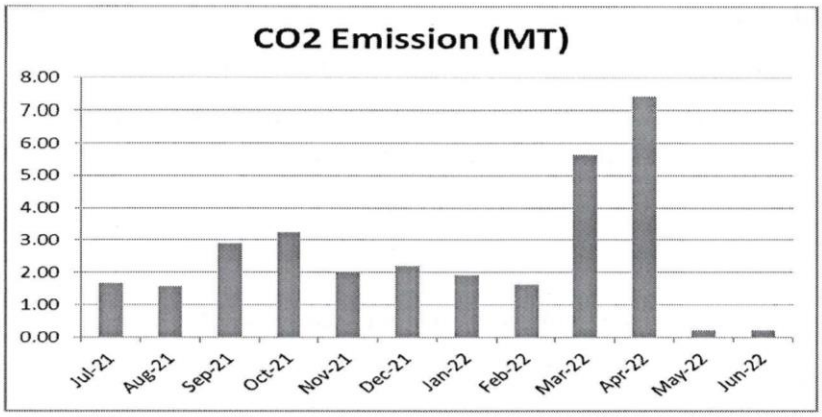

Figure 4.1: Month wise CO2 Emission

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5. Study of utilities

5.1 Study of Lighting

In the facility, the lighting system can be divided mainly in to parts, indoor lighting and outdoor lighting. There are 92 FTL fittings with Electronic/ magnetic chokes , 213 nos of CFLs, 358 nos of LED tubes, 600 nos of LED bulbs. It is recommended to install the 20 W LED Tube light fittings in place of these old T-8 fittings.

5.2 Air-conditioners

In the facility, there are about 46 Nos. of 1.5 Tr Air-conditioners.

5.3 Ceiling Fans

At building facility, there are about 411 Nos Old Ceiling Fans, which consumed about 65 W of Electrical Energy. It is recommended to replace these old Fans with BEE STAR Rated Ceiling Fans.

5.4 Water Pumps

There are in total Water pumps with 2HP and21HP capacities respectively.

Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

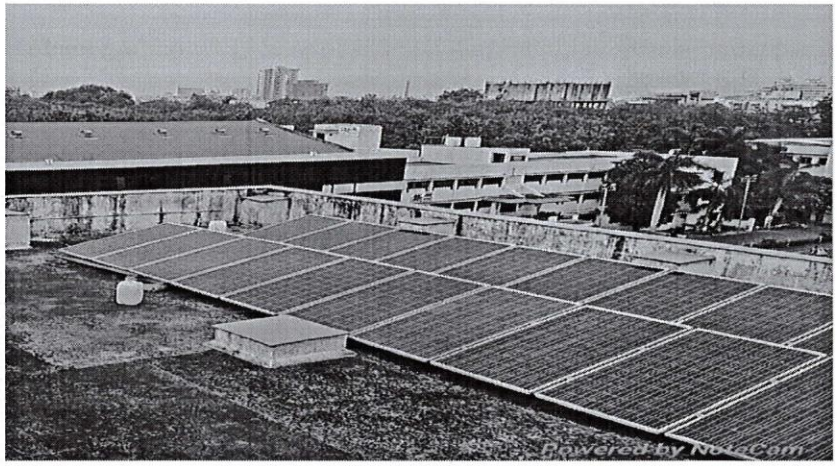
6. Study of usage of alternate energy

In this Chapter, we compute the percentage of Usage of Alternate/Renewable Energy to Annual Energy Requirement of the College. The College has installed Roof Top Solar PV System. The Installed Capacity of Solar PV Plant is **64 kWp**. The college has also installed 10,000 liters capacity Solar Thermal Hot Water system on hostel campus.

Table 6.1: Computation of % Usage of Alternate Energy to Annual Energy Requirement

No	Particulars	Value	Unit
1	Annual Energy Purchased from MSEDCL	38,202	kWh/Annum
2	Energy Generated by Roof Top Solar PV System	96000	kWh/Annum
3	Total Energy Requirement of College	1,34,202	kWh/Annum
4	% of Usage of Alternate Energy to Annual Energy Requirement	72	%

Photograph of Solar PV plant



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7. Study of usage of LED lighting

In this chapter we study the lighting system of college and compute the percentage of total load catered by LED lighting.

Table 7.1: Total lighting load

No	Particulars	Qty	Load, W/Unit	Load, kW
1	F T L-40 W	92	40	3.7
2	CFL	213	24	5.1
	LED lighting load			
1	LED tube	358	20	7.2
2	LED bulbs	600	12	7.2
3	LED street lights	4	35	0.1
	Total LED lighting load			14.5
	Total Lighting load			23.3

It can be seen that out of total lighting load 62% load is LED lighting load.

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Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

8. Energy conservation proposals

8.1 Replacement of Old T-8 FTLs with 20 W LED fittings

In the facility, there are about 92 Nos, T-8, FTL fittings with Electronic/magnetic chokes. It is recommended to install the 20 W LED Tube light fittings in place of these old T-8 fittings. In the following Table, we present the savings, investment required & payback analysis.

No	Particulars	Value	Unit
1	Present Qty of T-8 fittings	92	Nos
2	Energy Demand of T-8 fitting	40	W/Unit
3	Energy Demand of 20 W LED fittin	20	W/Unit
4	Reduction in demad	20	W/Unit
5	Average Daily Usage period	4	Hrs/Day
6	Daily saving in Energy	7.36	kWh/Day
7	Annual Working Days	250	Nos
8	Annual Energy Saving possible	1840	kWh/Annum
9	Rate of Electrical Energy	11	Rs/kWh
10	Annual Monetary saving	20240	Rs/Annum
11	Cost of 20 W LED Tube	641	Rs/Unit
12	Investment required	58972	Rs lump sum
13	Simple Payback period	35	Months

Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

8.2 Replacement of old fans with STAR Rated fans

During the Audit, it was observed that there are 411 no of fans. It is recommended to replace these old fans with STAR Rated fans.

In the following Table, we present the savings, investment required & payback analysis.

No	Particulars	Value	Unit
1	Present Qty of Old Ceiling Fan fittings	411	Nos
2	Energy Demand of Old Ceiling Fan fitting	65	W/Unit
3	Energy Demand of STAR Rated Fan	40	W/Unit
4	Reduction in demad	25	W/Unit
5	Average Daily Usage period	8	Hrs/Day
6	Daily saving in Energy	82.2	kWh/Day
7	Annual Working Days	250	Nos
8	Annual Energy Saving possible	20550	kWh/Annum
9	Rate of Electrical Energy	11	Rs/kWh
10	Annual Monetary saving	226050	Rs/Annum
11	Cost of STAR Rated Ceiling Fan	2174	Rs/unit
12	Investment required	893514	Rs lump sum
13	Simple Payback period	47	Months

Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

8.3 Summary of Savings

No	Recommendation	Annual Saving potential, kWh/Annum	Annual Monetary Gain, Rs.	Investment Required, Rs.	Payback period, Months
1	Replacement of 92 Nos T-8 fittings with 20W LED fittings	1,840	20,240	58,972	35
2	Replacement of 411 Nos Old Ceiling Fans with STAR rating fans	20,550	2,26,050	8,93,514	47
	Total	**22,390**	**2,46,290**	**9,52,486**	**46**

Report
On
Energy Audit
At
Shri Shivaji Education Society Amravati's
Science College,
Nagpur
(Year 2020-21)

Prepared by
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Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

Contents

Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

Acknowledgement

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We are also thankful to various Head of Departments & other Staff members for helping us during the field measurements.

We hope that the recommendations stated in this report will be useful and worthy of discussions to take things forward to help implementation of energy conservation measures through energy savings. While we have made every attempt to adhere to high quality standards, in both data collection and analysis through the report, we would welcome your suggestions so as to improve upon this report further.

Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

Executive Summary

After the Field measurements & analysis, we present herewith important observations made and various measures to reduce the Energy Consumption & mitigate the CO_2 emissions. College consumes Energy in the form of Electrical Energy used for various gadgets, Office & other facilities.

1. Present Energy Consumption

In the following Table, we present the details of Energy Consumption.

Table no 2.1: Details of energy consumption

Sr no	Parameter	Energy consumed, (kWh)	CO2 Emission (MT)
1	Maximum	4,603	3.68
2	Minimum	1,910	1.53
3	Average	3,211	2.57
4	Total	38,532	30.83

2. Energy Conservation Projects already installed

1. Usage of STAR Rated ACs at new installations
2. Usage of LED lights at some indoor locations
3. Usage of LED Lights for outdoor lighting.

3. Key Observations

1. Usage of LED lights.
2. Usage of star rated equipment.
3. Maintained a good power factor.

4. Percentage of Usage of Alternate Energy

The College has installed a Roof Top Solar PV Plant. The percentage of usage of Alternate Energy to Annual Energy Requirement is 71 %.

5. Percentage of Usage of LED Lighting

The College has various Types of Light fittings. The percentage of Annual LED Lighting Usage to Annual Lighting requirement works out to be 62 %.

Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

6. Recommendations

Table no 1: Recommendations for energy savings

No	Recommendation	Annual Saving potential, kWh/Annum	Annual Monetary Gain, Rs.	Investment Required, Rs.	Payback period, Months
1	Replacement of 92 Nos T-8 fittings with 20W LED fittings	1,840	20,240	58,972	35
2	Replacement of 411 Nos Old Ceiling Fans with STAR rating fans	20,550	2,26,050	8,93,514	47
	Total	22,390	2,46,290	9,52,486	46

7 Notes & Assumptions

1. Daily working hours-10 Nos
2. Annual working Days-300 Nos
3. Average Rate of Electrical Energy : **Rs 11/- per kWh**

Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

Abbreviations

CFL	:	Compact Fluorescent Lamp
FTL	:	Fluorescent Tube Light
LED	:	Light Emitting Diode
V	:	Voltage
I	:	Current
kW	:	Kilo- Watt
kWh	:	kilo-Watt Hour
kVA	:	Active Power

Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

1. Introduction

Shri Shivaji Education Society Amravati's Science College is located in Nagpur. With its competent galaxy of faculty members, the college has been rendering sincere services in the field of higher education since 1967. This is a single faculty college degree level and offers PG courses with recognized centers of Higher Learning and Research in Microbiology, Chemistry, Computer Science, Physics and Mathematics.

1.1 Objectives

1. To study present level of Energy Consumption
2. To Study Electrical Consumption
3. To assess the various equipment/facilities from Energy efficiency aspect
4. To study various measures to reduce the Energy Consumption

1.2 Audit Methodology:

1. Study of connected load
2. Study of various Electrical parameters
3. To prepare the Report with various Encon measures with payback analysis

1.3 General Details of College

Table No-1.1: Details of college

No	Head	Particulars
1	Name of Institution	Shri Shivaji Education Society Amravati's Science College, Nagpur
2	Address	Shri Shivaji Education Society Amravati's Science College, Nagpur, Congress Nagar, Nagpur
3	Affiliation	R. T. M. Nagpur University, Nagpur

Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

2. Study of connected load

In this chapter, we present details of various connected electrical equipment and electrical load.

Table No-2.1: Location wise study of Electrical fittings in various buildings

No	Location	FTL (40W)	CFL	LED tube (20W)	LED bulb (12W)	Computers (65W)	Fans	1.5 Tr Star rated AC
1	Office		14	2		11	9	
2	Cabin			1	8	2	4	1
3	Meeting Hall		30		2		6	3
4	Cabin Porch				3		2	
5	Porch			1	5			
6	Exam Room			2			1	
7	Store Room	1		1				
8	Micro Biology	12		18		4	15	3
9	Biotech	9	52	5		4	17	3
10	Zoology			20		3	11	
11	Statistics	4		2	8	2	12	
12	Jr. Electronics	5		4		3	9	1
13	Electronics	11		2			9	1
14	Mathematics	2		1	6	5	4	1
15	B 1	3		1			4	
16	Physical Dept.	2		5		1	2	
17	Jr. Chemistry	2		4			4	
18	English Dept.	1	1	2	6	6	6	1
19	Computer Dept.	1		66	3	132	14	16
20	Research Lab				4	9		1
21	B 2			1			4	
22	B 3	1					4	
23	B 4	1					2	

Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

24	Jr. Physics			3			5	
25	Jr. Biology			3			4	
26	Fisheries Jr.	1		1			2	
27	3rd Floor Pasage	3	1	4				
28	B 7	2					4	
29	B 6	1					4	
30	B 9	4		3			9	
31	BCA		28		360	51	8	4
32	BCA Lab 2					29	7	3
33	B 12				11		7	
34	B 13	1		3			5	
35	Conference Hall							
36	B Block Stairs			8				
37	B Block Bath		6					
38	B Block Pasage				72		2	
39	B Block Porch			4			4	
40	301 to 313		14	15			14	
41	201 to 212			20			20	
42	101to 119			20			20	
43	Mess	3	7	3			8	
44	Warden Room			5		1	5	
45	Guest House		4	4	8		6	3
46	Gym	8					7	
47	Hostel Porch & Stairs		32	2			1	
48	First Floor Bath	2	10					
49	Second Floor Bath	2	14					
50	Botany			6		3	5	1
51	Botany PG Lab			4			4	
52	Botany Laboratory			10			6	
53	Chemistry			56		7	30	1
54	Library	2			104	37	40	
55	IQAC	1		2		2	2	1

Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

56	Guard Room			1			1	
57	College Parking	5						
58	Jr. Office	2				2	2	1
59	Physics Dept.			43		18	40	1
	Total	**92**	**213**	**358**	**600**	**332**	**411**	**46**

Apart from above load, the college has pumps, street lights. Individual fitting wise load is as under.

Table No 2.2: Equipment wise Connected Load

No	Equipment	Qty	Load, W/Unit	Load, kW
1	F T L-40 W	92	40	3.7
2	CFL	213	24	5.1
3	LED Tube-20W	358	20	7.2
4	LED bulb	600	12	7.2
5	Computers	332	65	21.6
6	Ceiling Fan	411	65	26.7
7	AC (1.5Tr)	46	1838	84.5
8	LED focus Street light	4	35	0.1
9	Pumps (2 nos 2HP)			3.0
	Total			**114.4**

Data can be represented in terms of PIE chart as under,

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Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

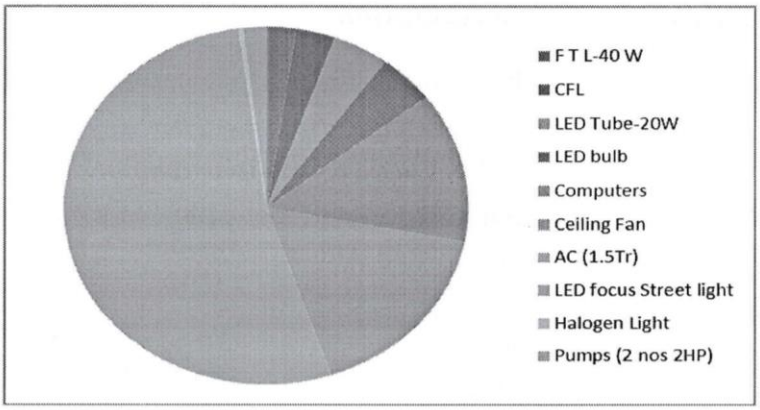

Figure 2.1: Distribution of connected load.

Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

3. Study of Electrical Energy Consumption

In this chapter, electricity bills are studied for the analysis of electrical energy consumption.

Table no 3.1: Summary of electricity bills

No	Month	Energy (kWh)	Bill Amount (Rs)
1	Jun-21	3443	31663
2	May-21	4603	39965
3	Apr-21	1910	15309
4	Mar-21	3221	28495
5	Feb-21	4026	29060
6	Jan-21	3949	29871
7	Dec-20	3933	31474
8	Nov-20	3820	29429
9	Oct-20	2472	36515
10	Sep-20	2528	37608
11	Aug-20	2087	36675
12	Jul-20	2540	34002
	Total	**38,532**	**3,80,066**

Variation in energy consumption is as follows,

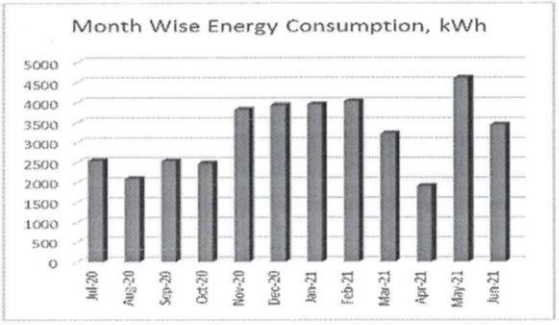

Figure 3.1: Month wise energy consumption

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Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

Monthly variation in electricity bill is as follows,

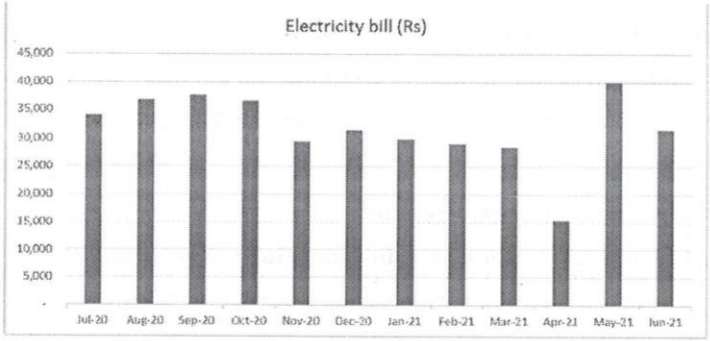


Figure 3.2: Month wise electricity bill

Key observations of electricity bill are as follows,

Table no 3.2: Key observations

Sr no	Parameter	Energy consumed, (kWh)	CO2 Emission (MT)
1	Maximum	4,603	3.68
2	Minimum	1,910	1.53
3	Average	3,211	2.57
4	Total	38,532	30.83

Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

4. Carbon Foot printing

1. A Carbon Foot print is defined as the Total Greenhouse Gas emissions (CO_2 emissions), emitted due to various activities. In this we compute the emissions of Carbon-Di-Oxide, by usage of the various form of Electrical Energy used by the College for performing its day to day activities

2. Basis for computation of CO_2 Emissions:

The basis of Calculation for CO_2 emissions due to Electrical Energy is as under

- 1 Unit (kWh) of Electrical Energy releases **0.8 Kg of CO_2** into atmosphere.

Based on the above Data we compute the CO_2 emissions which are being released in to the atmosphere by the College due to its Day to Day operations

We herewith furnish the details of various forms of Energy consumption as under

Table 4.1: Month wise Consumption of Electrical Energy & CO2 Emissions

No	Month	Energy Consumed, kWh	CO2 Emissions, MT
1	Jun-21	3,443	2.75
2	May-21	4,603	3.68
3	Apr-21	1,910	1.53
4	Mar-21	3,221	2.58
5	Feb-21	4,026	3.22
6	Jan-21	3,949	3.16
7	Dec-20	3,933	3.15
8	Nov-20	3,820	3.06
9	Oct-20	2,472	1.98
10	Sep-20	2,528	2.02
11	Aug-20	2,087	1.67
12	Jul-20	2,540	2.03
	Total	**38,532**	**30.83**

In the following Chart we present the CO2 emissions due to usage of Electrical Energy.

Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

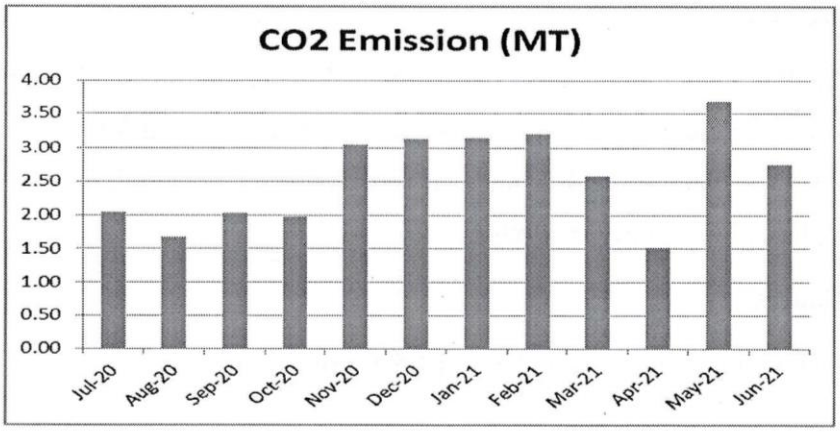


Figure 4.1: Month wise CO2 Emission

Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

5. Study of utilities

5.1 Study of Lighting

In the facility, the lighting system can be divided mainly in to parts, indoor lighting and outdoor lighting. There are 92 FTL fittings with Electronic/ magnetic chokes , 213 nos of CFLs, 358 nos of LED tubes, 600 nos of LED bulbs. It is recommended to install the 20 W LED Tube light fittings in place of these old T-8 fittings.

5.2 Air-conditioners

In the facility, there are about 46 Nos. of 1.5 Tr Air-conditioners.

5.3 Ceiling Fans

At building facility, there are about 411 Nos Old Ceiling Fans, which consumed about 65 W of Electrical Energy. It is recommended to replace these old Fans with BEE STAR Rated Ceiling Fans.

5.4 Water Pumps

There are in total Water pumps with 2HP and21HP capacities respectively.

Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

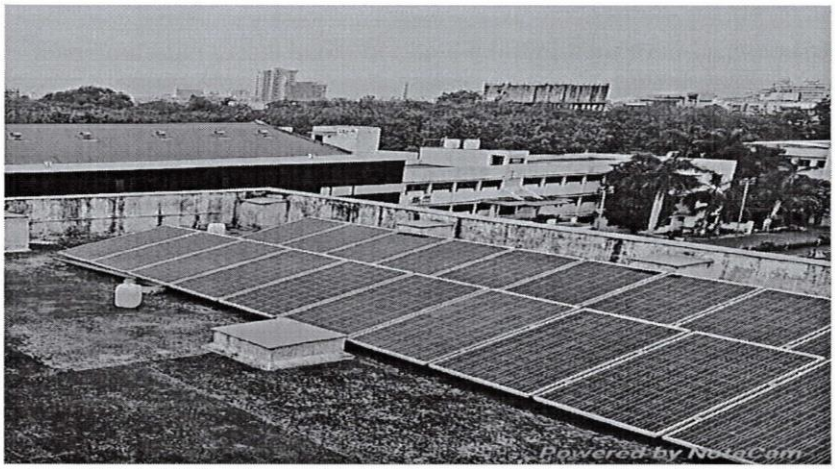
6. Study of usage of alternate energy

In this Chapter, we compute the percentage of Usage of Alternate/Renewable Energy to Annual Energy Requirement of the College. The College has installed Roof Top Solar PV System. The Installed Capacity of Solar PV Plant is **64 kWp**. The college has also installed 10,000 liters capacity Solar Thermal Hot Water system on hostel campus.

Table 6.1: Computation of % Usage of Alternate Energy to Annual Energy Requirement

No	Particulars	Value	Unit
1	Annual Energy Purchased from MSEDCL	38,532	kWh/Annum
2	Energy Generated by Roof Top Solar PV System	96000	kWh/Annum
3	Total Energy Requirement of College	134,532	kWh/Annum
4	% of Usage of Alternate Energy to Annual Energy Requirement	71	%

Photograph of Solar PV plant



Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

7. Study of usage of LED lighting

In this chapter we study the lighting system of college and compute the percentage of total load catered by LED lighting.

Table 7.1: Total lighting load

No	Particulars	Qty	Load, W/Unit	Load, kW
1	F T L-40 W	92	40	3.7
2	CFL	213	24	5.1
	LED lighting load			
1	LED tube	358	20	7.2
2	LED bulbs	600	12	7.2
3	LED street lights	4	35	0.1
	Total LED lighting load			14.5
	Total Lighting load			23.3

It can be seen that out of total lighting load 62% load is LED lighting load.

Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

8. Energy conservation proposals

8.1 Replacement of Old T-8 FTLs with 20 W LED fittings

In the facility, there are about 92 Nos, T-8, FTL fittings with Electronic/magnetic chokes. It is recommended to install the 20 W LED Tube light fittings in place of these old T-8 fittings. In the following Table, we present the savings, investment required & payback analysis.

No	Particulars	Value	Unit
1	Present Qty of T-8 fittings	92	Nos
2	Energy Demand of T-8 fitting	40	W/Unit
3	Energy Demand of 20 W LED fittin	20	W/Unit
4	Reduction in demad	20	W/Unit
5	Average Daily Usage period	4	Hrs/Day
6	Daily saving in Energy	7.36	kWh/Day
7	Annual Working Days	250	Nos
8	Annual Energy Saving possible	1840	kWh/Annum
9	Rate of Electrical Energy	11	Rs/kWh
10	Annual Monetary saving	20240	Rs/Annum
11	Cost of 20 W LED Tube	641	Rs/Unit
12	Investment required	58972	Rs lump sum
13	Simple Payback period	35	Months

Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

8.2 Replacement of old fans with STAR Rated fans

During the Audit, it was observed that there are 411 no of fans. It is recommended to replace these old fans with STAR Rated fans.

In the following Table, we present the savings, investment required & payback analysis.

No	Particulars	Value	Unit
1	Present Qty of Old Ceiling Fan fittings	411	Nos
2	Energy Demand of Old Ceiling Fan fitting	65	W/Unit
3	Energy Demand of STAR Rated Fan	40	W/Unit
4	Reduction in demad	25	W/Unit
5	Average Daily Usage period	8	Hrs/Day
6	Daily saving in Energy	82.2	kWh/Day
7	Annual Working Days	250	Nos
8	Annual Energy Saving possible	20550	kWh/Annum
9	Rate of Electrical Energy	11	Rs/kWh
10	Annual Monetary saving	226050	Rs/Annum
11	Cost of STAR Rated Ceiling Fan	2174	Rs/unit
12	Investment required	893514	Rs lump sum
13	Simple Payback period	47	Months

Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

8.3 Summary of Savings

No	Recommendation	Annual Saving potential, kWh/Annum	Annual Monetary Gain, Rs.	Investment Required, Rs.	Payback period, Months
1	Replacement of 92 Nos T-8 fittings with 20W LED fittings	1,840	20,240	58,972	35
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	Total	**22,390**	**2,46,290**	**9,52,486**	**46**

Report
On
Energy Audit
At
Shri Shivaji Education Society Amravati's
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(Year 2019-20)

Prepared by
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Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

Contents

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In the following Table, we present the details of Energy Consumption.

Table no 2.1: Details of energy consumption

Sr no	Parameter	Energy consumed, (kWh)	CO2 Emission (MT)
1	Maximum	8,923	7.14
2	Minimum	2,540	2.03
3	Average	5,458	4.37
4	Total	65,498	52.40

2. Energy Conservation Projects already installed

1. Usage of STAR Rated ACs at new installations
2. Usage of LED lights at some indoor locations
3. Usage of LED Lights for outdoor lighting.

3. Key Observations

1. Usage of LED lights.
2. Usage of star rated equipment.
3. Maintained a good power factor.

4. Percentage of Usage of Alternate Energy

The College has installed a Roof Top Solar PV Plant. The percentage of usage of Alternate Energy to Annual Energy Requirement is 59 %.

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The College has various Types of Light fittings. The percentage of Annual LED Lighting Usage to Annual Lighting requirement works out to be 62 %.

Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

6. Recommendations

Table no 1: Recommendations for energy savings

No	Recommendation	Annual Saving potential, kWh/Annum	Annual Monetary Gain, Rs.	Investment Required, Rs.	Payback period, Months
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	Total	22,390	2,46,290	9,52,486	46

7 Notes & Assumptions

1. Daily working hours-10 Nos
2. Annual working Days-300 Nos
3. Average Rate of Electrical Energy : **Rs 11/- per kWh**

Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

Abbreviations

CFL	:	Compact Fluorescent Lamp
FTL	:	Fluorescent Tube Light
LED	:	Light Emitting Diode
V	:	Voltage
I	:	Current
kW	:	Kilo- Watt
kWh	:	kilo-Watt Hour
kVA	:	Active Power

Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

1. Introduction

Shri Shivaji Education Society Amravati's Science College is located in Nagpur. With its competent galaxy of faculty members, the college has been rendering sincere services in the field of higher education since 1967. This is a single faculty college degree level and offers PG courses with recognized centers of Higher Learning and Research in Microbiology, Chemistry, Computer Science, Physics and Mathematics.

1.1 Objectives

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Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

2. Study of connected load

In this chapter, we present details of various connected electrical equipment and electrical load.

Table No-2.1: Location wise study of Electrical fittings in various buildings

No	Location	FTL (40W)	CFL	LED tube (20W)	LED bulb (12W)	Computers (65W)	Fans	1.5 Tr Star rated AC
1	Office		14	2		11	9	
2	Cabin			1	8	2	4	1
3	Meeting Hall		30		2		6	3
4	Cabin Porch				3		2	
5	Porch			1	5			
6	Exam Room			2			1	
7	Store Room	1		1				
8	Micro Biology	12		18		4	15	3
9	Biotech	9	52	5		4	17	3
10	Zoology			20		3	11	
11	Statistics	4		2	8	2	12	
12	Jr. Electronics	5		4		3	9	1
13	Electronics	11		2			9	1
14	Mathematics	2		1	6	5	4	1
15	B 1	3		1			4	
16	Physical Dept.	2		5		1	2	
17	Jr. Chemistry	2		4			4	
18	English Dept.	1	1	2	6	6	6	1
19	Computer Dept.	1		66	3	132	14	16
20	Research Lab				4	9		1
21	B 2			1			4	
22	B 3	1					4	
23	B 4	1					2	

Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

24	Jr. Physics			3			5	
25	Jr. Biology			3			4	
26	Fisheries Jr.	1		1			2	
27	3rd Floor Pasage	3	1	4				
28	B 7	2					4	
29	B 6	1					4	
30	B 9	4		3			9	
31	BCA		28		360	51	8	4
32	BCA Lab 2					29	7	3
33	B 12				11		7	
34	B 13	1		3			5	
35	Conference Hall							
36	B Block Stairs			8				
37	B Block Bath		6					
38	B Block Pasage				72		2	
39	B Block Porch			4			4	
40	301 to 313		14	15			14	
41	201 to 212			20			20	
42	101to 119			20			20	
43	Mess	3	7	3			8	
44	Warden Room			5		1	5	
45	Guest House		4	4	8		6	3
46	Gym	8					7	
47	Hostel Porch & Stairs		32	2			1	
48	First Floor Bath	2	10					
49	Second Floor Bath	2	14					
50	Botany			6		3	5	1
51	Botany PG Lab			4			4	
52	Botany Laboratory			10			6	
53	Chemistry			56		7	30	1
54	Library	2			104	37	40	
55	IQAC	1		2		2	2	1

Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

56	Guard Room			1			1	
57	College Parking	5						
58	Jr. Office	2				2	2	1
59	Physics Dept.			43		18	40	1
	Total	**92**	**213**	**358**	**600**	**332**	**411**	**46**

Apart from above load, the college has pumps, street lights. Individual fitting wise load is as under.

Table No 2.2: Equipment wise Connected Load

No	Equipment	Qty	Load, W/Unit	Load, kW
1	F T L-40 W	92	40	3.7
2	CFL	213	24	5.1
3	LED Tube-20W	358	20	7.2
4	LED bulb	600	12	7.2
5	Computers	332	65	21.6
6	Ceiling Fan	411	65	26.7
7	AC (1.5Tr)	46	1838	84.5
8	LED focus Street light	4	35	0.1
9	Pumps (2 nos 2HP)			3.0
	Total			**114.4**

Data can be represented in terms of PIE chart as under,

Nutan Urja Solutions, Pune

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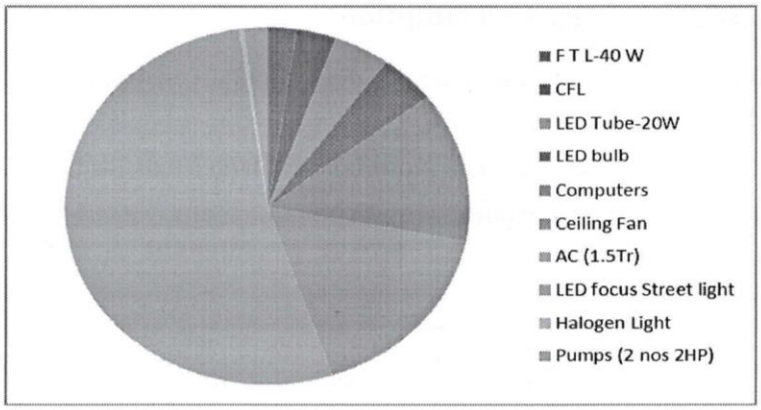

Figure 2.1: Distribution of connected load.

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3. Study of Electrical Energy Consumption

In this chapter, electricity bills are studied for the analysis of electrical energy consumption.

Table no 3.1: Summary of electricity bills

No	Month	Energy (kWh)	Bill Amount (Rs)
1	Jun-20	7517	-967
2	May-20	2540	30388
3	Apr-20	2540	5360
4	Mar-20	4481	53743
5	Feb-20	4481	55268
6	Jan-20	5361	65695
7	Dec-19	3969	53500
8	Nov-19	5579	66753
9	Oct-19	5806	67732
10	Sep-19	8923	103797
11	Aug-19	6970	77676
12	Jul-19	7331	82277
	Total	**65,498**	**6,61,222**

Variation in energy consumption is as follows,

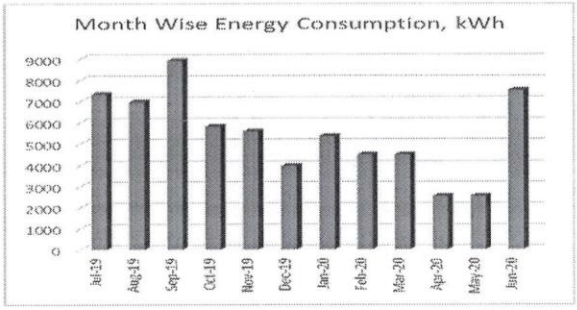

Figure 3.1: Month wise energy consumption

Nutan Urja Solutions, Pune

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Monthly variation in electricity bill is as follows,

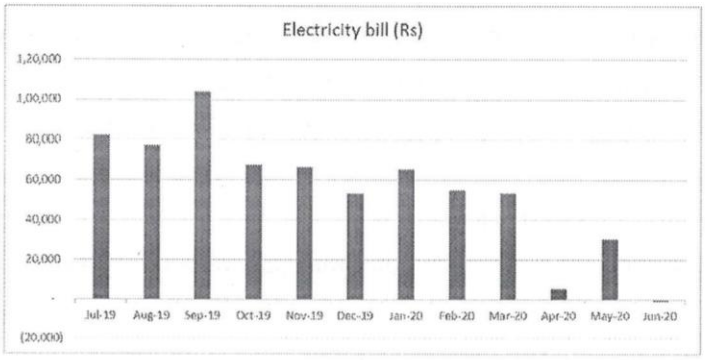

Figure 3.2: Month wise electricity bill

Key observations of electricity bill are as follows,

Table no 3.2: Key observations

Sr no	Parameter	Energy consumed, (kWh)	CO2 Emission (MT)
1	Maximum	8,923	7.14
2	Minimum	2,540	2.03
3	Average	5,458	4.37
4	Total	65,498	52.40

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4. Carbon Foot printing

1. A Carbon Foot print is defined as the Total Greenhouse Gas emissions (CO_2 emissions), emitted due to various activities. In this we compute the emissions of Carbon-Di-Oxide, by usage of the various form of Electrical Energy used by the College for performing its day to day activities

2. Basis for computation of CO_2 Emissions:

The basis of Calculation for CO_2 emissions due to Electrical Energy is as under

- 1 Unit (kWh) of Electrical Energy releases **0.8 Kg of CO_2** into atmosphere.

Based on the above Data we compute the CO_2 emissions which are being released in to the atmosphere by the College due to its Day to Day operations

We herewith furnish the details of various forms of Energy consumption as under

Table 4.1: Month wise Consumption of Electrical Energy & CO2 Emissions

No	Month	Energy Consumed, kWh	CO2 Emissions, MT
1	Jun-20	7,517	6.01
2	May-20	2,540	2.03
3	Apr-20	2,540	2.03
4	Mar-20	4,481	3.58
5	Feb-20	4,481	3.58
6	Jan-20	5,361	4.29
7	Dec-19	3,969	3.18
8	Nov-19	5,579	4.46
9	Oct-19	5,806	4.64
10	Sep-19	8,923	7.14
11	Aug-19	6,970	5.58
12	Jul-19	7,331	5.86
	Total	**65,498**	**52.40**

In the following Chart we present the CO2 emissions due to usage of Electrical Energy.

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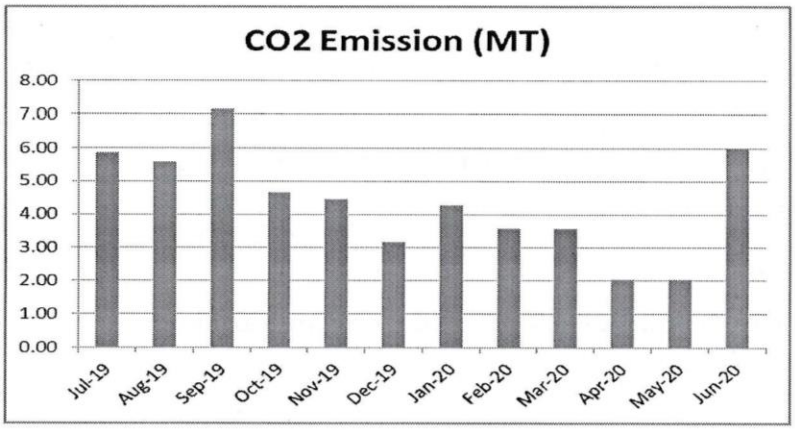

Figure 4.1: Month wise CO2 Emission

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5. Study of utilities

5.1 Study of Lighting

In the facility, the lighting system can be divided mainly in to parts, indoor lighting and outdoor lighting. There are 92 FTL fittings with Electronic/ magnetic chokes , 213 nos of CFLs, 358 nos of LED tubes, 600 nos of LED bulbs. It is recommended to install the 20 W LED Tube light fittings in place of these old T-8 fittings.

5.2 Air-conditioners

In the facility, there are about 46 Nos. of 1.5 Tr Air-conditioners.

5.3 Ceiling Fans

At building facility, there are about 411 Nos Old Ceiling Fans, which consumed about 65 W of Electrical Energy. It is recommended to replace these old Fans with BEE STAR Rated Ceiling Fans.

5.4 Water Pumps

There are in total Water pumps with 2HP and21HP capacities respectively.

Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

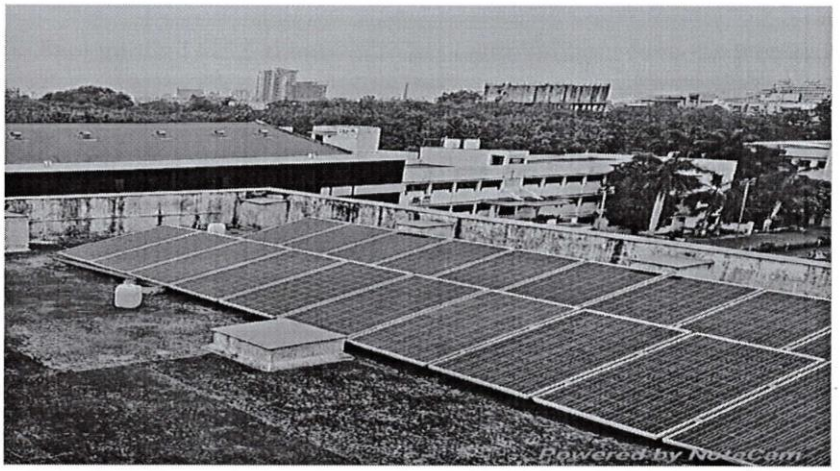
6. Study of usage of alternate energy

In this Chapter, we compute the percentage of Usage of Alternate/Renewable Energy to Annual Energy Requirement of the College. The College has installed Roof Top Solar PV System. The Installed Capacity of Solar PV Plant is **64 kWp**. The college has also installed 10,000 liters capacity Solar Thermal Hot Water system on hostel campus.

Table 6.1: Computation of % Usage of Alternate Energy to Annual Energy Requirement

No	Particulars	Value	Unit
1	Annual Energy Purchased from MSEDCL	65,498	kWh/Annum
2	Energy Generated by Roof Top Solar PV System	96000	kWh/Annum
3	Total Energy Requirement of College	161,498	kWh/Annum
4	% of Usage of Alternate Energy to Annual Energy Requirement	59	%

Photograph of Solar PV plant



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7. Study of usage of LED lighting

In this chapter we study the lighting system of college and compute the percentage of total load catered by LED lighting.

Table 7.1: Total lighting load

No	Particulars	Qty	Load, W/Unit	Load, kW
1	F T L-40 W	92	40	3.7
2	CFL	213	24	5.1
	LED lighting load			
1	LED tube	358	20	7.2
2	LED bulbs	600	12	7.2
3	LED street lights	4	35	0.1
	Total LED lighting load			14.5
	Total Lighting load			23.3

It can be seen that out of total lighting load 62% load is LED lighting load.

Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

8. Energy conservation proposals

8.1 Replacement of Old T-8 FTLs with 20 W LED fittings

In the facility, there are about 92 Nos, T-8, FTL fittings with Electronic/magnetic chokes. It is recommended to install the 20 W LED Tube light fittings in place of these old T-8 fittings. In the following Table, we present the savings, investment required & payback analysis.

No	Particulars	Value	Unit
1	Present Qty of T-8 fittings	92	Nos
2	Energy Demand of T-8 fitting	40	W/Unit
3	Energy Demand of 20 W LED fittin	20	W/Unit
4	Reduction in demad	20	W/Unit
5	Average Daily Usage period	4	Hrs/Day
6	Daily saving in Energy	7.36	kWh/Day
7	Annual Working Days	250	Nos
8	Annual Energy Saving possible	1840	kWh/Annum
9	Rate of Electrical Energy	11	Rs/kWh
10	Annual Monetary saving	20240	Rs/Annum
11	Cost of 20 W LED Tube	641	Rs/Unit
12	Investment required	58972	Rs lump sum
13	Simple Payback period	35	Months

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8.2 Replacement of old fans with STAR Rated fans

During the Audit, it was observed that there are 411 no of fans. It is recommended to replace these old fans with STAR Rated fans.

In the following Table, we present the savings, investment required & payback analysis.

No	Particulars	Value	Unit
1	Present Qty of Old Ceiling Fan fittings	411	Nos
2	Energy Demand of Old Ceiling Fan fitting	65	W/Unit
3	Energy Demand of STAR Rated Fan	40	W/Unit
4	Reduction in demad	25	W/Unit
5	Average Daily Usage period	8	Hrs/Day
6	Daily saving in Energy	82.2	kWh/Day
7	Annual Working Days	250	Nos
8	Annual Energy Saving possible	20550	kWh/Annum
9	Rate of Electrical Energy	11	Rs/kWh
10	Annual Monetary saving	226050	Rs/Annum
11	Cost of STAR Rated Ceiling Fan	2174	Rs/unit
12	Investment required	893514	Rs lump sum
13	Simple Payback period	47	Months

Report on Energy Audit: Shri Shivaji Education Society Amravati's Science College, Nagpur

8.3 Summary of Savings

No	Recommendation	Annual Saving potential, kWh/Annum	Annual Monetary Gain, Rs.	Investment Required, Rs.	Payback period, Months
1	Replacement of 92 Nos T-8 fittings with 20W LED fittings	1,840	20,240	58,972	35
2	Replacement of 411 Nos Old Ceiling Fans with STAR rating fans	20,550	2,26,050	8,93,514	47
	Total	**22,390**	**2,46,290**	**9,52,486**	**46**