Report

On

Energy Audit

At

Dr. Madhukarrao Wasnik P.W.S. Arts, Commerce, Science College, Nagpur

(Year 2018-19)

Prepared by

Nutan Urja Solutions

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Acknowledgement

We at Nutan Urja Solutions, Pune, express our sincere gratitude to the management of Dr. Madhukarrao Wasnik P.W.S. Arts, Commerce, 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, (Units)	CO2 Emission (MT)
1	Maximum	3,145	2.52
2	Minimum	1,608	1.29
3	Average	2,470	1.98
4	Total	29,645	23.72

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.
4. Usage of STAR rated fans at new installations

3. Key Observations

1. Usage of LED lights.
2. Usage of star rated equipment.
3. Maintained a good power factor.
4. There are about 67 Nos old T-8 type fittings which need to be replaced by 20 W LEDs.

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 68.8 %.

5. Percentage of Usage of LED Lighting

The College has various Types of Light fittings, namely: LED, FTL & CFL. The percentage of Annual LED Lighting Usage to Annual Lighting requirement works out to be 51.12%.

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 67 Nos T-8 fittings with 20W LED fittings	1,340	14,740	42,947	35
2	Replacement of 190 Nos Old Ceiling Fans with STAR rating fans	2,470	27,170	413,060	182
3	Replacement of 1 Nos of 100W focus halogen street lights with 50W focus LEDs	100	1,100	1,200	13
4	Replacement of 2 Nos of 400W focus halogen street lights with 50W focus LEDs	1,400	15,400	2,400	2
	Total	**3,810**	**41,910**	**456,007**	**131**

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

People's Welfare society established its first college, named PWS College of Arts and Commerce, on Kamptee Road, Nagpur in 1967. This is one of the biggest and well known institutions for marginalized sections in North Nagpur. Since its inception, more than 4000 students have joined the college every year and with various facilities at its disposal, the college is one of the best colleges in Northern Nagpur. The institute envisions molding of students who have humanitarian views, scientific approaches and are firm believer in positive social change. Such inspired youth will uphold the human values of liberty, equality and fraternity, and also shoulder the responsibilities of taking their nations to greater heights. The institute also offers affordable and various courses in the disciplines of Arts and Commerce.

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	Dr. Madhukarrao Wasnik P.W.S. Arts, Commerce, Science College, Nagpur
2	Address	786, Kamptee Rd, Old Teka Naka, Teka Naka, Nagpur, Maharashtra 440026.
3	Affiliation	Rashtrasant Tukdoji Maharaj 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)	LED tube (20W)	LED bulb (15W)	Computers	Fans	1.5TR Star rated AC
	Ground Floor						
1	Lok Kalyan Kendra		6			5	
2	Canteen	1				2	
3	Digital Room	4				6	
4	Sidharth Hall	14				20	
5	Jr College Office	2	2	1	4	3	
6	Passage	2	3	2		1	
7	Yashvantrao Mukt Vidyapith		2		1	1	
8	Vice Principal		2			1	
9	Guest House	2		1		1	1
10	Management Room		2	3	1	1	
11	NAAC Room		2		2	2	
12	Principal Office			15		3	1
13	Conference Hall			12		2	
14	Office	2	8	1	9	8	
15	People Welfare Society		2			2	1
16	Library	7	9		2	16	
17	Computer Lab		8		38	6	
18	Gym	7				7	
	First Floor						
19	Passage		8				
20	NSS		1			2	
21	102		4			2	
22	Economics and Research	1	1			2	
23	104		2			2	

24	105		2			2	
25	106		2			2	
26	107		2			2	
27	108		2			2	
28	109		2			2	
29	110		2			2	
30	111	4				2	
31	Pali Dept.	3				2	
32	Staff Room		7		2	6	
33	Toilet			8			
34	112		4		1	5	
35	113		3			3	
36	114		3			3	
37	115		1			1	
38	Toilet		2				
39	Common Room		1			1	
	Second Floor						
40	Passage		8				
41	217		3			2	
42	216		2			3	
43	215		3			3	
44	214		3			4	
45	English Dept.	9				9	
46	Psychology		4			2	
47	Marathi	1	1			2	
48	Hindi		2			2	
49	209		3			2	
50	208	2				2	
51	207		2			2	
52	206		2			2	
53	205	2				2	
54	204		2			2	
55	203	2				2	
56	202		2			2	
57	201		2			2	
58	200	2			2	2	
	Third Floor						
59	Botany Lab		3			1	
60	Physics lab		4			2	

61	Passage					4	
62	Chemistry lab		4			2	
63	Zoology lab		2			2	
64	Staff Room		2			2	
65	Passage		4				
	Total	**67**	**153**	**43**	**62**	**190**	**3**

Apart from above load, the school has pumps, LED street lights, CFLs and LED focus street lights on streets and grounds. Individual fitting wise load is as under.

Table No 2.2: Equipment wise Connected Load

No	Equipment	Qty	Load, W/Unit	Load, kW
1	Ceiling Fan	190	65	12.4
3	AC-New (1.5 TR)	3	1838	5.5
5	LED-20W	155	20	3.1
6	LED bulb (15W)	43	15	0.6
7	F T L-40 W	67	40	2.7
8	Computers	62	65	4.0
9	Pump(3HP)			2.3
10	Halogen street lights (100W)	1	100	0.1
11	Halogen street lights (400W)	2	400	0.8
	Total			31.5

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

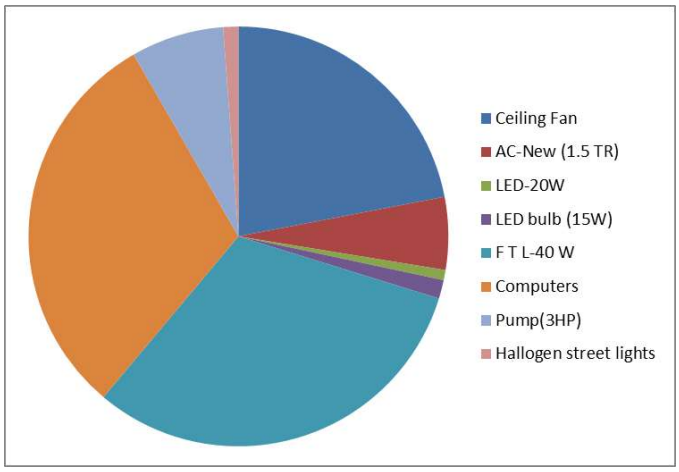

Figure 2.1: Distribution of connected load.

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	Aug-19	3,048	45,540
2	Jul-19	3,145	43,087
3	Jun-19	2,945	46,780
4	May-19	3,116	50,350
5	Apr-19	2,644	39,920
6	Mar-19	2,399	35,480
7	Feb-19	1,781	24,400
8	Jan-19	1,868	25,592
9	Dec-18	1,608	22,030
10	Nov-18	1,670	22,879
11	Oct-18	2,680	36,716
12	Sep-18	2,741	37,552
	Total	**29,645**	**430,324**

Variation in energy consumption is as follows,

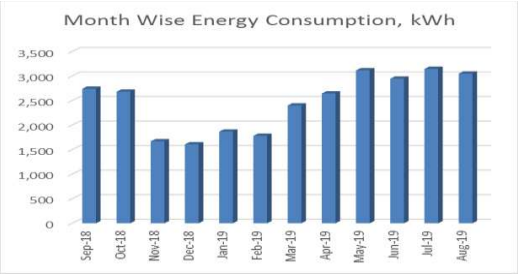

Figure 3.1: Month wise energy consumption

Monthly variation in electricity bill is as follows,

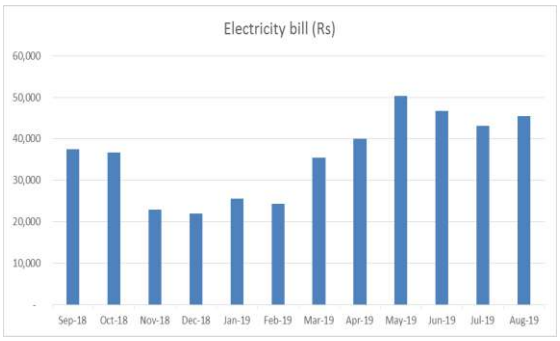

Figure 3.2: Month wise electricity bill

Key observations of electricity bill are as follows,

Table no 3.2: Key observations

Sr no	Parameter	Energy consumed, (Units)	CO2 Emission (MT)
1	Maximum	3,145	2.52
2	Minimum	1,608	1.29
3	Average	2,470	1.98
4	Total	29,645	23.72

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	Aug-19	3,048	2.44
2	Jul-19	3,145	2.52
3	Jun-19	2,945	2.36
4	May-19	3,116	2.49
5	Apr-19	2,644	2.12
6	Mar-19	2,399	1.92
7	Feb-19	1,781	1.42
8	Jan-19	1,868	1.49
9	Dec-18	1,608	1.29
10	Nov-18	1,670	1.34
11	Oct-18	2,680	2.14
12	Sep-18	2,741	2.19
	Total	**29,645**	**23.72**

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

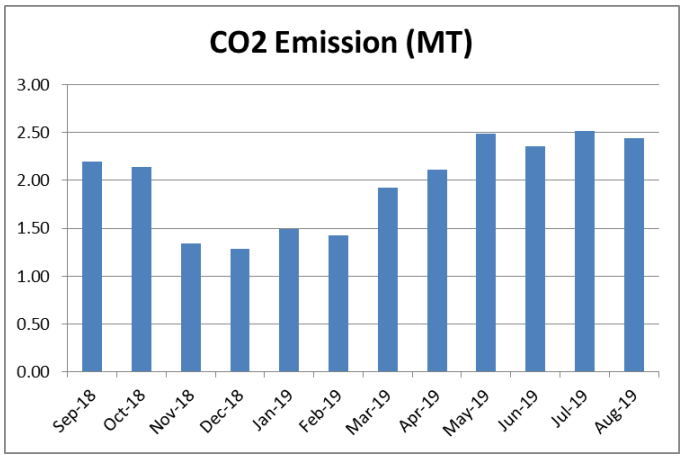

Figure 4.1: Month wise CO2 Emission

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 67 FTL fittings with Electronic/ magnetic chokes, 153 no of 20W LED tubes and 43 nos of 15W LED bulbs in indoor lightings. It is recommended to install the 20 W LED Tube light fittings in place of these old T-8 fittings. There are 2 number of 20W LED tube lights, 2 Nos of 400W focus halogen street light and 1 Nos of 100W focus halogen street lights. It is recommended to replace halogen street lights with 50W focus LED street lights,

5.2 Air-conditioners

There are 3 nos of star rated new AC of 1.5Tr capacity.

5.3 Ceiling Fans

At building facility, there are about 190 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 1 Water pumps with 3HPcapacity.

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 **20 kWp**.

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

No	Particulars	Value	Unit
1	Annual Energy Purchased from MSEDCL	29,645	kWh/Annum
2	Energy Generated by Roof Top Solar PV System	30,000	kWh/Annum
3	Total Energy Requirement of College	59,645	kWh/Annum
4	% of Usage of Alternate Energy to Annual Energy Requirement = 2*100/3	50	**%**

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	67	40	2.68
2	Halogen street lights (100 W)	1	100	0.1
3	Halogen street lights (400W)	2	400	0.8
	LED lighting load			
1	LED tube	155	20	3.1
2	LED bulb	43	15	0.645
	Total LED lighting load			**3.745**
	Total Lighting load			**7.325**

It can be seen that out of total lighting load 51% 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 67 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	67	Nos
2	Energy Demand of T-8 fitting	40	W/Unit
3	Energy Demand of 20 W LED fitting	20	W/Unit
4	Reduction in demand	20	W/Unit
5	Average Daily Usage period	4	Hrs/Day
6	Daily saving in Energy	5.36	kWh/Day
7	Annual Working Days	250	Nos
8	Annual Energy Saving possible	1340	kWh/Annum
9	Rate of Electrical Energy	11	Rs/kWh
10	Annual Monetary saving	14740	Rs/Annum
11	Cost of 20 W LED Tube	641	Rs/Unit
12	Investment required	42947	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 190 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	190	Nos
2	Energy Demand of Old Ceiling Fan fitting	65	W/Unit
3	Energy Demand of STAR Rated Fan	52	W/Unit
4	Reduction in demand	13	W/Unit
5	Average Daily Usage period	4	Hrs/Day
6	Daily saving in Energy	9.88	kWh/Day
7	Annual Working Days	250	Nos
8	Annual Energy Saving possible	2470	kWh/Annum
9	Rate of Electrical Energy	11	Rs/kWh
10	Annual Monetary saving	27170	Rs/Annum
11	Cost of STAR Rated Ceiling Fan	2174	Rs/unit
12	Investment required	413060	Rs lump sum
13	Simple Payback period	182	Months

8.3 Replacement of 100W focus halogen street lights with 50W focus LEDs

In the facility, there are about 01 Nos, 100W focus halogen. It is recommended to install the 50 W LED focus street light fittings in place of these halogen street lights. In the following Table, we present the savings, investment required & payback analysis.

No	Particulars	Value	Unit
1	Present Qty of 100W focus halogen street lights	1	Nos
2	Energy Demand of 100W focus halogen street lights	100	W/Unit
3	Energy Demand of LED street light	50	W/Unit
4	Reduction in demand	50	W/Unit
5	Average Daily Usage period	8	Hrs/Day
6	Daily saving in Energy	0.4	kWh/Day
7	Annual Working Days	250	Nos
8	Annual Energy Saving possible	100	kWh/Annum
9	Rate of Electrical Energy	11	Rs/kWh
10	Annual Monetary saving	1100	Rs/Annum
11	Cost of LED street lights	1200	Rs/Unit
12	Investment required	1200	Rs lump sum
13	Simple Payback period	13	Months

8.4 Replacement of 400W focus halogen street lights with 50W focus LEDs

In the facility, there are about 02 Nos, 400W focus halogen. It is recommended to install the 50 W LED focus street light fittings in place of these halogen street lights. In the following Table, we present the savings, investment required & payback analysis.

No	Particulars	Value	Unit
1	Present Qty of 400W focus halogen street lights	2	Nos
2	Energy Demand of 400W focus halogen street lights	400	W/Unit
3	Energy Demand of LED street light	50	W/Unit
4	Reduction in demand	350	W/Unit
5	Average Daily Usage period	8	Hrs/Day
6	Daily saving in Energy	5.6	kWh/Day
7	Annual Working Days	250	Nos
8	Annual Energy Saving possible	1400	kWh/Annum
9	Rate of Electrical Energy	11	Rs/kWh
10	Annual Monetary saving	15400	Rs/Annum
11	Cost of LED street lights	1200	Rs/Unit
12	Investment required	2400	Rs lump sum
13	Simple Payback period	2	Months

8.5 Summary of Savings

No	Recommendation	Annual Saving potential, kWh/Annum	Annual Monetary Gain, Rs.	Investment Required, Rs.	Payback period, Months
1	Replacement of 67 Nos T-8 fittings with 20W LED fittings	1,340	14,740	42,947	35
2	Replacement of 190 Nos Old Ceiling Fans with STAR rating fans	2,470	27,170	413,060	182
3	Replacement of 1 Nos of 100W focus halogen street lights with 50W focus LEDs	100	1,100	1,200	13
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I	:	Current
kW	:	Kilo- Watt
kWh	:	kilo-Watt Hour
kVA	:	Active Power

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2	Canteen	1				2	
3	Digital Room	4				6	
4	Sidharth Hall	14				20	
5	Jr College Office	2	2	1	4	3	
6	Passage	2	3	2		1	
7	Yashvantrao Mukt Vidyapith		2		1	1	
8	Vice Principal		2			1	
9	Guest House	2		1		1	1
10	Management Room		2	3	1	1	
11	NAAC Room		2		2	2	
12	Principal Office			15		3	1
13	Conference Hall			12		2	
14	Office	2	8	1	9	8	
15	People Welfare Society		2			2	1
16	Library	7	9		2	16	
17	Computer Lab		8		38	6	
18	Gym	7				7	
	First Floor						
19	Passage		8				
20	NSS		1			2	
21	102		4			2	
22	Economics and Research	1	1			2	
23	104		2			2	

24	105		2			2	
25	106		2			2	
26	107		2			2	
27	108		2			2	
28	109		2			2	
29	110		2			2	
30	111	4				2	
31	Pali Dept.	3				2	
32	Staff Room		7		2	6	
33	Toilet			8			
34	112		4		1	5	
35	113		3			3	
36	114		3			3	
37	115		1			1	
38	Toilet		2				
39	Common Room		1			1	
	Second Floor						
40	Passage		8				
41	217		3			2	
42	216		2			3	
43	215		3			3	
44	214		3			4	
45	English Dept.	9				9	
46	Psychology		4			2	
47	Marathi	1	1			2	
48	Hindi		2			2	
49	209		3			2	
50	208	2				2	
51	207		2			2	
52	206		2			2	
53	205	2				2	
54	204		2			2	
55	203	2				2	
56	202		2			2	
57	201		2			2	
58	200	2			2	2	
	Third Floor						
59	Botany Lab		3			1	
60	Physics lab		4			2	

61	Passage					4	
62	Chemistry lab		4			2	
63	Zoology lab		2			2	
64	Staff Room		2			2	
65	Passage		4				
	Total	**67**	**153**	**43**	**62**	**190**	**3**

Apart from above load, the school has pumps, LED street lights, CFLs and LED focus street lights on streets and grounds. Individual fitting wise load is as under.

Table No 2.2: Equipment wise Connected Load

No	Equipment	Qty	Load, W/Unit	Load, kW
1	Ceiling Fan	190	65	12.4
3	AC-New (1.5 TR)	3	1838	5.5
5	LED-20W	155	20	3.1
6	LED bulb (15W)	43	15	0.6
7	F T L-40 W	67	40	2.7
8	Computers	62	65	4.0
9	Pump(3HP)			2.3
10	Halogen street lights (100W)	1	100	0.1
11	Halogen street lights (400W)	2	400	0.8
	Total			31.5

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

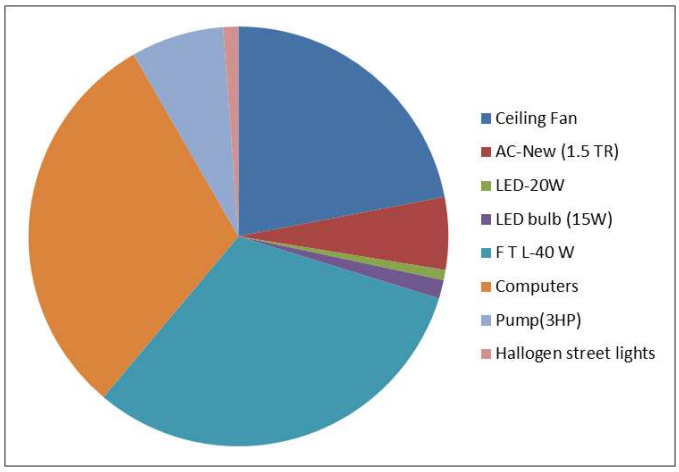

Figure 2.1: Distribution of connected load.

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	Sep-20	1,243	17,110
2	Aug-20	1,317	16,090
3	Jul-20	1,068	13,760
4	Jun-20	3,579	49,032
5	May-20	1,626	22,276
6	Apr-20	1,626	22,276
7	Mar-20	1,822	24,961
8	Feb-20	1,645	25,200
9	Jan-20	1,410	21,090
10	Dec-19	1,753	27,370
11	Nov-19	1,320	19,690
12	Oct-19	2,726	43,350
	Total	21,135	302,206

Variation in energy consumption is as follows,

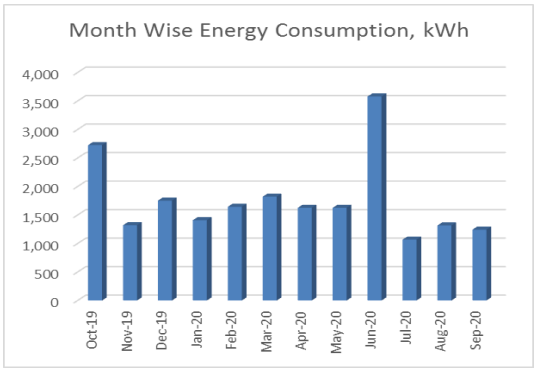

Figure 3.1: Month wise energy consumption

Monthly variation in electricity bill is as follows,

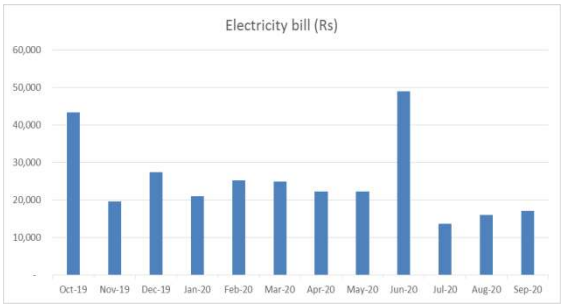

Figure 3.2: Month wise electricity bill

Key observations of electricity bill are as follows,

Table no 3.2: Key observations

Sr no	Parameter	Energy consumed, (Units)	CO2 Emission (MT)
1	Maximum	3,579	2.86
2	Minimum	1,068	0.85
3	Average	1,761	1.41
4	Total	21,135	16.91

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	Sep-20	1,243	0.99
2	Aug-20	1,317	1.05
3	Jul-20	1,068	0.85
4	Jun-20	3,579	2.86
5	May-20	1,626	1.30
6	Apr-20	1,626	1.30
7	Mar-20	1,822	1.46
8	Feb-20	1,645	1.32
9	Jan-20	1,410	1.13
10	Dec-19	1,753	1.40
11	Nov-19	1,320	1.06
12	Oct-19	2,726	2.18
	Total	**21,135**	**16.91**

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

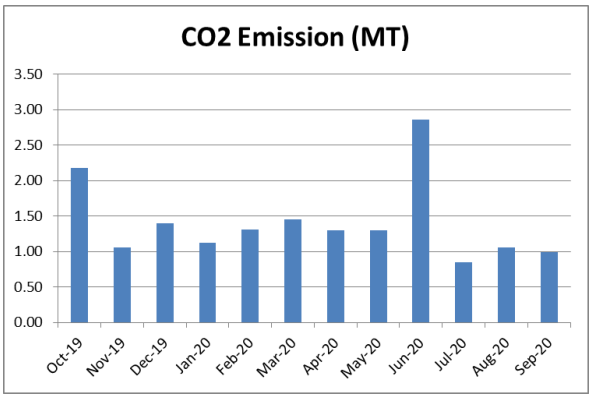

Figure 4.1: Month wise CO2 Emission

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 67 FTL fittings with Electronic/ magnetic chokes, 153 no of 20W LED tubes and 43 nos of 15W LED bulbs in indoor lightings. It is recommended to install the 20 W LED Tube light fittings in place of these old T-8 fittings. There are 2 number of 20W LED tube lights, 2 Nos of 400W focus halogen street light and 1 Nos of 100W focus halogen street lights. It is recommended to replace halogen street lights with 50W focus LED street lights,

5.2 Air-conditioners

There are 3 nos of star rated new AC of 1.5Tr capacity.

5.3 Ceiling Fans

At building facility, there are about 190 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 1 Water pumps with 3HPcapacity.

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 **20 kWp**.

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

No	Particulars	Value	Unit
1	Annual Energy Purchased from MSEDCL	21,135	kWh/Annum
2	Energy Generated by Roof Top Solar PV System	30000	kWh/Annum
3	Total Energy Requirement of College	51135	kWh/Annum
4	% of Usage of Alternate Energy to Annual Energy Requirement = 2*100/3	59	**%**

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	67	40	2.68
2	Halogen street lights (100 W)	1	100	0.1
3	Halogen street lights (400W)	2	400	0.8
	LED lighting load			
1	LED tube	155	20	3.1
2	LED bulb	43	15	0.645
	Total LED lighting load			**3.745**
	Total Lighting load			**7.325**

It can be seen that out of total lighting load 51% 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 67 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	67	Nos
2	Energy Demand of T-8 fitting	40	W/Unit
3	Energy Demand of 20 W LED fitting	20	W/Unit
4	Reduction in demand	20	W/Unit
5	Average Daily Usage period	4	Hrs/Day
6	Daily saving in Energy	5.36	kWh/Day
7	Annual Working Days	250	Nos
8	Annual Energy Saving possible	1340	kWh/Annum
9	Rate of Electrical Energy	11	Rs/kWh
10	Annual Monetary saving	14740	Rs/Annum
11	Cost of 20 W LED Tube	641	Rs/Unit
12	Investment required	42947	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 190 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	190	Nos
2	Energy Demand of Old Ceiling Fan fitting	65	W/Unit
3	Energy Demand of STAR Rated Fan	52	W/Unit
4	Reduction in demand	13	W/Unit
5	Average Daily Usage period	4	Hrs/Day
6	Daily saving in Energy	9.88	kWh/Day
7	Annual Working Days	250	Nos
8	Annual Energy Saving possible	2470	kWh/Annum
9	Rate of Electrical Energy	11	Rs/kWh
10	Annual Monetary saving	27170	Rs/Annum
11	Cost of STAR Rated Ceiling Fan	2174	Rs/unit
12	Investment required	413060	Rs lump sum
13	Simple Payback period	182	Months

8.3 Replacement of 100W focus halogen street lights with 50W focus LEDs

In the facility, there are about 01 Nos, 100W focus halogen. It is recommended to install the 50 W LED focus street light fittings in place of these halogen street lights. In the following Table, we present the savings, investment required & payback analysis.

No	Particulars	Value	Unit
1	Present Qty of 100W focus halogen street lights	1	Nos
2	Energy Demand of 100W focus halogen street lights	100	W/Unit
3	Energy Demand of LED street light	50	W/Unit
4	Reduction in demand	50	W/Unit
5	Average Daily Usage period	8	Hrs/Day
6	Daily saving in Energy	0.4	kWh/Day
7	Annual Working Days	250	Nos
8	Annual Energy Saving possible	100	kWh/Annum
9	Rate of Electrical Energy	11	Rs/kWh
10	Annual Monetary saving	1100	Rs/Annum
11	Cost of LED street lights	1200	Rs/Unit
12	Investment required	1200	Rs lump sum
13	Simple Payback period	13	Months

8.4 Replacement of 400W focus halogen street lights with 50W focus LEDs

In the facility, there are about 02 Nos, 400W focus halogen. It is recommended to install the 50 W LED focus street light fittings in place of these halogen street lights. In the following Table, we present the savings, investment required & payback analysis.

No	Particulars	Value	Unit
1	Present Qty of 400W focus halogen street lights	2	Nos
2	Energy Demand of 400W focus halogen street lights	400	W/Unit
3	Energy Demand of LED street light	50	W/Unit
4	Reduction in demand	350	W/Unit
5	Average Daily Usage period	8	Hrs/Day
6	Daily saving in Energy	5.6	kWh/Day
7	Annual Working Days	250	Nos
8	Annual Energy Saving possible	1400	kWh/Annum
9	Rate of Electrical Energy	11	Rs/kWh
10	Annual Monetary saving	15400	Rs/Annum
11	Cost of LED street lights	1200	Rs/Unit
12	Investment required	2400	Rs lump sum
13	Simple Payback period	2	Months

8.5 Summary of Savings

No	Recommendation	Annual Saving potential, kWh/Annum	Annual Monetary Gain, Rs.	Investment Required, Rs.	Payback period, Months
1	Replacement of 67 Nos T-8 fittings with 20W LED fittings	1,340	14,740	42,947	35
2	Replacement of 190 Nos Old Ceiling Fans with STAR rating fans	2,470	27,170	413,060	182
3	Replacement of 1 Nos of 100W focus halogen street lights with 50W focus LEDs	100	1,100	1,200	13
4	Replacement of 2 Nos of 400W focus halogen street lights with 50W focus LEDs	1,400	15,400	2,400	2
	Total	**3,810**	**41,910**	**456,007**	**131**

Report

On

Energy Audit

At

Dr. Madhukarrao Wasnik P.W.S. Arts, Commerce, Science College, Nagpur

(Year 2020-21)

Prepared by

Nutan Urja Solutions

A 703, Balaji Witefield, Near Sunni's World,

Sus Road, Sus, Pune 411 021

Phone: 83568 18381. Email: nutanurja.solutions@gmail.com

Contents

Acknowledgement

We at Nutan Urja Solutions, Pune, express our sincere gratitude to the management of Dr. Madhukarrao Wasnik P.W.S. Arts, Commerce, 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, (Units)	CO2 Emmision (MT)
1	Maximum	1,809	1.45
2	Minimum	649	0.52
3	Average	1,135	0.91
4	Total	13,616	10.89

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.
4. Usage of STAR rated fans at new installations

3. Key Observations

1. Usage of LED lights.
2. Usage of star rated equipment.
3. Maintained a good power factor.
4. There are about 67 Nos old T-8 type fittings which need to be replaced by 20 W LEDs.

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 68.8 %.

5. Percentage of Usage of LED Lighting

The College has various Types of Light fittings, namely: LED, FTL & CFL. The percentage of Annual LED Lighting Usage to Annual Lighting requirement works out to be 51.12%.

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 67 Nos T-8 fittings with 20W LED fittings	1,340	14,740	42,947	35
2	Replacement of 190 Nos Old Ceiling Fans with STAR rating fans	2,470	27,170	413,060	182
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4	Replacement of 2 Nos of 400W focus halogen street lights with 50W focus LEDs	1,400	15,400	2,400	2
	Total	**3,810**	**41,910**	**456,007**	**131**

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

People's Welfare society established its first college, named PWS College of Arts and Commerce, on Kamptee Road, Nagpur in 1967. This is one of the biggest and well known institutions for marginalized sections in North Nagpur. Since its inception, more than 4000 students have joined the college every year and with various facilities at its disposal, the college is one of the best colleges in Northern Nagpur. The institute envisions molding of students who have humanitarian views, scientific approaches and are firm believer in positive social change. Such inspired youth will uphold the human values of liberty, equality and fraternity, and also shoulder the responsibilities of taking their nations to greater heights. The institute also offers affordable and various courses in the disciplines of Arts and Commerce.

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	Dr. Madhukarrao Wasnik P.W.S. Arts, Commerce, Science College, Nagpur
2	Address	786, Kamptee Rd, Old Teka Naka, Teka Naka, Nagpur, Maharashtra 440026.
3	Affiliation	Rashtrasant Tukdoji Maharaj 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)	LED tube (20W)	LED bulb (15W)	Computers	Fans	1.5TR Star rated AC
	Ground Floor						
1	Lok Kalyan Kendra		6			5	
2	Canteen	1				2	
3	Digital Room	4				6	
4	Sidharth Hall	14				20	
5	Jr College Office	2	2	1	4	3	
6	Passage	2	3	2		1	
7	Yashvantrao Mukt Vidyapith		2		1	1	
8	Vice Principal		2			1	
9	Guest House	2		1		1	1
10	Management Room		2	3	1	1	
11	NAAC Room		2		2	2	
12	Principal Office			15		3	1
13	Conference Hall			12		2	
14	Office	2	8	1	9	8	
15	People Welfare Society		2			2	1
16	Library	7	9		2	16	
17	Computer Lab		8		38	6	
18	Gym	7				7	
	First Floor						
19	Passage		8				
20	NSS		1			2	
21	102		4			2	
22	Economics and Research	1	1			2	
23	104		2			2	

24	105		2			2	
25	106		2			2	
26	107		2			2	
27	108		2			2	
28	109		2			2	
29	110		2			2	
30	111	4				2	
31	Pali Dept.	3				2	
32	Staff Room		7		2	6	
33	Toilet			8			
34	112		4		1	5	
35	113		3			3	
36	114		3			3	
37	115		1			1	
38	Toilet		2				
39	Common Room		1			1	
	Second Floor						
40	Passage		8				
41	217		3			2	
42	216		2			3	
43	215		3			3	
44	214		3			4	
45	English Dept.	9				9	
46	Psychology		4			2	
47	Marathi	1	1			2	
48	Hindi		2			2	
49	209		3			2	
50	208	2				2	
51	207		2			2	
52	206		2			2	
53	205	2				2	
54	204		2			2	
55	203	2				2	
56	202		2			2	
57	201		2			2	
58	200	2			2	2	
	Third Floor						
59	Botany Lab		3			1	
60	Physics lab		4			2	

61	Passage					4	
62	Chemistry lab		4			2	
63	Zoology lab		2			2	
64	Staff Room		2			2	
65	Passage		4				
	Total	**67**	**153**	**43**	**62**	**190**	**3**

Apart from above load, the school has pumps, LED street lights, CFLs and LED focus street lights on streets and grounds. Individual fitting wise load is as under.

Table No 2.2: Equipment wise Connected Load

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8	Computers	62	65	4.0
9	Pump(3HP)			2.3
10	Halogen street lights (100W)	1	100	0.1
11	Halogen street lights (400W)	2	400	0.8
	Total			31.5

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

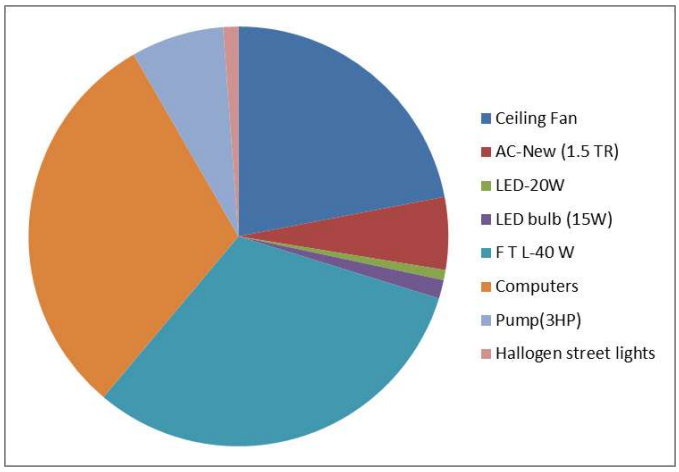

Figure 2.1: Distribution of connected load.

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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	Jul-21	1809	26,010
2	Jun-21	918	12,110
3	May-21	649	18,600
4	Apr-21	881	11,560
5	Mar-21	952	13,050
6	Feb-21	1321	18,190
7	Jan-21	1215	16,750
8	Dec-20	1121	15,300
9	Nov-20	1025	13,710
10	Oct-20	1165	16,330
11	Sep-20	1243	17110
12	Aug-20	1317	16090
	Total	**13616**	**194810**

Variation in energy consumption is as follows,

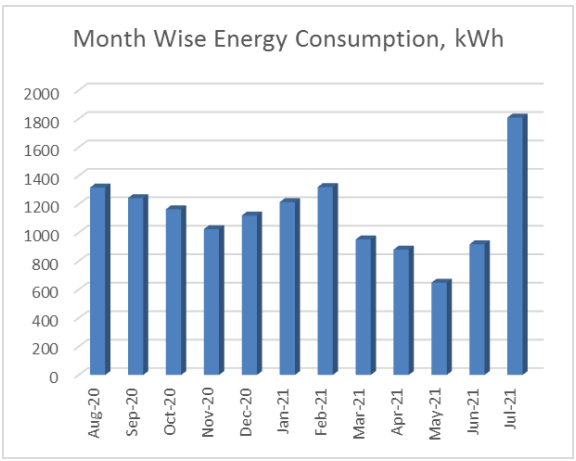

Figure 3.1: Month wise energy consumption

Monthly variation in electricity bill is as follows,

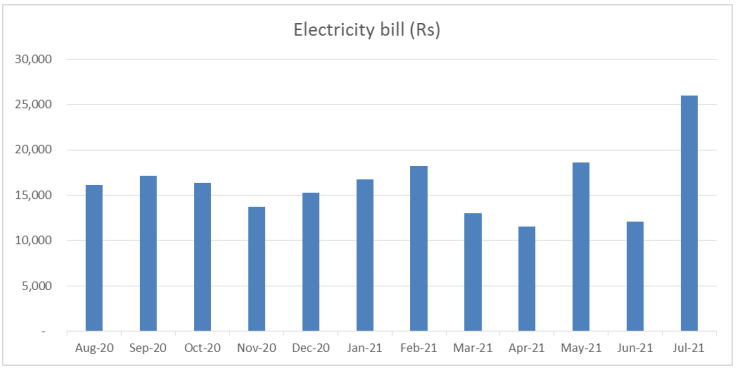

Figure 3.2: Month wise electricity bill

Key observations of electricity bill are as follows,

Table no 3.2: Key observations

Sr no	Parameter	Energy consumed, (Units)	CO2 Emmision (MT)
1	Maximum	1,809	1.45
2	Minimum	649	0.52
3	Average	1,135	0.91
4	Total	13,616	10.89

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	Jul-21	1,809	1.45
2	Jun-21	918	0.73
3	May-21	649	0.52
4	Apr-21	881	0.70
5	Mar-21	952	0.76
6	Feb-21	1,321	1.06
7	Jan-21	1,215	0.97
8	Dec-20	1,121	0.90
9	Nov-20	1,025	0.82
10	Oct-20	1,165	0.93
11	Sep-20	1,243	0.99
12	Aug-20	1,317	1.05
	Total	**13,616**	**10.89**

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

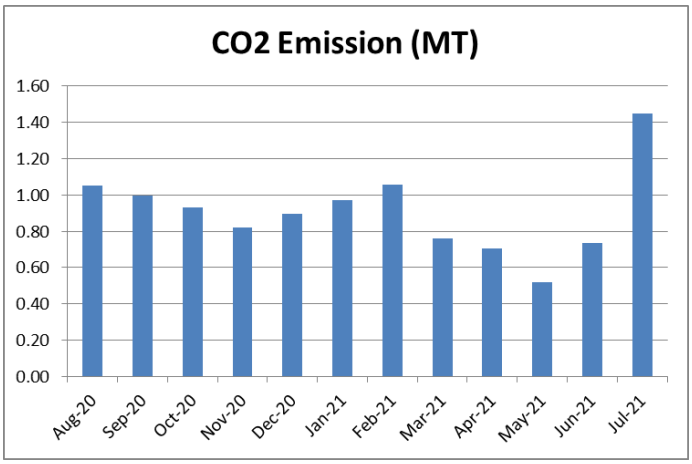

Figure 4.1: Month wise CO2 Emission

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 67 FTL fittings with Electronic/ magnetic chokes, 153 no of 20W LED tubes and 43 nos of 15W LED bulbs in indoor lightings. It is recommended to install the 20 W LED Tube light fittings in place of these old T-8 fittings. There are 2 number of 20W LED tube lights, 2 Nos of 400W focus halogen street light and 1 Nos of 100W focus halogen street lights. It is recommended to replace halogen street lights with 50W focus LED street lights,

5.2 Air-conditioners

There are 3 nos of star rated new AC of 1.5Tr capacity.

5.3 Ceiling Fans

At building facility, there are about 190 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 1 Water pumps with 3HPcapacity.

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 **20 kWp**.

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

No	Particulars	Value	Unit
1	Annual Energy Purchased from MSEDCL	13616	kWh/Annum
2	Energy Generated by Roof Top Solar PV System	30000	kWh/Annum
3	Total Energy Requirement of College	43616	kWh/Annum
4	% of Usage of Alternate Energy to Annual Energy Requirement = 2*100/3	68.8	**%**

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	67	40	2.68
2	Halogen street lights (100 W)	1	100	0.1
3	Halogen street lights (400W)	2	400	0.8
	LED lighting load			
1	LED tube	155	20	3.1
2	LED bulb	43	15	0.645
	Total LED lighting load			**3.745**
	Total Lighting load			**7.325**

It can be seen that out of total lighting load 51% 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 67 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	67	Nos
2	Energy Demand of T-8 fitting	40	W/Unit
3	Energy Demand of 20 W LED fitting	20	W/Unit
4	Reduction in demand	20	W/Unit
5	Average Daily Usage period	4	Hrs/Day
6	Daily saving in Energy	5.36	kWh/Day
7	Annual Working Days	250	Nos
8	Annual Energy Saving possible	1340	kWh/Annum
9	Rate of Electrical Energy	11	Rs/kWh
10	Annual Monetary saving	14740	Rs/Annum
11	Cost of 20 W LED Tube	641	Rs/Unit
12	Investment required	42947	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 190 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	190	Nos
2	Energy Demand of Old Ceiling Fan fitting	65	W/Unit
3	Energy Demand of STAR Rated Fan	52	W/Unit
4	Reduction in demand	13	W/Unit
5	Average Daily Usage period	4	Hrs/Day
6	Daily saving in Energy	9.88	kWh/Day
7	Annual Working Days	250	Nos
8	Annual Energy Saving possible	2470	kWh/Annum
9	Rate of Electrical Energy	11	Rs/kWh
10	Annual Monetary saving	27170	Rs/Annum
11	Cost of STAR Rated Ceiling Fan	2174	Rs/unit
12	Investment required	413060	Rs lump sum
13	Simple Payback period	182	Months

8.3 Replacement of 100W focus halogen street lights with 50W focus LEDs

In the facility, there are about 01 Nos, 100W focus halogen. It is recommended to install the 50 W LED focus street light fittings in place of these halogen street lights. In the following Table, we present the savings, investment required & payback analysis.

No	Particulars	Value	Unit
1	Present Qty of 100W focus halogen street lights	1	Nos
2	Energy Demand of 100W focus halogen street lights	100	W/Unit
3	Energy Demand of LED street light	50	W/Unit
4	Reduction in demand	50	W/Unit
5	Average Daily Usage period	8	Hrs/Day
6	Daily saving in Energy	0.4	kWh/Day
7	Annual Working Days	250	Nos
8	Annual Energy Saving possible	100	kWh/Annum
9	Rate of Electrical Energy	11	Rs/kWh
10	Annual Monetary saving	1100	Rs/Annum
11	Cost of LED street lights	1200	Rs/Unit
12	Investment required	1200	Rs lump sum
13	Simple Payback period	13	Months

8.4 Replacement of 400W focus halogen street lights with 50W focus LEDs

In the facility, there are about 02 Nos, 400W focus halogen. It is recommended to install the 50 W LED focus street light fittings in place of these halogen street lights. In the following Table, we present the savings, investment required & payback analysis.

No	Particulars	Value	Unit
1	Present Qty of 400W focus halogen street lights	2	Nos
2	Energy Demand of 400W focus halogen street lights	400	W/Unit
3	Energy Demand of LED street light	50	W/Unit
4	Reduction in demand	350	W/Unit
5	Average Daily Usage period	8	Hrs/Day
6	Daily saving in Energy	5.6	kWh/Day
7	Annual Working Days	250	Nos
8	Annual Energy Saving possible	1400	kWh/Annum
9	Rate of Electrical Energy	11	Rs/kWh
10	Annual Monetary saving	15400	Rs/Annum
11	Cost of LED street lights	1200	Rs/Unit
12	Investment required	2400	Rs lump sum
13	Simple Payback period	2	Months

8.5 Summary of Savings

No	Recommendation	Annual Saving potential, kWh/Annum	Annual Monetary Gain, Rs.	Investment Required, Rs.	Payback period, Months
1	Replacement of 67 Nos T-8 fittings with 20W LED fittings	1,340	14,740	42,947	35
2	Replacement of 190 Nos Old Ceiling Fans with STAR rating fans	2,470	27,170	413,060	182
3	Replacement of 1 Nos of 100W focus halogen street lights with 50W focus LEDs	100	1,100	1,200	13
4	Replacement of 2 Nos of 400W focus halogen street lights with 50W focus LEDs	1,400	15,400	2,400	2
	Total	**3,810**	**41,910**	**456,007**	**131**

Nutan Urja Solutions

A 703, Balaji Witefield, Near Sunni's World,
Sus Road, Sus, Pune 411 021
Phone: 83568 18381. Email: nutanurja.solutions@gmail.com

10/07/2022

CERTIFICATE

This is to certify that we have conducted Energy Audit at Dr. Madhukarrao Wasnik P.W.S. Arts, Commerce, Science College, Nagpur as per the guidelines of Maharashtra Energy Development Agency (www.mahaurja.com) in the year 2021-22.

The College has already adopted **Energy Efficient** practices like:

- Usage of Energy Efficient LED Fittings
- Usage of Energy Efficient BEE STAR Rated equipment
- Installation of **20 kW** Roof Top Solar PV Power Plant.

We appreciate the support of Management, involvement of faculty members and students in the process of Energy Conservation & making the campus Green.

Nutan Urja Solutions,

K G Bhatwadekar,
Certified Energy Auditor,
EA - 22428

Report

On

Energy Audit

At

Dr. Madhukarrao Wasnik P.W.S. Arts, Commerce, Science College, Nagpur

(Year 2021-22)

Prepared by

Nutan Urja Solutions

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Contents

Acknowledgement

We at Nutan Urja Solutions, Pune, express our sincere gratitude to the management of Dr. Madhukarrao Wasnik P.W.S. Arts, Commerce, 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.

Nutan Urja Solutions

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, (Units)	CO2 Emission (MT)
1	Maximum	2,151	1.72
2	Minimum	328	0.26
3	Average	1,261	1.01
4	Total	15,128	12.10

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.*
4. Usage of STAR rated fans at new installations

3. Key Observations

1. Usage of LED lights.
2. Usage of star rated equipment.
3. Maintained a good power factor.
4. There are about 67 Nos old T-8 type fittings which need to be replaced by 20 W LEDs.

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 68.8 %.

5. Percentage of Usage of LED Lighting

The College has various Types of Light fittings, namely: LED, FTL & CFL. The percentage of Annual LED Lighting Usage to Annual Lighting requirement works out to be 51.12%.

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 67 Nos T-8 fittings with 20W LED fittings	1,340	14,740	42,947	35
2	Replacement of 190 Nos Old Ceiling Fans with STAR rating fans	2,470	27,170	413,060	182
3	Replacement of 1 Nos of 100W focus halogen street lights with 50W focus LEDs	100	1,100	1,200	13
4	Replacement of 2 Nos of 400W focus halogen street lights with 50W focus LEDs	1,400	15,400	2,400	2
	Total	**3,810**	**41,910**	**456,007**	**131**

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

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)	LED tube (20W)	LED bulb (15W)	Computers	Fans	1.5TR Star rated AC
	Ground Floor						
1	Lok Kalyan Kendra		6			5	
2	Canteen	1				2	
3	Digital Room	4				6	
4	Sidharth Hall	14				20	
5	Jr College Office	2	2	1	4	3	
6	Passage	2	3	2		1	
7	Yashvantrao Mukt Vidyapith		2		1	1	
8	Vice Principal		2			1	
9	Guest House	2		1		1	1
10	Management Room		2	3	1	1	
11	NAAC Room		2		2	2	
12	Principal Office			15		3	1
13	Conference Hall			12		2	
14	Office	2	8	1	9	8	
15	People Welfare Society		2			2	1
16	Library	7	9		2	16	
17	Computer Lab		8		38	6	
18	Gym	7				7	
	First Floor						
19	Passage		8				
20	NSS		1			2	
21	102		4			2	
22	Economics and Research	1	1			2	
23	104		2			2	

24	105		2			2	
25	106		2			2	
26	107		2			2	
27	108		2			2	
28	109		2			2	
29	110		2			2	
30	111	4				2	
31	Pali Dept.	3				2	
32	Staff Room		7		2	6	
33	Toilet			8			
34	112		4		1	5	
35	113		3			3	
36	114		3			3	
37	115		1			1	
38	Toilet		2				
39	Common Room		1			1	
	Second Floor						
40	Passage		8				
41	217		3			2	
42	216		2			3	
43	215		3			3	
44	214		3			4	
45	English Dept.	9				9	
46	Psychology		4			2	
47	Marathi	1	1			2	
48	Hindi		2			2	
49	209		3			2	
50	208	2				2	
51	207		2			2	
52	206		2			2	
53	205	2				2	
54	204		2			2	
55	203	2				2	
56	202		2			2	
57	201		2			2	
58	200	2			2	2	
	Third Floor						
59	Botany Lab		3			1	
60	Physics lab		4			2	

61	Passage					4	
62	Chemistry lab		4			2	
63	Zoology lab		2			2	
64	Staff Room		2			2	
65	Passage		4				
	Total	**67**	**153**	**43**	**62**	**190**	**3**

Apart from above load, the school has pumps, LED street lights, CFLs and LED focus street lights on streets and grounds. Individual fitting wise load is as under.

Table No 2.2: Equipment wise Connected Load

No	Equipment	Qty	Load, W/Unit	Load, kW
1	Ceiling Fan	190	65	12.4
3	AC-New (1.5 TR)	3	1838	5.5
5	LED-20W	155	20	3.1
6	LED bulb (15W)	43	15	0.6
7	F T L-40 W	67	40	2.7
8	Computers	62	65	4.0
9	Pump(3HP)			2.3
10	Halogen street lights (100W)	1	100	0.1
11	Halogen street lights (400W)	2	400	0.8
	Total			31.5

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

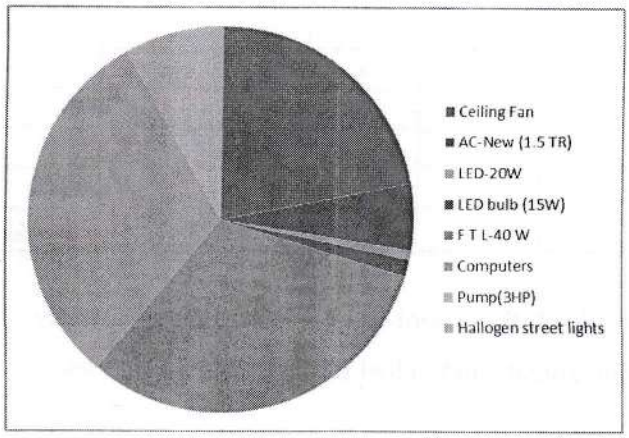

Figure 2.1: Distribution of connected load.

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-22	676	8,880
2	May-22	792	10,530
3	Apr-22	848	10,360
4	Mar-22	865	15,320
5	Feb-22	328	3,590
6	Jan-22	402	4,492
7	Dec-21	1,743	27,614
8	Nov-21	1,916	28,120
9	Oct-21	1,672	24,220
10	Sep-21	2,151	59,380
11	Aug-21	1,926	27,990
12	Jul-21	1,809	26,010
	Total	**15128**	**246506**

Variation in energy consumption is as follows,

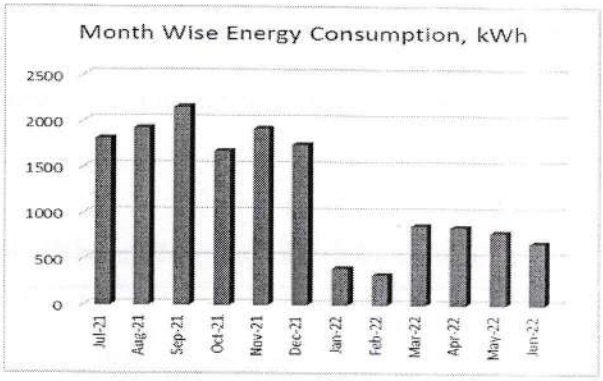

Figure 3.1: Month wise energy consumption

Monthly variation in electricity bill is as follows,

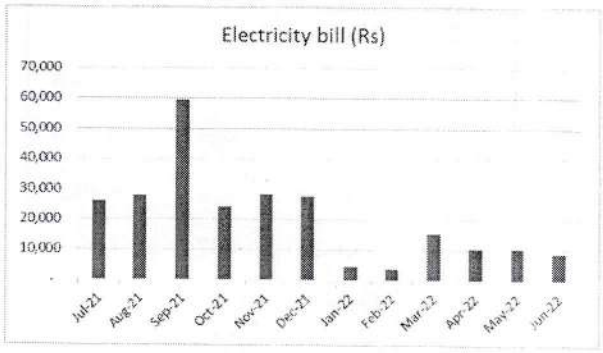

Figure 3.2: Month wise electricity bill

Key observations of electricity bill are as follows,

Table no 3.2: Key observations

Sr no	Parameter	Energy consumed, (Units)	CO2 Emission (MT)
1	Maximum	2,151	1.72
2	Minimum	328	0.26
3	Average	1,261	1.01
4	Total	15,128	12.10

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	676	0.54
2	May-22	792	0.63
3	Apr-22	848	0.68
4	Mar-22	865	0.69
5	Feb-22	328	0.26
6	Jan-22	402	0.32
7	Dec-21	1,743	1.39
8	Nov-21	1,916	1.53
9	Oct-21	1,672	1.34
10	Sep-21	2,151	1.72
11	Aug-21	1,926	1.54
12	Jul-21	1,809	1.45
	Total	**15,128**	**12.10**

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

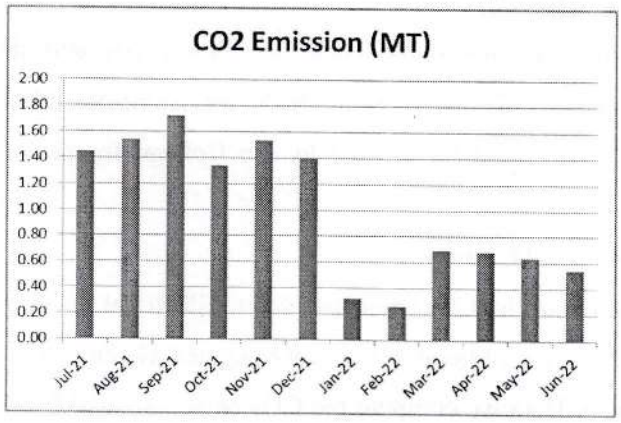

Figure 4.1: Month wise CO2 Emission

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 67 FTL fittings with Electronic/ magnetic chokes, 153 no of 20W LED tubes and 43 nos of 15W LED bulbs in indoor lightings. It is recommended to install the 20 W LED Tube light fittings in place of these old T-8 fittings. There are 2 number of 20W LED tube lights, 2 Nos of 400W focus halogen street light and 1 Nos of 100W focus halogen street lights. It is recommended to replace halogen street lights with 50W focus LED street lights,

5.2 Air-conditioners

There are 3 nos of star rated new AC of 1.5Tr capacity.

5.3 Ceiling Fans

At building facility, there are about 190 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 1 Water pumps with 3HPcapacity.

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 **20 kWp**.

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

No	Particulars	Value	Unit
1	Annual Energy Purchased from MSEDCL	15128	kWh/Annum
2	Energy Generated by Roof Top Solar PV System	30000	kWh/Annum
3	Total Energy Requirement of College	45128	kWh/Annum
4	% of Usage of Alternate Energy to Annual Energy Requirement	66	%

Photograph of Solar PV plant

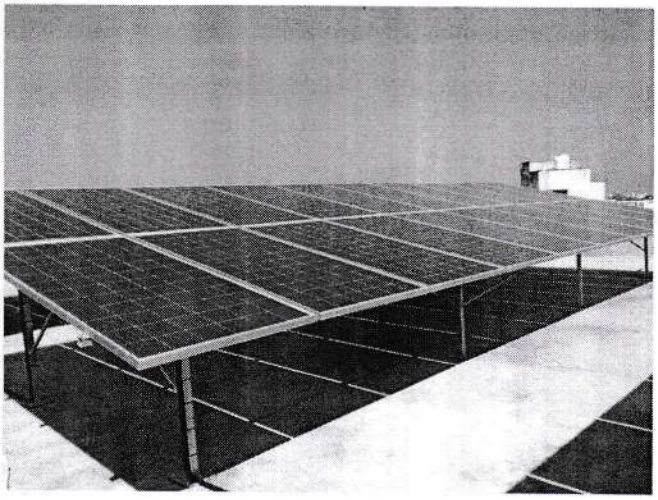

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Table 7.1: Total lighting load

No	Particulars	Qty	Load, W/Unit	Load, kW
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3	Halogen street lights (400W)	2	400	0.8
	LED lighting load			
1	LED tube	155	20	3.1
2	LED bulb	43	15	0.645
	Total LED lighting load			**3.745**
	Total Lighting load			**7.325**

It can be seen that out of total lighting load 51% 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 67 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	67	Nos
2	Energy Demand of T-8 fitting	40	W/Unit
3	Energy Demand of 20 W LED fitting	20	W/Unit
4	Reduction in demand	20	W/Unit
5	Average Daily Usage period	4	Hrs/Day
6	Daily saving in Energy	5.36	kWh/Day
7	Annual Working Days	250	Nos
8	Annual Energy Saving possible	1340	kWh/Annum
9	Rate of Electrical Energy	11	Rs/kWh
10	Annual Monetary saving	14740	Rs/Annum
11	Cost of 20 W LED Tube	641	Rs/Unit
12	Investment required	42947	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 190 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	190	Nos
2	Energy Demand of Old Ceiling Fan fitting	65	W/Unit
3	Energy Demand of STAR Rated Fan	52	W/Unit
4	Reduction in demand	13	W/Unit
5	Average Daily Usage period	4	Hrs/Day
6	Daily saving in Energy	9.88	kWh/Day
7	Annual Working Days	250	Nos
8	Annual Energy Saving possible	2470	kWh/Annum
9	Rate of Electrical Energy	11	Rs/kWh
10	Annual Monetary saving	27170	Rs/Annum
11	Cost of STAR Rated Ceiling Fan	2174	Rs/unit
12	Investment required	413060	Rs lump sum
13	Simple Payback period	182	Months

8.3 Replacement of 100W focus halogen street lights with 50W focus LEDs

In the facility, there are about 01 Nos, 100W focus halogen. It is recommended to install the 50 W LED focus street light fittings in place of these halogen street lights. In the following Table, we present the savings, investment required & payback analysis.

No	Particulars	Value	Unit
1	Present Qty of 100W focus halogen street lights	1	Nos
2	Energy Demand of 100W focus halogen street lights	100	W/Unit
3	Energy Demand of LED street light	50	W/Unit
4	Reduction in demand	50	W/Unit
5	Average Daily Usage period	8	Hrs/Day
6	Daily saving in Energy	0.4	kWh/Day
7	Annual Working Days	250	Nos
8	Annual Energy Saving possible	100	kWh/Annum
9	Rate of Electrical Energy	11	Rs/kWh
10	Annual Monetary saving	1100	Rs/Annum
11	Cost of LED street lights	1200	Rs/Unit
12	Investment required	1200	Rs lump sum
13	Simple Payback period	13	Months

8.4 Replacement of 400W focus halogen street lights with 50W focus LEDs

In the facility, there are about 02 Nos, 400W focus halogen. It is recommended to install the 50 W LED focus street light fittings in place of these halogen street lights. In the following Table, we present the savings, investment required & payback analysis.

No	Particulars	Value	Unit
1	Present Qty of 400W focus halogen street lights	2	Nos
2	Energy Demand of 400W focus halogen street lights	400	W/Unit
3	Energy Demand of LED street light	50	W/Unit
4	Reduction in demand	350	W/Unit
5	Average Daily Usage period	8	Hrs/Day
6	Daily saving in Energy	5.6	kWh/Day
7	Annual Working Days	250	Nos
8	Annual Energy Saving possible	1400	kWh/Annum
9	Rate of Electrical Energy	11	Rs/kWh
10	Annual Monetary saving	15400	Rs/Annum
11	Cost of LED street lights	1200	Rs/Unit
12	Investment required	2400	Rs lump sum
13	Simple Payback period	2	Months

8.5 Summary of Savings

No	Recommendation	Annual Saving potential, kWh/Annum	Annual Monetary Gain, Rs.	Investment Required, Rs.	Payback period, Months
1	Replacement of 67 Nos T-8 fittings with 20W LED fittings	1,340	14,740	42,947	35
2	Replacement of 190 Nos Old Ceiling Fans with STAR rating fans	2,470	27,170	413,060	182
3	Replacement of 1 Nos of 100W focus halogen street lights with 50W focus LEDs	100	1,100	1,200	13
4	Replacement of 2 Nos of 400W focus halogen street lights with 50W focus LEDs	1,400	15,400	2,400	2
	Total	**3,810**	**41,910**	**456,007**	**131**

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On

Energy Audit

At

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(Year 2022-23)

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Acknowledgement

We at Nutan Urja Solutions, Pune, express our sincere gratitude to the management of Dr. Madhukarrao Wasnik P.W.S. Arts, Commerce, 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, (Units)	CO2 Emission (MT)
1	Maximum	1,454	1.16
2	Minimum	-	-
3	Average	425	0.34
4	Total	5,104	4.08

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.
4. Usage of STAR rated fans at new installations

3. Key Observations

1. Usage of LED lights.
2. Usage of star rated equipment.
3. Maintained a good power factor.
4. There are about 67 Nos old T-8 type fittings which need to be replaced by 20 W LEDs.

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 68.8 %.

5. Percentage of Usage of LED Lighting

The College has various Types of Light fittings, namely: LED, FTL & CFL. The percentage of Annual LED Lighting Usage to Annual Lighting requirement works out to be 51.12%.

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 67 Nos T-8 fittings with 20W LED fittings	1,340	14,740	42,947	35
2	Replacement of 190 Nos Old Ceiling Fans with STAR rating fans	2,470	27,170	413,060	182
3	Replacement of 1 Nos of 100W focus halogen street lights with 50W focus LEDs	100	1,100	1,200	13
4	Replacement of 2 Nos of 400W focus halogen street lights with 50W focus LEDs	1,400	15,400	2,400	2
	Total	**3,810**	**41,910**	**456,007**	**131**

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

People's Welfare society established its first college, named PWS College of Arts and Commerce, on Kamptee Road, Nagpur in 1967. This is one of the biggest and well known institutions for marginalized sections in North Nagpur. Since its inception, more than 4000 students have joined the college every year and with various facilities at its disposal, the college is one of the best colleges in Northern Nagpur. The institute envisions molding of students who have humanitarian views, scientific approaches and are firm believer in positive social change. Such inspired youth will uphold the human values of liberty, equality and fraternity, and also shoulder the responsibilities of taking their nations to greater heights. The institute also offers affordable and various courses in the disciplines of Arts and Commerce.

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	Dr. Madhukarrao Wasnik P.W.S. Arts, Commerce, Science College, Nagpur
2	Address	786, Kamptee Rd, Old Teka Naka, Teka Naka, Nagpur, Maharashtra 440026.
3	Affiliation	Rashtrasant Tukdoji Maharaj 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)	LED tube (20W)	LED bulb (15W)	Computers	Fans	1.5TR Star rated AC
	Ground Floor						
1	Lok Kalyan Kendra		6			5	
2	Canteen	1				2	
3	Digital Room	4				6	
4	Sidharth Hall	14				20	
5	Jr College Office	2	2	1	4	3	
6	Passage	2	3	2		1	
7	Yashvantrao Mukt Vidyapith		2		1	1	
8	Vice Principal		2			1	
9	Guest House	2		1		1	1
10	Management Room		2	3	1	1	
11	NAAC Room		2		2	2	
12	Principal Office			15		3	1
13	Conference Hall			12		2	
14	Office	2	8	1	9	8	
15	People Welfare Society		2			2	1
16	Library	7	9		2	16	
17	Computer Lab		8		38	6	
18	Gym	7				7	
	First Floor						
19	Passage		8				
20	NSS		1			2	
21	102		4			2	
22	Economics and Research	1	1			2	
23	104		2			2	

24	105		2			2	
25	106		2			2	
26	107		2			2	
27	108		2			2	
28	109		2			2	
29	110		2			2	
30	111	4				2	
31	Pali Dept.	3				2	
32	Staff Room		7		2	6	
33	Toilet			8			
34	112		4		1	5	
35	113		3			3	
36	114		3			3	
37	115		1			1	
38	Toilet		2				
39	Common Room		1			1	
	Second Floor						
40	Passage		8				
41	217		3			2	
42	216		2			3	
43	215		3			3	
44	214		3			4	
45	English Dept.	9				9	
46	Psychology		4			2	
47	Marathi	1	1			2	
48	Hindi		2			2	
49	209		3			2	
50	208	2				2	
51	207		2			2	
52	206		2			2	
53	205	2				2	
54	204		2			2	
55	203	2				2	
56	202		2			2	
57	201		2			2	
58	200	2			2	2	
	Third Floor						
59	Botany Lab		3			1	
60	Physics lab		4			2	

61	Passage					4	
62	Chemistry lab		4			2	
63	Zoology lab		2			2	
64	Staff Room		2			2	
65	Passage		4				
	Total	**67**	**153**	**43**	**62**	**190**	**3**

Apart from above load, the school has pumps, LED street lights, CFLs and LED focus street lights on streets and grounds. Individual fitting wise load is as under.

Table No 2.2: Equipment wise Connected Load

No	Equipment	Qty	Load, W/Unit	Load, kW
1	Ceiling Fan	190	65	12.4
3	AC-New (1.5 TR)	3	1838	5.5
5	LED-20W	155	20	3.1
6	LED bulb (15W)	43	15	0.6
7	F T L-40 W	67	40	2.7
8	Computers	62	65	4.0
9	Pump(3HP)			2.3
10	Halogen street lights (100W)	1	100	0.1
11	Halogen street lights (400W)	2	400	0.8
	Total			31.5

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

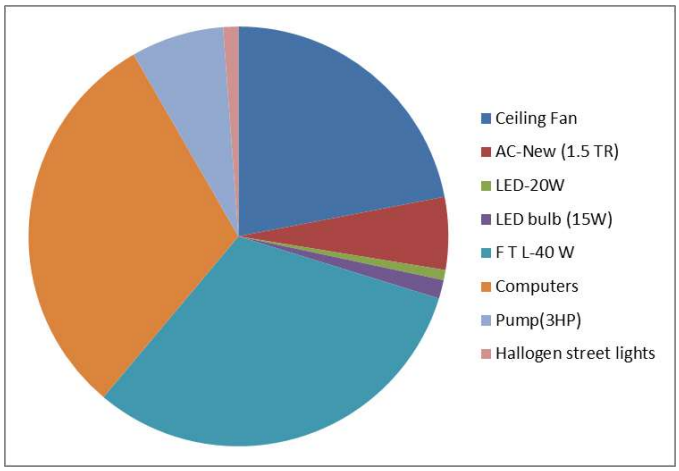

Figure 2.1: Distribution of connected load.

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	Jul-23	0	600
2	Jun-23	0	595
3	May-23	0	595
4	Apr-23	0	555
5	Mar-23	0	555
6	Feb-23	0	555
7	Jan-23	0	555
8	Dec-22	645	555
9	Nov-22	545	9990
10	Oct-22	1454	7349
11	Sep-22	1197	24032
12	Aug-22	1263	19393
	Total	**5104**	**65329**

Variation in energy consumption is as follows,

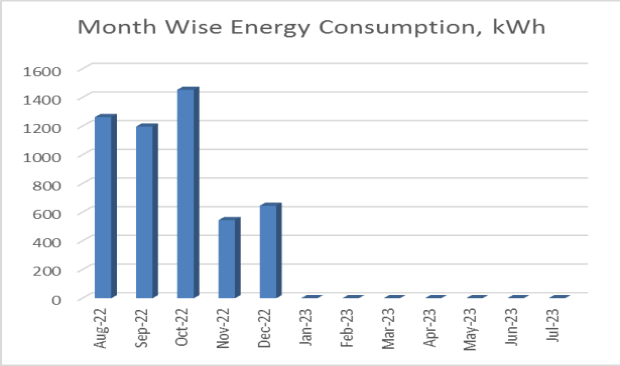

Figure 3.1: Month wise energy consumption

Monthly variation in electricity bill is as follows,

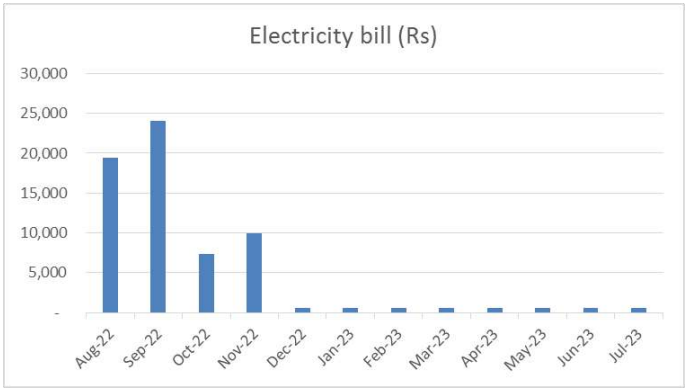

Figure 3.2: Month wise electricity bill

Key observations of electricity bill are as follows,

Table no 3.2: Key observations

Sr no	Parameter	Energy consumed, (Units)	CO2 Emission (MT)
1	Maximum	1,454	1.16
2	Minimum	-	-
3	Average	425	0.34
4	Total	5,104	4.08

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	Jul-23	-	0.00
2	Jun-23	-	0.00
3	May-23	-	0.00
4	Apr-23	-	0.00
5	Mar-23	-	0.00
6	Feb-23	-	0.00
7	Jan-23	-	0.00
8	Dec-22	645	0.52
9	Nov-22	545	0.44
10	Oct-22	1,454	1.16
11	Sep-22	1,197	0.96
12	Aug-22	1,263	1.01
	Total	**5,104**	**4.08**

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

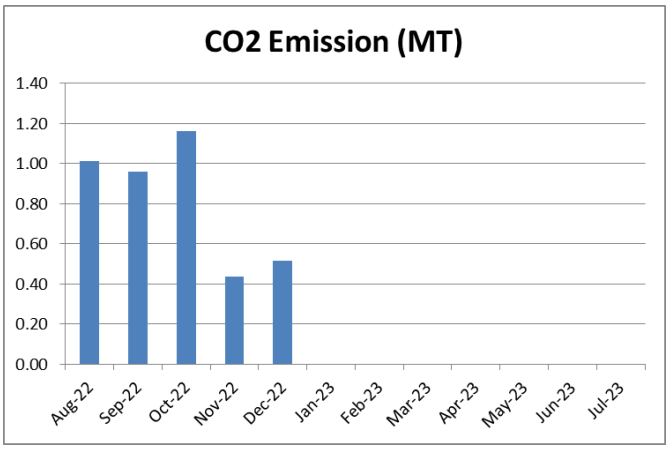

Figure 4.1: Month wise CO2 Emission

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 67 FTL fittings with Electronic/ magnetic chokes, 153 no of 20W LED tubes and 43 nos of 15W LED bulbs in indoor lightings. It is recommended to install the 20 W LED Tube light fittings in place of these old T-8 fittings. There are 2 number of 20W LED tube lights, 2 Nos of 400W focus halogen street light and 1 Nos of 100W focus halogen street lights. It is recommended to replace halogen street lights with 50W focus LED street lights,

5.2 Air-conditioners

There are 3 nos of star rated new AC of 1.5Tr capacity.

5.3 Ceiling Fans

At building facility, there are about 190 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 1 Water pumps with 3HPcapacity.

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 **20 kWp**.

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

No	Particulars	Value	Unit
1	Annual Energy Purchased from MSEDCL	5,104	kWh/Annum
2	Energy Generated by Roof Top Solar PV System	30,000	kWh/Annum
3	Total Energy Requirement of College	35,104	kWh/Annum
4	% of Usage of Alternate Energy to Annual Energy Requirement	85	**%**

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	67	40	2.68
2	Halogen street lights (100 W)	1	100	0.1
3	Halogen street lights (400W)	2	400	0.8
	LED lighting load			
1	LED tube	155	20	3.1
2	LED bulb	43	15	0.645
	Total LED lighting load			**3.745**
	Total Lighting load			**7.325**

It can be seen that out of total lighting load 51% 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 67 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	67	Nos
2	Energy Demand of T-8 fitting	40	W/Unit
3	Energy Demand of 20 W LED fitting	20	W/Unit
4	Reduction in demand	20	W/Unit
5	Average Daily Usage period	4	Hrs/Day
6	Daily saving in Energy	5.36	kWh/Day
7	Annual Working Days	250	Nos
8	Annual Energy Saving possible	1340	kWh/Annum
9	Rate of Electrical Energy	11	Rs/kWh
10	Annual Monetary saving	14740	Rs/Annum
11	Cost of 20 W LED Tube	641	Rs/Unit
12	Investment required	42947	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 190 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	190	Nos
2	Energy Demand of Old Ceiling Fan fitting	65	W/Unit
3	Energy Demand of STAR Rated Fan	52	W/Unit
4	Reduction in demand	13	W/Unit
5	Average Daily Usage period	4	Hrs/Day
6	Daily saving in Energy	9.88	kWh/Day
7	Annual Working Days	250	Nos
8	Annual Energy Saving possible	2470	kWh/Annum
9	Rate of Electrical Energy	11	Rs/kWh
10	Annual Monetary saving	27170	Rs/Annum
11	Cost of STAR Rated Ceiling Fan	2174	Rs/unit
12	Investment required	413060	Rs lump sum
13	Simple Payback period	182	Months

8.3 Replacement of 100W focus halogen street lights with 50W focus LEDs

In the facility, there are about 01 Nos, 100W focus halogen. It is recommended to install the 50 W LED focus street light fittings in place of these halogen street lights. In the following Table, we present the savings, investment required & payback analysis.

No	Particulars	Value	Unit
1	Present Qty of 100W focus halogen street lights	1	Nos
2	Energy Demand of 100W focus halogen street lights	100	W/Unit
3	Energy Demand of LED street light	50	W/Unit
4	Reduction in demand	50	W/Unit
5	Average Daily Usage period	8	Hrs/Day
6	Daily saving in Energy	0.4	kWh/Day
7	Annual Working Days	250	Nos
8	Annual Energy Saving possible	100	kWh/Annum
9	Rate of Electrical Energy	11	Rs/kWh
10	Annual Monetary saving	1100	Rs/Annum
11	Cost of LED street lights	1200	Rs/Unit
12	Investment required	1200	Rs lump sum
13	Simple Payback period	13	Months

8.4 Replacement of 400W focus halogen street lights with 50W focus LEDs

In the facility, there are about 02 Nos, 400W focus halogen. It is recommended to install the 50 W LED focus street light fittings in place of these halogen street lights. In the following Table, we present the savings, investment required & payback analysis.

No	Particulars	Value	Unit
1	Present Qty of 400W focus halogen street lights	2	Nos
2	Energy Demand of 400W focus halogen street lights	400	W/Unit
3	Energy Demand of LED street light	50	W/Unit
4	Reduction in demand	350	W/Unit
5	Average Daily Usage period	8	Hrs/Day
6	Daily saving in Energy	5.6	kWh/Day
7	Annual Working Days	250	Nos
8	Annual Energy Saving possible	1400	kWh/Annum
9	Rate of Electrical Energy	11	Rs/kWh
10	Annual Monetary saving	15400	Rs/Annum
11	Cost of LED street lights	1200	Rs/Unit
12	Investment required	2400	Rs lump sum
13	Simple Payback period	2	Months

8.5 Summary of Savings

No	Recommendation	Annual Saving potential, kWh/Annum	Annual Monetary Gain, Rs.	Investment Required, Rs.	Payback period, Months
1	Replacement of 67 Nos T-8 fittings with 20W LED fittings	1,340	14,740	42,947	35
2	Replacement of 190 Nos Old Ceiling Fans with STAR rating fans	2,470	27,170	413,060	182
3	Replacement of 1 Nos of 100W focus halogen street lights with 50W focus LEDs	100	1,100	1,200	13
4	Replacement of 2 Nos of 400W focus halogen street lights with 50W focus LEDs	1,400	15,400	2,400	2
	Total	**3,810**	**41,910**	**456,007**	**131**