

# Energy Audit Repots (2020-21)

**Report  
On  
Energy Audit  
At  
Khandesh College Education Society's  
Post Graduate College of Science Technology & Research, Jalgaon.  
(Year 2020-21)**



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Date: 29/11/2021

### CERTIFICATE


This is to certify that we have conducted Energy Audit at Khandesh College Education Society's Post Graduate College of Science Technology & Research, Jalgaon as per the guidelines of Maharashtra Energy Development Agency ([www.mahaurja.com](http://www.mahaurja.com)) in the year 2020-21.

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 **1.8 kW** Roof Top Solar PV Power Plant.
- Installation of 6500 liters solar thermal hot water system.

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,

  
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### Acknowledgement

We at Nutan Urja Solutions, Pune, express our sincere gratitude to the management of Khandesh College Education Society's Post Graduate College of Science Technology & Research, Jalgaon 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<sub>2</sub> 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)	CO <sub>2</sub> Emission (MT)
1	Maximum	2,422	1.94
2	Minimum	964	0.77
3	Average	1,401	1.12
4	Total	16,815	13.45

### 2. Energy Conservation Projects already installed

1. Usage of LED lights at some indoor locations
2. 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. There are about 110 Nos old T-8 type fittings which are required to be replaced by 18 W LEDs.
5. There are 2 Nos, 1.5 TR Old ACs which required to be replaced with STAR Rated ACs.



#### 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 11.8 %.

#### 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 11.79 %.

#### 6. Recommendations

Table 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 110 Nos T-8 fittings with 20W LED fittings	2,200	24,200	70,510	35
2	Replacement of 52 Nos Old Ceiling Fans with STAR rating fans	676	7,436	113,048	182
3	Replacement of 2 Nos Old 1.5 TR Acs with STAR rating Acs	2,000	22,000	105,750	58
4	Installation of 5kW grid connected PV panel	7,500	82,500	250,000	36
	<b>Total</b>	<b>12,376</b>	<b>136,136</b>	<b>539,308</b>	<b>48</b>

#### 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

Khandesh College Education Society's Post Graduate College of Science Technology & Research, Jalgaon is one of the premier academic institutes having only science stream with post graduate courses. The institution is committed to achieve the highest academic standards and provides an opportunity to the students to choose and enroll in program that are best suited to them. It is well known for its educational, cultural, social and spiritual enterprises.

Post Graduate College of Science, Technology and Research, Jalgaon was established in 2010 as the first institution to impart post graduate education in not only the region of North Maharashtra University, but also in whole state. The overall development of the institution over the period of a decade is multidimensional. Introduction of relevant courses / subjects at apt time, provision of optimum academic and other support facilities, development of healthy environment, organization of conferences, seminars, workshops, competitions and such other activities have helped the institution in gaining strength and thereby reputation.

### 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 1.1: Details of college

No	Head	Particulars
1	Name of Institution	Khandesh College Education Society's Post Graduate College of Science Technology & Research, Jalgaon
2	Address	Shivram Nagar Rd, Shivram Nagar, Prabhat Colony, Jalgaon, Maharashtra 425001.
3	Affiliation	Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon.



## 2. Study of connected load

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

**Table 2.1: Location wise study of Electrical fittings in various buildings**

No	Location	FTL (40W)	LED tube (20W)	Computers (65W)	Old fan	1.5TR old Acs
<b>College Building</b>						
<b>Ground Floor</b>						
1	Office	3		3	2	1
2	Meeting hall	4		1	2	1
3	Biotech lab	6	2		2	
4	Pantry room	2				
5	Research lab	3	2		1	
6	Staff room	2		1	2	
<b>First Floor</b>						
7	Passage	7				
8	Lecture hall 2	3			3	
9	Library	3		2	4	
10	Lecture hall 3	3			2	
11	Ladies room	1		1	2	
12	Lecture hall 4	3			2	
<b>Second floor</b>						
13	Microbiology lab	5	2			
14	Record room	1				
15	Lecture hall 5	4			2	
16	Physics	4			2	
17	Chemistry lab	17		2	8	
18	Chemistry Dept.	1		2		
19	Toilet	2				
<b>Ekalavya Building</b>						
20	Lecture hall 6	2			1	
21	Lecture hall 7	2			1	
22	Computer lab		4	12	1	
23	Toilet	4				
24	Passage	2	3			
25	Lecture hall 8	4			2	

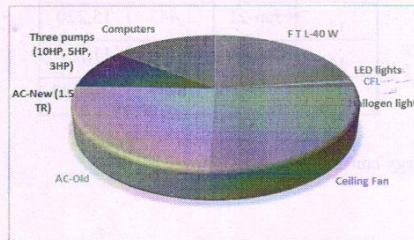
26	Lecture hall 9	6			3	
27	Psychology lab	5			2	
28	Lecture hall 10	5			2	
29	Math Dept.	1			1	
30	Store room	1				
31	Passage	4				
32	<b>Total</b>	<b>110</b>	<b>13</b>	<b>24</b>	<b>52</b>	<b>2</b>

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

**Table 2.2: Equipment wise Connected Load**

No	Equipment	Qty	Load, W/Unit	Load, kW
1	Ceiling Fan	52	65	3.4
2	AC-Old (1.5 Tr)	2	2200	4.4
5	LED-20W	13	20	0.3
7	F T L-40 W	114	40	4.6
8	Computers	24	65	1.6
9	Pump (1HP)			0.8
10	LED street lights	10	35	0.4
	<b>Total</b>			<b>15.3</b>

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



**Figure 2.1: Distribution of connected load.**



### 3. Study of Electrical Energy Consumption

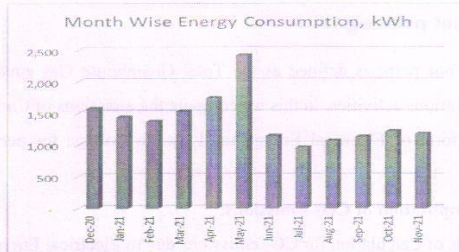
In this chapter, electricity bills are studied for the analysis of electrical energy consumption.

**Table 3.1: Summary of electricity bills**

No	Month	Energy (kWh)	Bill Amount (Rs)
1	Nov-21	1,184	13,270
2	Oct-21	1,218	13,500
3	Sep-21	1,136	12,600
4	Aug-21	1,070	11,500
5	Jul-21	964	10,590
6	Jun-21	1,151	13,130
7	May-21	2,422	16,800
8	Apr-21	1,746	13,530
9	Mar-21	1,533	23,250
10	Feb-21	1,372	13,770
11	Jan-21	1,443	15,220
12	Dec-20	1,576	11,230
	Total	<b>16815</b>	<b>168,390</b>

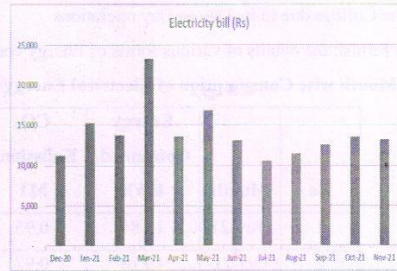
Variation in energy consumption is as follows,





**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 3.2: Key observations**

Sr no	Parameter	Energy consumed, (Units)	Bill Amount (Rs)
1	Maximum	2,422	23,250
2	Minimum	964	10,590
3	Average	1,401	14,033



#### 4. Carbon Foot printing

1. A **Carbon Foot print** is defined as the Total Greenhouse Gas emissions (CO<sub>2</sub> 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<sub>2</sub> Emissions:

The basis of Calculation for CO<sub>2</sub> emissions due to Electrical Energy is as under

- 1 Unit (kWh) of Electrical Energy releases **0.8 Kg of CO<sub>2</sub>** into atmosphere.

Based on the above Data we compute the CO<sub>2</sub> 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 & CO<sub>2</sub> Emissions**

No	Month	Energy Consumed, kWh	CO <sub>2</sub> Emissions, MT
1	Nov-21	1,184	0.95
2	Oct-21	1,218	0.97
3	Sep-21	1,136	0.91
4	Aug-21	1,070	0.86
5	Jul-21	964	0.77
6	Jun-21	1,151	0.92
7	May-21	2,422	1.94
8	Apr-21	1,746	1.40
9	Mar-21	1,533	1.23
10	Feb-21	1,372	1.10
11	Jan-21	1,443	1.15
12	Dec-20	1,576	1.26
	<b>Total</b>	<b>16,815</b>	<b>13.45</b>

In the following Chart we present the CO<sub>2</sub> emissions due to usage of Electrical Energy.



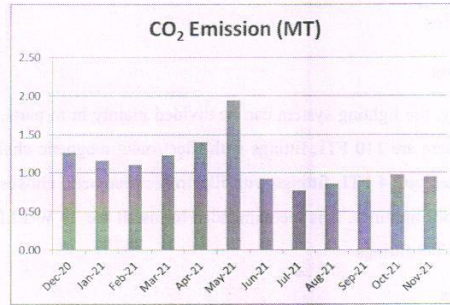


Figure 4.1: Month wise CO<sub>2</sub> Emission



## **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 110 FTL fittings with Electronic/ magnetic chokes and 13 LEDs in indoor lightings. There are 4 FTL fittings with Electronic/ magnetic chokes and 10 No of LED street lights in outdoor lightings. 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 02 Nos. of 1.5 Tr old Air-conditioners. It is recommended to replace these Old ACs with BEE STAR Rated ACs.

### **5.3 Ceiling Fans**

At building facility, there are about 52 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 1HP capacity.





## 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 **1.8 kWp**.

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

No	Particulars	Value	Unit
1	Annual Energy Purchased from MSEDCL	16,815	kWh/Annum
2	Energy Generated by Roof Top Solar PV System	2,700	kWh/Annum
3	Total Energy Requirement of College	19,515	kWh/Annum
4	% of Usage of Alternate Energy to Annual Energy Requirement	<b>13.8</b>	<b>%</b>

### 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	114	40	4.56
<b>LED lighting load</b>				
1	LED tube	13	20	0.26
2	LED street lights	10	35	0.35
<b>Total LED lighting load</b>				<b>0.61</b>
<b>Total Lighting load</b>				<b>5.17</b>

It can be seen that out of total lighting load 11.8% 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 110 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	110	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	8.8	kWh/Day
7	Annual Working Days	250	Nos
8	Annual Energy Saving possible	2200	kWh/Annum
9	Rate of Electrical Energy	11	Rs/kWh
10	Annual Monetary saving	24200	Rs/Annum
11	Cost of 20 W LED Tube	641	Rs/Unit
12	Investment required	70510	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 52 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	52	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 demad	13	W/Unit
5	Average Daily Usage period	4	Hrs/Day
6	Daily saving in Energy	2.704	kWh/Day
7	Annual Working Days	250	Nbs
8	Annual Energy Saving possible	676	kWh/Annum
9	Rate of Electrical Energy	11	Rs/kWh
10	Annual Monetary saving	7436	Rs/Annum
11	Cost of STAR Rated Ceiling Fan	2174	Rs/unit
12	Investment required	113048	Rs lump sum
13	Simple Payback period	182	Months



### 8.3 Replacement of 1.5 TR Old ACs with STAR Rated ACs

During the Audit, it was observed that there are 02 Nos, of 1.5 TR old ACs. It is recommended to replace these old ACs with STAR Rated ACs.

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

No	Particulars	Value	Unit
1	Present Qty of 1.5 TR Old ACs	2	Nos
2	Energy Demand of Old 1.5 TR AC	2.15	kW/Unit
3	Energy Demand of New AC	1.15	kW/Unit
4	Reduction in demad	1	kW/Unit
5	Average Daily Usage period	4	Hrs/Day
6	Daily saving in Energy	8	kWh/Day
7	Annual Working Days	250	Nos
8	Annual Energy Saving possible	2000	kWh/Annum
9	Rate of Electrical Energy	11	Rs/kWh
10	Annual Monetary saving	22000	Rs/Annum
11	Cost of STAR Rated 1.5 TR AC	52875	Rs/unit
12	Investment required	105750	Rs lump sum
13	Simple Payback period	58	Months



#### 8.4 Installation of PV panel

It is recommended to install PV panels of 5 kW capacity. In the following Table, we present the savings, investment required & payback analysis.

No	Particulars	Value	Unit
1	Installation of 20kW PV unit	5	kW
2	Energy saving	7500	kWh/Annum
3	Rate of electrical energy	11	Rs
4	Annual monetary savings	82500	Rs/ Annum
5	Investment required	250000	Rs lump sum
6	Simple payback period	36	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 110 Nos T-8 fittings with 20W LED fittings	2,200	24,200	70,510	35
2	Replacement of 52 Nos Old Ceiling Fans with STAR rating fans	676	7,436	113,048	182
3	Replacement of 2 Nos Old 1.5 TR Acs with STAR rating Acs	2,000	22,000	105,750	58
4	Installation of 5kW grid connected PV panel	7,500	82,500	250,000	36
	<b>Total</b>	<b>12,376</b>	<b>136,136</b>	<b>539,308</b>	<b>48</b>

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Date: 29/11/2021

### CERTIFICATE


This is to certify that we have conducted Environmental Audit at Khandesh College Education Society's Post Graduate College of Science Technology & Research, Jalgaon in the year 2020-21.

The College has already adopted following projects for making the campus **Energy Efficient**.

- Installation of Bio Composting Pit
- Installation of Rain Water Harvesting System
- Installation of **1.8 kW** 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,  
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### Acknowledgement

We at Nutan Urja Solutions, Pune wish to express our sincere gratitude to the management of Khandesh College Education Society's Post Graduate College of Science Technology & Research, Jalgaon for assigning the work of Environmental Audit of college campus for the Year: 2020-21.

We appreciate the co-operation and support extended to our team members during the entire tenure of field study.

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

We are also thankful to all other staff members who helped us during the Measurements at the field and for giving us the necessary inputs to carry out this vital exercise.



## Executive Summary

After the Field measurements & analysis, we present herewith important observations made and various measures to reduce the dependency on Natural resources & reduce the pollution.

Khandesh College Education Society's Post Graduate College of Science Technology & Research, Jalgaon consumes various resources for day to day operations, namely: Air, Water, Electrical Energy & LPG.

### 1. Various Pollution due to College Activities:

- Air pollution: Mainly CO<sub>2</sub> on account of Electricity & LPG Consumption
- Solid Waste: Bio degradable Kitchen Waste, Garden Waste
- Liquid Waste: Human liquid waste

### 2. Present Level of CO<sub>2</sub> Emissions:

Sr no	Parameter	Energy consumed, (Units)	CO <sub>2</sub> Emmision (MT)
1	Maximum	2,422	1.94
2	Minimum	964	0.77
3	Average	1,401	1.12
4	Total	16,815	13.45

### 3. The various projects already implemented for Environmental Conservation:

- Usage of Natural Day light in corridors
- Implementation of Bio Composting pit for disposal of Bio degradable waste
- Implementation of Rain Water Harvesting
- Installation of 1.8 kW Solar PV Power Plant.

### 4. Recommendations:

1. Installation of Bio Gas Generator Plant instead of Bio composting Plant.
2. Installation of Sewage treatment Plant to make campus a Zero Discharge campus.



**5. Notes & Assumptions:**

1. **1 kWh** of Electrical Energy releases **0.8 Kg of CO<sub>2</sub>** into atmosphere
2. 1 kWp Solar PV plant generates 5 kWh/day Electrical Energy for 300 days in an year.

Sl. No.	Parameter (Units)	Value	Parameter (Units)	Value
1	Maximum	2.03	Minimum	0.17
2	Minimum	0.04	Average	1.00
3	Average	1.00	Total	10.81



**Abbreviations**

- AC : Air conditioner
- PES : Progressive Education Society
- CFL : Compact Fluorescent Lamp
- FTL : Fluorescent Tube Light
- LED : Light Emitting Diode
- kWh : kilo-Watt Hour
- Qty : Quantity
- W : Watt
- kW : Kilo Watt
- PF : Power Factor
- MD : Maximum Demand
- PC : Personal Computer
- MSEDCL : Maharashtra State Electricity Distribution Company Ltd

Table No. 1

Year	Energy Consumed (kWh)	CO <sub>2</sub> Emission (kg)
2010	1000	1000
2011	1200	1200
2012	1500	1500
2013	1800	1800
2014	2000	2000
2015	2200	2200
2016	2500	2500
2017	2800	2800
2018	3000	3000
2019	3200	3200
2020	3500	3500



## 1. Introduction

### 1.1 Important Definitions:

#### 1.1.1 Environment: Definition as per environment Protection Act: 1986

Environment includes water, air and land and the inter-relationship which exists among and between Water, Air, Land and Human beings, other living creatures, plants microorganism and property

#### 1.1.2. Environmental Audit: Definition:

An audit which aims at verification and validation to ensure that various environmental laws are complied with and adequate care has been taken towards environmental protection and preservation

*According to UNEP, 1990, "Environmental audit can be defined as a management tool comprising systematic, documented and periodic evaluation of how well environmental organization management and equipment are performing with an aim of helping to regularize the environment"*

**1.1.3. Environmental Pollutant:** means any solid, liquid and gaseous substance present in the concentration as may be, or tend to be, injurious to Environment.

#### 1.1.4. Relevant Environmental Laws in India: Table No-1:

1927	The Indian Forest Act
1972	The Wildlife Protection Act
1974	The Water (Prevention and Control of Pollution) Act
1977	The Water (Prevention & Control of Pollution) Cess Act
1980	The Forest (Conservation) Act
1981	The Air (Prevention and Control of Pollution) Act
1986	The Environment Protection Act
1991	The Public Liability Insurance Act
2002	The Biological Diversity Act
2010	The National Green Tribunal Act

#### 1.1.5. Some Important Environmental Rules in India: Table No-2:

1989	Hazardous Waste (Management and Handling) Rules
1989	Manufacture, Storage and Import of Hazardous Chemical Rules
2000	Municipal Solid Waste (Management and Handling) Rules
1998	The Biomedical Waste (Management and Handling) Rules
1999	The Environment (Siting for Industrial Projects) Rules
2000	Noise Pollution (Regulation and Control) Rules
2000	Ozone Depleting Substances (Regulation and Control) Rules

2011	E-waste (Management and Handling) Rules
2011	National Green Tribunal (Practices and Procedure) Rules
2011	Plastic Waste (Management and Handling) Rules

**1.1.6 National Environmental Plans & Policy Documents: Table No-3:**

1.	National Forest Policy, 1988
2.	National Water Policy, 2002
3.	National Environment Policy or NEP (2006)
4.	National Conservation Strategy and Policy Statement on Environment and Development, 1992
5.	Policy Statement for Abatement of Pollution (1992)
6.	National Action Plan on Climate Change
7.	Vision Statement on Environment and Human Health
8.	Technology Vision 2030 (The Energy Research Institute)
9.	Addressing Energy Security and Climate Change (MoEF and Bureau of Energy Efficiency)
10	The Road to Copenhagen; India's Position on Climate Change Issues (MoEF)

**1.2 Objectives**

1. To study present usage of Natural resources the College is consuming
2. To Study the present pollution sources
3. To study various measures to make the campus Self sustainable in respect of Natural resources
4. To suggest the various measures to reduce the pollution: Air, Water, Noise

**1.3 Audit Methodology:**

1. Study of College as System
2. Study of Electrical Energy Consumption
3. Study of CO2 emissions
4. Suggestions on usage of Renewable Energy

**1.4 General Details of College**

No	Head	Particulars
1	Name of Institution	Khandesh College Education Society's Post Graduate College of Science Technology & Research, Jalgaon
2	Address	Shivram Nagar Rd, Shivram Nagar, Prabhat Colony, Jalgaon, Maharashtra 425001.
3	Affiliation	Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon.



## 2. Study of Consumption of Various Resources

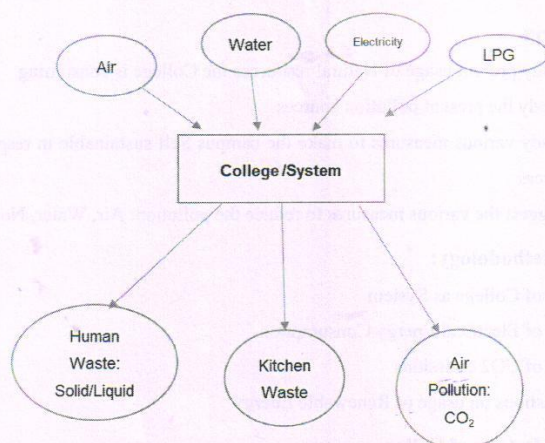
The Institute consumes following basic/derived Resources:

1. Air
2. Water
3. Electrical Energy
4. Liquefied Petroleum Gas

Also, college emits following pollutants to environment

1. Human Waste: Solid/ Liquid
2. Kitchen waste
3. Air pollution

We try to draw a schematic diagram for the College System & Environment as under.



Now we compute the Generation of CO<sub>2</sub> on account of consumption of Electrical Energy & LPG as under.

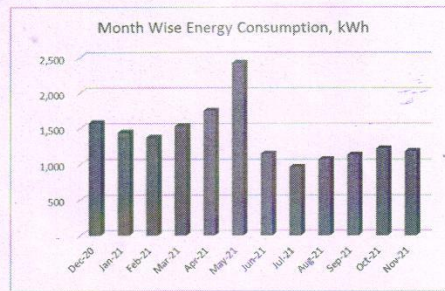
The calculation of electrical energy consumption by college can be given as,



**Table 2.1: Electrical Energy Consumption**

No	Month	Energy (kWh)
1	Nov-21	1,184
2	Oct-21	1,218
3	Sep-21	1,136
4	Aug-21	1,070
5	Jul-21	964
6	Jun-21	1,151
7	May-21	2,422
8	Apr-21	1,746
9	Mar-21	1,533
10	Feb-21	1,372
11	Jan-21	1,443
12	Dec-20	1,576
	Total	<b>16,815</b>

**2.1 Variation of Monthly Electrical Energy Consumption**



**Figure 2.1 : Monthly Electrical Energy Consumption**



## 2.2 Key Inference drawn

From the above analysis, we present following important parameters:

**Table 2.2: Variation in Important Parameters**

No	Parameter/ Value	Energy Consumed, kWh
1	Total	16,815
2	Maximum	2422
3	Minimum	964
4	Average	1401



### 3. Study of Air Pollution and Liquid Waste Generation

The College is using two forms of Energies, namely: Thermal in the form of LPG and Electrical Energy used for day to day operations of the College.

#### 3.1 Study of Carbon Emission

The major pollutant on account of above Energy forms is the Carbon Di Oxide.

- 1 unit (kWh) of Electrical Energy emits 0.8 Kg of CO<sub>2</sub> in the atmosphere
- 1 Kg of LPG emits 3 Kg of CO<sub>2</sub> in the atmosphere

In the following Table, we present the CO<sub>2</sub> emissions.

**Table 3.1: Month wise Consumption of Electrical Energy & CO<sub>2</sub> Emissions:**

No	Month	Energy Consumed, kWh	CO <sub>2</sub> Emissions, MT
1	Nov-21	1,184	0.95
2	Oct-21	1,218	0.97
3	Sep-21	1,136	0.91
4	Aug-21	1,070	0.86
5	Jul-21	964	0.77
6	Jun-21	1,151	0.92
7	May-21	2,422	1.94
8	Apr-21	1,746	1.40
9	Mar-21	1,533	1.23
10	Feb-21	1,372	1.10
11	Jan-21	1,443	1.15
12	Dec-20	1,576	1.26
	<b>Total</b>	<b>16,815</b>	<b>13.45</b>
	Maximum	2,422	1.94
	Minimum	964	0.77
	Average	1,401	1.12

In the following Chart we present the CO<sub>2</sub> emissions due to usage of Electrical Energy.

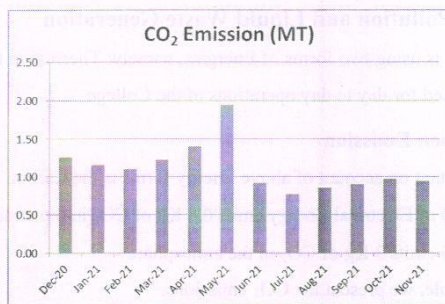


Figure 3.1: CO<sub>2</sub>emission due to usage of electrical energy.

### 3.2 Air pollution from vehicles

Pollution Under Control (PUC) is mandatory for the Vehicles coming in the campus.

The following practices are observed in college premises

1. Staff and student entries are strictly prohibited without wearing of helmets.
2. The campus have dense canopy of indigenous bloomed plants.
3. Most of plants play major role in minimize the air and noise pollution.

### 3.3 Study of Liquid waste Generation

The college has designed the outflow of the liquid waste in such away as to prevent contamination in the campus. A properly constructed leakage proof sewer system is used for drainage. At present the Liquid Waste generated due to day to day operations is drained off to the municipal Corporation through a pipe.

The College has already installed Rain Water Harvesting project, wherein the rain water falling on the terrace is collected and through pipes it is fed to underground Water Storage tank. This stored water is then reused for domestic purpose.



**Photograph of Rain Water Harvesting pipe**



#### 4. Study of Solid Waste Generation

In this chapter, we study solid waste generated in college and disposal mechanism of solid waste in college.

##### 4.1 Solid waste collection

The garbage collected in college is segregated into wet and dry centrally in campus. Waste bins are placed in college campus for collection of waste. It is daily dispatched to solid waste collection vehicle of Municipal Corporation.

Proper dustbins are provided to each department. also 2 large (steel and plastic) dustbins are install at various location in the college campus for collection of waste including administration office, college canteen, near garden etc. Some dustbins are provided to girl's hostel (1 dustbin for 2 rooms) for collection of solid waste. The stored waste is collected by Municipal Corporation on every day.

##### Photograph of Dustbins in college campus



##### 4.2 Mess and Canteen food wastage

The students and canteen staff are encouraged to have minimal food wastage. Canteen contractor have food license and shop act certificate. Food waste collected in canteen disposed for vermicomposting pit. The canteen is encouraged for usage of paper tea cups. Around 80 kg/ day food and other waste is generated in the form of biodegradable solid waste from the hostel mess and canteen.

##### 4.3 E-waste management

All electronic gadgets are periodically repaired for efficient utilization and replaced under by back scheme of supplier. Hence, minimum e-waste is generated in the campus. The



remaining non-working computers, monitors and printers are discarded and scrapped on a systematic basis. If some parts are useful, in other systems they are kept aside for future use.

#### 4.4 Paper wastage

The students and office staff are encouraged to work with minimal use of paper. Regular activities of students are digitally monitored. Two sides of paper (back to back) printing method is preferable. The projects reports pages (one sided) submitted by students was used to avoid the dependence on fresh pages.

#### 4.5 Bio composting pit

The College has already installed a Bio composting Plant, wherein, the bio-degradable waste is composted & is used as fertilizer for the garden.

##### Photograph of Bio Composting Processing Tanks





### 5. Recommendations

In order to reduce the dependency on natural resources and also in order to reduce the various pollutions arising due to the day to day operations of the College we herewith suggest following recommendations.

- Installation of Bio Gas Generator Plant instead of Bio composting Plant.
- Installation of Sewage treatment Plant to make campus a Zero Discharge campus



## Green Audit (2020-21)

**Report  
On  
Green Audit  
Khandesh College Education Society's  
Post Graduate College of Science Technology & Research, Jalgaon.  
(Year 2020-21)**



Prepared by

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Date: 29/11/2021

### CERTIFICATE

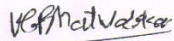
This is to certify that we have conducted Green Audit at Khandesh College Education Society's Post Graduate College of Science Technology & Research, Jalgaon in the year 2020-21.

The College has already adopted **Green** practices like:

- Installation of Rain Water Harvesting system
- Installation of Bio composting pit
- Installation of **1.8 kW** Roof Top Solar PV Power Plant.
- Installation of 6500 liters solar thermal hot water system.
- Usage of Energy Efficient LED

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

Nutan Urja Solutions,



K G Bhatwadekar,

Certified Energy Auditor,

EA - 22428



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### Acknowledgement

We at Nutan Urja Solutions, Pune, express our sincere gratitude to the management of Khandesh College Education Society's Post Graduate College of Science Technology & Research, Jalgaon for awarding us the assignment of Green 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 and green practices. 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, Pune.



## Executive Summary

Green Audit of Khandesh College Education Society's Post Graduate College of Science Technology & Research, Jalgaon is conducted by Nutan Urja Solutions, Pune. Based On the audit field study, following important points can be presented.

### 1. Present Energy Consumption

Khandesh College Education Society's Post Graduate College of Science Technology & Research, Jalgaon uses Electrical Energy as the source of Energy for various equipment in the college campus. In the following Table, we present the details of Energy Consumption.

**Table no 1: Details of energy consumption**

Sr no	Parameter	Energy consumed, (Units)	CO2 Emission (MT)
1	Maximum	2,422	1.94
2	Minimum	964	0.77
3	Average	1,401	1.12
4	Total	16,815	13.45

### 2. Various Measures Adopted for Energy Conservation

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. Usage of Renewable Energy

The collage has installed 1.8 kW Solar PV Power Plant.

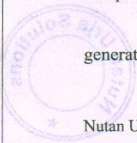
### 4. Rain Water Harvesting

The College has installed the Rainwater harvesting project, to reduce dependency on municipal corporation water supply. The rainwater is used for chemistry practical.

### 5. Waste Management

The College has already installed a Bio composting Plant, wherein, the bio-degradable waste is composted & is used as fertilizer for the garden.

The internal communication is through emails, Whatsapp groups, phones and there is hardly any generation of e-Waste in the premises.



**6. Notes and Assumptions**

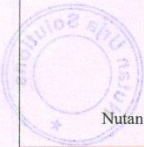
1. Daily working hours-10 Nos
2. Annual working Days-250 Nos
3. Average Rate of Electrical Energy : Rs 11/- per kWh

Category	Consumption (kWh)	Rate (Rs/kWh)	Total Cost (Rs)
Lighting	1000	11	11000
AC	500	11	5500
Other	100	11	1100
<b>Total</b>	<b>1600</b>	<b>11</b>	<b>17600</b>



### 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

Khandesh College Education Society's Post Graduate College of Science Technology & Research, Jalgaon is one of the premier academic institutes having only science stream with post graduate courses. The institution is committed to achieve the highest academic standards and provides an opportunity to the students to choose and enroll in program that are best suited to them. It is well known for its educational, cultural, social and spiritual enterprises.

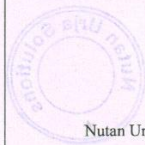
Post Graduate College of Science, Technology and Research, Jalgaon was established in 2010 as the first institution to impart post graduate education in not only the region of North Maharashtra University, but also in whole state. The overall development of the institution over the period of a decade is multidimensional. Introduction of relevant courses / subjects at apt time, provision of optimum academic and other support facilities, development of healthy environment, organization of conferences, seminars, workshops, competitions and such other activities have helped the institution in gaining strength and thereby reputation.

### 1.1 Objectives

1. To study present level of Energy Consumption
2. To Study the present CO<sub>2</sub> emissions
3. To assess the various equipment/facilities from Energy efficiency aspect
4. To measure various Electrical parameters
5. To study scope for usage of Renewable Energy
6. 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



## 2. Study of Electrical Energy Consumption

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

**Table 2.1: Summary of electricity bills**

No	Month	Energy (kWh)	Bill Amount (Rs)
1	Nov-21	1,184	13,270
2	Oct-21	1,218	13,500
3	Sep-21	1,136	12,600
4	Aug-21	1,070	11,500
5	Jul-21	964	10,590
6	Jun-21	1,151	13,130
7	May-21	2,422	16,800
8	Apr-21	1,746	13,530
9	Mar-21	1,533	23,250
10	Feb-21	1,372	13,770
11	Jan-21	1,443	15,220
12	Dec-20	1,576	11,230
	Total	<b>16,815</b>	<b>168,390</b>

Variation in energy consumption is as follows,

Month	Energy (kWh)	Bill Amount (Rs)
Nov-21	1,184	13,270
Oct-21	1,218	13,500
Sep-21	1,136	12,600
Aug-21	1,070	11,500
Jul-21	964	10,590
Jun-21	1,151	13,130
May-21	2,422	16,800
Apr-21	1,746	13,530
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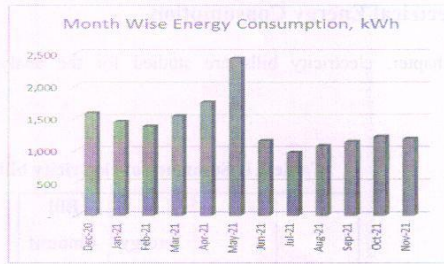


Figure 2.1: Month wise energy consumption

Monthly variation in electricity bill is as follows,

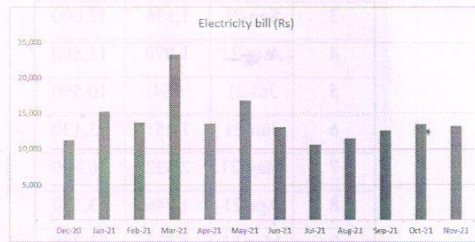


Figure 2.2: Month wise electricity bill

Key observations of electricity bill are as follows,

Table 2.2: Key observations

Sr no	Parameter	Energy consumed, (Units)	CO <sub>2</sub> Emission (MT)
1	Maximum	2,422	1.94
2	Minimum	964	0.77
3	Average	1,401	1.12
4	Total	16,815	13.45



### 3. Carbon Foot printing

1. A **Carbon Foot print** is defined as the Total Greenhouse Gas emissions (CO<sub>2</sub> 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<sub>2</sub> Emissions:

The basis of Calculation for CO<sub>2</sub> emissions due to Electrical Energy is as under

- 1 Unit (kWh) of Electrical Energy releases **0.8 Kg of CO<sub>2</sub>** into atmosphere.

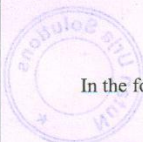
Based on the above Data we compute the CO<sub>2</sub> emissions which are being released in to the atmosphere by the College due to its Day to Day operations

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

**Table 3.1: Month wise Consumption of Electrical Energy & CO<sub>2</sub> Emissions**

No	Month	Energy Consumed, kWh	CO <sub>2</sub> Emissions, MT
1	Nov-21	1,184	0.95
2	Oct-21	1,218	0.97
3	Sep-21	1,136	0.91
4	Aug-21	1,070	0.86
5	Jul-21	964	0.77
6	Jun-21	1,151	0.92
7	May-21	2,422	1.94
8	Apr-21	1,746	1.40
9	Mar-21	1,533	1.23
10	Feb-21	1,372	1.10
11	Jan-21	1,443	1.15
12	Dec-20	1,576	1.26
	<b>Total</b>	<b>16,815</b>	<b>13.45</b>

In the following Chart we present the CO<sub>2</sub>emissions due to usage of Electrical Energy.



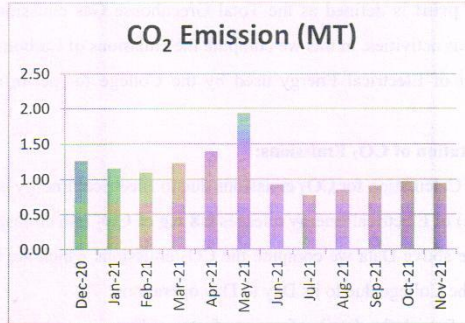


Figure 3.1: Month wise CO<sub>2</sub> Emission

Sl. No.	Month	CO <sub>2</sub> Emission (MT)
1	Nov-21	0.95
2	Oct-21	0.95
3	Sep-21	0.90
4	Aug-21	0.85
5	Jul-21	0.80
6	Jun-21	0.95
7	May-21	1.95
8	Apr-21	1.40
9	Mar-21	1.25
10	Feb-21	1.10
11	Jan-21	1.15
12	Dec-20	1.30
	<b>Total</b>	<b>12.85</b>



#### 4. 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 **1.8 kWp**.

**Table 4.1: Computation of % Usage of Alternate Energy to Annual Energy Requirement**

No	Particulars	Value	Unit
1	Annual Energy Purchased from MSEDCL	16,815	kWh/Annum
2	Energy Generated by Roof Top Solar PV System	2,700	kWh/Annum
3	Total Energy Requirement of College	19,515	kWh/Annum
4	% of Usage of Alternate Energy to Annual Energy Requirement	<b>13.8</b>	<b>%</b>

#### Photograph of Solar PV plant



### 5. Study of Rain Water Harvesting

The College has already installed Rain Water Harvesting project, wherein the rain water falling on the terrace is collected and through pipes it is fed to underground Water Storage tank. This stored water is then reused for chemistry laboratory.

Photograph of Rain Water Harvesting pipe



## 6. Study of Waste Management

### 6.1 Solid Waste Management

The College has already installed a Bio composting Plant, wherein, the bio-degradable waste is composted & is used as fertilizer for the garden. The collected wastes from garden, debris, leaf litter are collect dumped into vermicomposting bins to prepare the compost manure from the waste. Eisenia Foetida species of earthworm is used for the process.

#### Photographs of Bio Composting Storage Tanks:



### 6.2 e-Waste Management

The internal communication is through emails and hence there is hardly any generation of paper waste in the premises. The E-waste generated in all colleges of Khandesh Education Society is collected. Most of the material in waste is reused before disposal.



## 7. Study of Green Practices

### 7.1 Usage of vehicles for coming to Institute

The college conducts campaign for students and faculty to understand the importance of environmental protection and be mindful about saving energy. The authority frequently appeals to the students and faculty to maintain the tradition of no vehicle day on Saturday. To motivate and aware the students regarding minimum use of vehicles "Cycle Day" programme is arranged by college faculty.

### 7.2 Usage of Public Transport

During the Students transport study, it was revealed that the local students who are residing near areas make use of Public Transport like Municipal Transport local buses, local sharing type auto rickshaws. Some students use bicycles. Institute encourages students to not to use automobiles.

### 7.3 Pedestrian Friendly Roads

The Institute has well defined pedestrian foot paths as to facilitate the easy movement of the students within the campus.

#### Photograph of Road within campus



### 7.4 Plastic Free Campus

The Institute is an active participant in the Government of India's most prestigious project of SWATCHH BHART ABHIYAN. The Institute has displayed boards in the Campus, to make the campus plastic free. Various measures adopted for this purpose are as follows

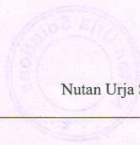
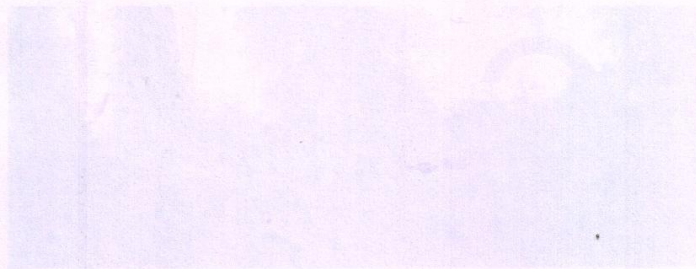
- Installation of Separate waste bins for Dry waste & wet waste
- Usage of paper tea cups in the Institute canteen



- Display of boards in the campus for Plastic Free campus

#### 7.5 Paperless Office

The internal communication of the Institute is through the Internet. There are hardly any day to day operations, where printing is required.



### 8. Green Landscaping with Trees and Plants

To understand the plant biodiversity of the campus, the college has been conducting census of tree, herbs and shrubs. The college campus has rich plant biodiversity including 33 tree species with a dominance of family *Caesalpinaceae*. With regard to shrubs dominance of *Securinega virosa* and herbs with dominance of *Veruoniacerneria* are recorded.

#### Photograph of Beautifully Maintained Garden of College

