# CAUVERY COLLEGE FOR WOMEN
## (Autonomous)
### TIRUCHIRAPPALLI

# ENERGY AUDIT REPORT

## 2023 – 2024


**CENTRE FOR ENVIRONMENTAL SUSTAINABILITY**
**DEPARTMENT OF ENVIRONMENTAL SCIENCES**
**Bishop Heber College (Autonomous)**
Tiruchirappalli, Tamilnadu – 620 017

# CAMPUS ENVIRONMENT AUDIT CERTIFICATE

*Issued under the Green Campus Certification Process*

CENTRE FOR ENVIRONMENTAL SUSTAINABILITY

ENERGY AUDIT

## CAUVERY COLLEGE FOR WOMEN (AUTONOMOUS)

Annamalai Nagar, Woraiyur,
Tiruchirappalli District Tamilnadu – 620018

Has successfully conducted the **ENERGY AUDIT** in accordance with the Sustainable Development Goals (SDGs) and standards of regulatory agencies in India.

**Based on the Scope of Energy audit we hereby acknowledge and certify that:**

The Management, Teaching fraternity, students, and support staff of the **Cauvery College for Women (Autonomous)** have taken efforts to create a strategic change in attaining holistic Environmental Sustainability.

Period of Audit : 2023 – 2024

Date of Certification : 22 March 2024

Prof. A. Alagappa Moses
Ecology and Biodiversity Consultant
Functional Area Expert - NABET

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**CAMPUSENVIRONMENT AUDIT**
CentreforEnvironmentalSustainabilityDepartmentofEnvironmentalSciencesBishopHeberCollege(Autonomous)Tiruchirappalli,Tamilnadu

TowardsCleanandGreenCampus

## CAMPUS GREEN AUDIT PERSONNEL

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**Category A** Projects
*(vide AC MOM III, 2010*
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SA- 270th AC Meeting February 28 ,2020_Rev.01*)*

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# PREFACE

An Environmental Audit is a tool comprising a systematic, documented, periodic and objective evaluation of how well a project, organization or equipment is performing with the aim of helping to safeguard the environment. The audit should facilitate management control of environmental practices and assess compliance with policy objectives and regulatory requirements.

A clean and healthy environment aids effective learning and provides a conducive learning environment.

Green audit is an official examination of the effects a college on the environment. It helps to improve the existing practices with the aim of reducing the adverse effects of these on the environment concerned.

Higher Educational Institutions are committed to preserve the environment within the campus through promotion of energy savings, recycling of waste, water use reduction, water harvesting etc.

Green audit visualizes the documentation of all such activities taking stock of the infrastructure of the college, their academic and managerial policies and future plans in the form of an environmental audit report.

Green audit can be a useful tool for a college to determine how and where they are using the most energy or water or resources; the college can then consider how to implement changes and make savings. It can also be used to determine the type and volume of waste which can be used for a recycling project or to improve waste minimization plan. It can create health consciousness and promote environmental awareness, values and ethics. It provides staff and students better understanding of green impact on campus.

Green audit promotes financial savings through reduction of resource use. It gives an opportunity for the development of ownership, personal and social responsibility for the students and teachers. Thus, it is imperative that the college evaluate its own contributions toward a sustainable future. As environmental sustainability is becoming an increasingly important issue for the nation, the role of higher educational institutions in relation to environmental sustainability is more relevant.

The audit process in Cauvery College for Women, Tiruchirappalli involved initial interviews with management to clarify policies, activities, records and the co-operation of staff and students in the implementation of mitigation measures. Staff and students were given training how to collect the data for the green audit process. This was followed by staff and student interviews, collection of data through the questionnaire-based survey, review of records, observation of practices and observable outcomes. In addition, the approach ensured that the management and staff are active participants in the green auditing process in the college.

The baseline data prepared for the College will be a useful tool for campus greening, resource management, planning of future projects, and a document for implementation of sustainable development of the college. Existing data will allow the college to compare its programs and operations with those of peer institutions, identify areas in need of improvement, and prioritize the implementation of future projects. The green audit reports assist in the process of attaining an eco-friendly approach to the sustainable development of the college.

The results presented in the green audit report will serve as a guide for educating the college community on the existing environment related practices and resource usage at the college as well as spawn new activities and innovative practices. The Green Audit team expects the management to express their commitment to implement the recommendations.

Prof. A. ALAGAPPA MOSES
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# ENERGY AUDIT
## 2023-24

# ENERGY AUDIT

## 1.1 Introduction

Energy audit has a vital role in the implementation of energy conservation measures. The energy audit enables the institution to meet the Energy efficiency Standards and to reduce carbon foot print. There are several types of energy audits that are commonly performed by energy service personnel or engineers with various degrees of complexity.

## 1.2 Need for Energy Audit

The energy crisis in the present day world has led us to the design of new energy efficient buildings. An energy audit establishes both where and how energy is being used, and the potential for energy savings. It includes a walk-through survey, a review of energy using systems, analysis of energy use and the preparation of an energy budget, and provides a baseline from which energy consumption can be compared over time. An audit can be conducted by an employee of the organization who has appropriate expertise, or by a specialist energy-auditing firm. An energy audit report also includes recommendations for actions, which will result in energy and cost savings. It should also indicate the costs and savings for each recommended action, and a priority order for implementation. Energy Audit is defined as the verification, monitoring and analysis of use of energy including submission of technical report containing recommendations for improving energy efficiency with cost benefit analysis and an action plan to reduce energy consumption.

## 1.3 Electrical Energy Audit

Energy cannot be seen, but we know it is there because we can see its effects in the forms of heat, light and power.

This indicator addresses energy consumption, energy sources, energy monitoring, lighting, appliances, and vehicles. Energy use is clearly an important aspect of campus sustainability and thus requires no explanation for its inclusion in the assessment. Energy auditing deals with the conservation and methods to reduce its consumption related to environmental degradation. It is therefore essential that any environmentally responsible institution examine its energy use practices.

### 1.4 Energy-saving measures and Carbon Footprint Reduction

A carbon footprint is historically the total set of greenhouse emissions caused by an individual event organization or product. It is expressed as $CO_2e$ (Carbon dioxide equivalent) which can broadly be defined as a measure of the greenhouse gas emission that are directly and indirectly caused by an activity or are accumulated over the life stages of a product or service.

The main elements that generates large amounts of carbon dioxide are fossil fuels (especially oil and coal), through burning them for obtaining energy. Of all greenhouse gases, $CO_2$ has the largest share. Thus, emissions of other greenhouse gases as stated earlier are converted into units of $CO_2$ equivalents ($CO_2e$) using the warming potential related to each gas.

The calculation of carbon footprint in Cauvery College for Women (Autonomous) has been carried out to set a standard on environmental policies and practices, operational platform to achieving a friendly accommodating and sustainable environment in the future.

### 1.5 Electrical Energy Consumption in the Campus

The Energy Audit Report of Cauvery College for Women (Autonomous) during the period 2023-24 is presented in the following sections.

The total consumption of electricity is 66,230 electrical units of the academic year 2023-24. This includes air conditioners which consume about 20% of electricity.

One electrical unit (EU) equals consumption of 1000 watts per hour (1kWh) and requires 0.538 kg or approximately ½ kg of coal to produce the same.

The total quantity of coal required to produce **4,83,037**units of electricity (**4,83,037**× 0.538 kg coal) = **2,59,873.80** kg or **259.87 tons** per year. $CO_2$ emission by coal One kilogram of coal emits 2.86 kg of $CO_2$, thereby increasing the carbon footprint which in turn contributes to global warming.

Therefore, **259.87 tons** of coal consumed indirectly by the Institution through consumption of **4,83,037**units of electricity led to the emission of (**2,59,873.80** kg of coal × 2.86 kg $CO_2$) **7,40,640.33 kg or 740.64 ton of $CO_2$ into the atmosphere per year.**

**Calculation of Electrical Unit**

- voltage X ampere = Power (V X I = P)
- Unit: (volt X ampere = watt)
- Tariff Structure and Power cost
- One electrical Unit = 1000W/hour
- *(1000 watt bulb glows 9for an hour or 100 watt bulb glows for 10 hours)*
- Power factor(pf)= Actual power/ apparent power

**Table.1 Electrical Energy consumed as per service connection S.No: 06204021173 for a year**

| Month/ Year | Units Consumed (KW) | Amount Paid (Rs) |
|---|---|---|
| Jan-23 | 6,000 | 94,220.00 |
| Feb-23 | 10,912 | 1,39,723.00 |
| Mar-23 | 12,248 | 2,98,749.00 |
| Apr-23 | 9,348 | 1,25,335.00 |
| May-23 | 7,668 | 1,09,145.00 |
| Jun-23 | 9,304 | 1,25,231.00 |
| Jul-23 | 13,436 | 3,75,169.00 |
| Aug-23 | 10,896 | 4,17,325.00 |
| Sep-23 | 12,808 | 2,08,200.00 |
| Oct-23 | 7,216 | 1,08,058.00 |
| Nov-23 | 7,396 | 1,09,021.00 |
| Dec-23 | 8,424 | 1,19,213.00 |
| **TOTAL** | **1,15,656** | **22,29,389.00** |

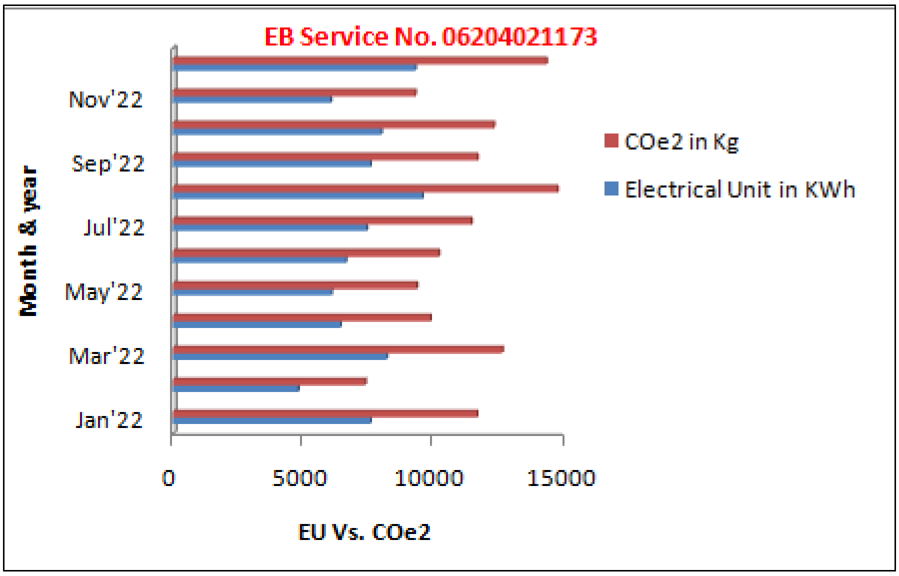



**Fig.1 Electrical Unit Verses Coe2 Emission on month wise for S.No: 06204021173**

**Table.2 Electrical Energy consumed as per service connection S.No: 06204021174 for a year**

| Month/ Year | Units Consumed (KW) | Amount Paid (Rs) |
|---|---|---|
| Jan-23 | 6,671.2 | 99,616.00 |
| Feb-23 | 10,938.4 | 1,39,532.00 |
| Mar-23 | 9,970.8 | 1,30,567.00 |
| Apr-23 | 8,053.6 | 1,12,594.00 |
| May-23 | 7,900.4 | 1,10,818.00 |
| Jun-23 | 10,718.8 | 1,37,946.00 |
| Jul-23 | 15,020.8 | 1,82,201.00 |
| Aug-23 | 11,974.0 | 1,53,347.00 |
| Sep-23 | 13,950.0 | 1,72,417.00 |
| Oct-23 | 79,42.39 | 1,14,328.00 |
| Nov-23 | 7,194.0 | 1,06,801.00 |
| Dec-23 | 9,241.6 | 1,26,757.00 |
| **TOTAL** | 11,95,75.99 | 15,86,924.00 |

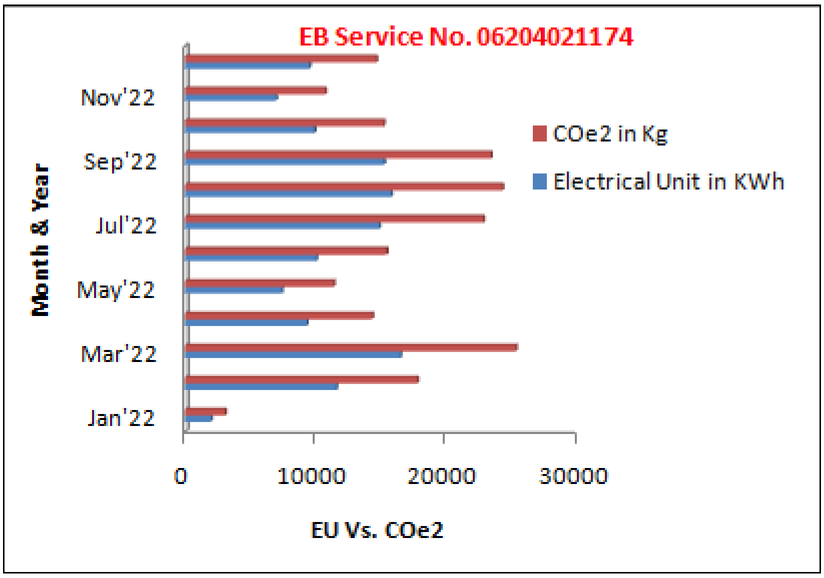



**Fig.2 Electrical Unit Verses Coe2 Emission on month wise for S.No: 062040211754**

**Table.3 Electrical Energy consumed as per service connection S.No: 06203061839 for a year**

| Month/ Year | Units Consumed (KW) | Amount Paid (Rs) |
|---|---|---|
| Jan-23 | 19,152.0 | 2,16,366.00 |
| Feb-23 | 29,746.8 | 3,15,577.00 |
| Mar-23 | 30,307.6 | 3,20,700.00 |
| Apr-23 | 17,838.4 | 2,03,783.00 |
| May-23 | 3,799.2 | 71,561.00 |
| Jun-23 | 14,108.0 | 1,68,747.00 |
| Jul-23 | 25,172.4 | 2,78,831.00 |
| Aug-23 | 23,706.4 | 2,64,819.00 |
| Sep-23 | 25,042.8 | 2,77,521.00 |
| Oct-23 | 21,518.0 | 2,43,862.00 |
| Nov-23 | 17,701.6 | 2,07,272.00 |
| Dec-23 | 19,711.6 | 2,26,635.00 |
| **TOTAL** | 2,47,804.8 | 27,95,674.00 |

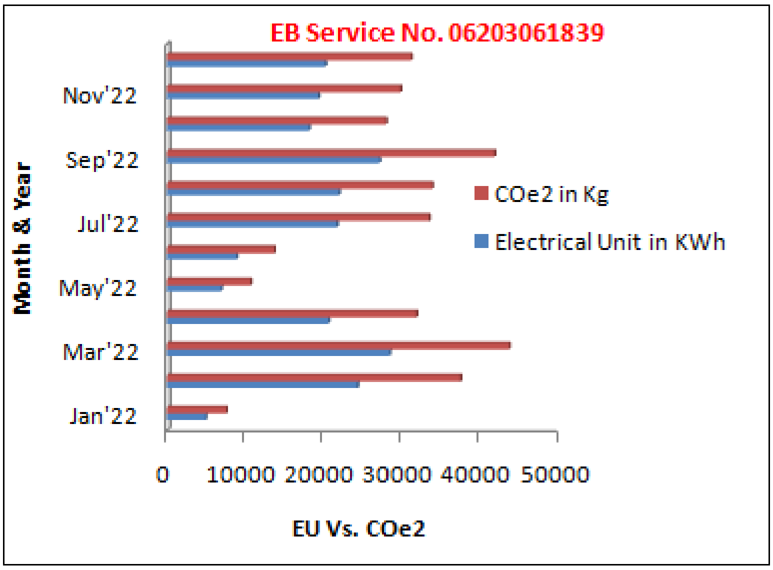



**Fig.3 Electrical Unit Verses Coe2 Emission on month wise for S.No: 06203061839**

**Chart : Data Analysis:**

**Table 4. Consolidated Electrical Energy Vs. Coe2 of the Campus**

| EB Service Number | Units consumed (KW) | Qty. of Carbon required (Kg) | Emissive $CO_2$e (Kg) |
|---|---|---|---|
| 6E+09 | 115656.00 | 62222.93 | 177335.34 |
| 6E+09 | 119576.00 | 64331.89 | 183345.88 |
| 6E+09 | 247804.80 | 133318.98 | 379959.10 |
| **Total** | **483036.80** | **259873.80** | **740640.33** |

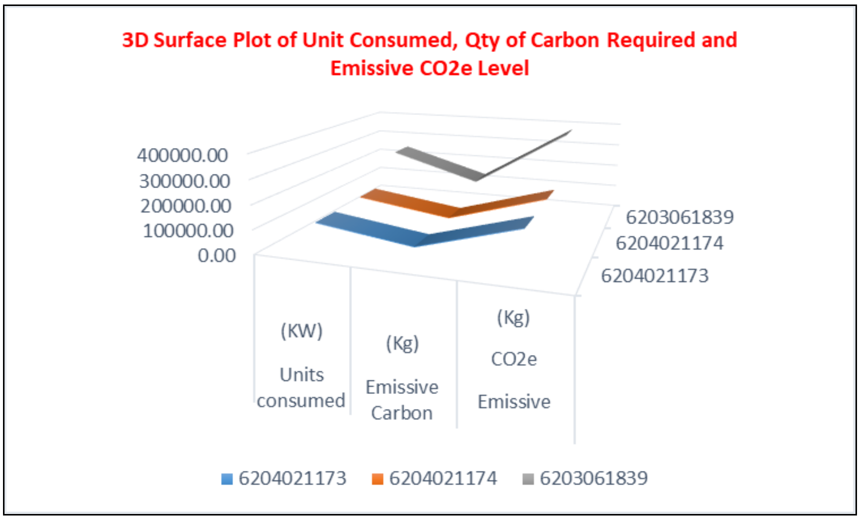



**Fig. 4 Component of Electrical Energy Consumed, Quantity of Carbon Required and Emissive CO2e**

**Based on the data**

i) The electrical energy consumption of last year 2023-24
**4,83,037KWh or Electrical Units (average)**

ii) Total Electricity Charge paid during the year 2023-24
**Rs. 66,11,987/-**

**Observation :**

- The Power factor is good but need to improve.
- The Load Factor is low could be improve to get the benefits of

good Load F actor.

- MD KVA exceeds in month of March '23

**Remedies:**

- It is suggested to install a Thyristor 150 KVAr A PFC panel with 7.68% detuned reactors.

- Install a Maximum Demand Controller

**Benefits :**

- You will get 3.5 % discount on your basic bill amount by maintaining PF to Unity.
- BY achieving Load Factor above 75 % you will get 1% discount for each percent. upto 90 Load factor and total discount will be 15 % on basic value.

- By installing Demand Controller you can avoid charges for excess demand.

The facility may save Rs. 50,000 (Approximately) per month

**Conclusion:**

The present energy consumption is **4,83,037** KWh per annum (Approximately)

The proposed energy consumption shall be **5.00,000** kwh per annum (Approx.) which will vary as per the season

**Saving Terms:**

The saving in terms of monitory benefit will be **15 Lakhs** per annum only. (Without Roof Top Solar Power Plant)

**The saving in terms of monitory benefit will be 65 Lakhs per** annum only (with Off Grid upgrading to 150 KW ROOF TOP SOLAR POWER **PLANT)**

## 2. Fuel Consumption Audit

### 2.1 Diesel Consumption by Generators

1 liter of diesel weighs 835 gram. Diesel consists for 86.2% of carbon, or 720 gram of carbon per liter diesel. In order to combust this carbon to $CO_2$, 1920 gram of oxygen is needed. The sum is then 720 + 1920 = 2640 gram or 2.7 kg of $CO_2$/liter diesel.

Consumption of Fuel in liters/month by generators is 270 liters per month and an average. Total fuel consumption per year = 270 X 12 = 3,240 liters

The carbon foot print assessed per year by diesel consumption in the campus 3,240 X 2.7 = 8,748 Kg or **8.75 ton/year**

**Table.3 Specification of generators and fuel consumption**

| S.No | Specifications | Fuel Consumption (Liters/Hour) | Duartion per month in hour | Fule consumed per month |
|---|---|---|---|---|
| 1 | 250KVA | 9 | 15 | 135 |
| 2 | 250KVA | 9 | 15 | 135 |
| **TOTAL** | | | | **270** |

### 2.3 Battery / UPS Calculation

**Step 1:** A **12V 8Ah** Battery is used to supply power to a system with a current draw of 0.5 Amperes. How long will the battery last?

Using the same equation in the first example we get:

**Step 2: Amp Hour (Ah) = Current (I) x Discharge Time (T)**

8Ah = (0.5 Amperes) x T

T = 8Ah / 0.5 A

**T = 16 Hours**

**The battery will power your system up to 16 hours.** Batteries with a higher voltage will deliver more energy. Another unit that can be useful to calculate the stored energy of the battery is Watt-hours.

**Step 3: Volt x Amp-hours = Watt-hours**

Battery - 1 has a voltage of 7.2V and battery has a voltage of 11.1V.

Thus if we calculate their Watt-hours

7.2V x 2.2Ah = 15.84Wh - for battery1

11.1V x 2.2Ah = 24.42Wh – for battery 2.

It's obvious to accesses which battery has more energy.

The voltage is usually a critical parameter for a battery, once we select a voltage, and then the capacity can specify by the amp-hour rating. The battery having more watt-hours will have more energy than the other. Another common terminology that we can use is C-Rating. The C-Rating is a way of describing how much current the battery can safely deliver. The Amp-hour is a unit of battery energy capacity, equal to the amount of continuous current multiplied by the discharge time that a battery can supply before exhausting its internal store of chemical energy.

**Table 5 Details of UPS and BATTERY & UPS**

| Location | Capacity KVA | Pf | No.of Battery | Batt Capacity (Ah) | Tot (Ah) | Volt (V) | Power (Wh) |
|---|---|---|---|---|---|---|---|
| COE | 3.5 | 9.7 | 4 | 150 | 600 | 18 | 10,800 |
| | | 9.7 | 10 | 75 | 750 | 18 | 13,500 |
| LRC | 10 | 9.7 | 16 | 135 | 2,160 | 18 | 38,880 |
| HI-TEC LAB | 10 | 9.7 | 16 | 100 | 1,600 | 18 | 28,800 |
| | 10 | 9.7 | 10 | 100 | 1,000 | 18 | 18,000 |
| | 10 | 9.7 | 16 | 100 | 1,600 | 18 | 28,800 |
| | 10 | 9.7 | 20 | 150 | 3,000 | 18 | 54,000 |
| MORDEN LAB | 10 | 9.6 | 16 | 100 | 1,600 | 18 | 28,800 |
| | 5 | 9.6 | 10 | 100 | 1,000 | 18 | 18,000 |
| | 10 | 9.6 | 5 | 100 | 500 | 18 | 9,000 |
| | 5 | 9.6 | 10 | 100 | 1,000 | 18 | 18,000 |
| | 5 | 9.6 | 5 | 100 | 500 | 18 | 9,000 |
| ULTRA | 5 | 9.7 | 10 | 26 | 260 | 18 | 4,680 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **LAB** | 10 | 9.7 | 20 | 42 | 840 | 18 | 15,120 |
| **NET LAB** | 10 | 9.7 | 32 | 42 | 1,344 | 18 | 24,192 |
| | 10 | 9.7 | 20 | 75 | 1,500 | 18 | 27,000 |
| **DT LAB** | 10 | 9.8 | 15 | 75 | 1,125 | 18 | 20,250 |
| | 10 | 9.8 | 15 | 75 | 1,125 | 18 | 20,250 |
| **TOTAL** | | | | | | | **3,87,072** |

$$\text{Continuous current (in Amps)} = \frac{\text{Amp-hour rating}}{\text{Charge/dischrge time (in Hours)}}$$

$$\text{Charge/discharge time (in Hours)} = \frac{\text{Amp-hour rating}}{\text{Continuous current (in Amps)}}$$

Power back up required is about 48 hours per month on an average during the period 2023-24. The net electrical units consumes by the backup device UPS is 3,87,072 Wh / Annum

Then 3,87,072 EU X 0.538 = 2,08,244.74 Kg of Coal required

Will produce 2,08,244.74 X 2.86 = 5,95,579.95 Kg of $CO_2$ emitted in to atmosphere

The total Carbon foot prints by UPS and BATTERY is **5,95,579.95 Kg** or **595.6 ton (approx)**

## 2.4. LPG Consumption

1 liter of LPG weighs 550 gram. LPG consists for 82,5% of carbon, or 454 gram of carbon per liter of LPG. In order to combust this carbon to $CO_2$, 1211 gram of oxygen is needed. The sum is then 454 + 1211 = 1665 gram of $CO_2$/liter of LPG. 1 Kg of LPG = 1.94 liter

**Table.6 LPG Consumption for one year-2022**

| **Details of LPG (Commercial) Units** | | |
|---|---|---|
| Yearly | **No. of Cylinders** | **Amount (Rs)** |
| **TOTAL** | **512** | **488,930.00** |

The campus uses about 512 units of commercial LPG cylinders each year. A commercial cylinder contains 19Kg of LPG. Therefore 21 commercial cylinders net weight (512 X 19 Kg) = 9,728 Kg /Year

9,728 X 1.94 = 18,872.32 liter/year

Emission of $CO_2$ per month of the institution (18,872.32 X 1.67kg)

=31,516.77 Kg of $CO_2$ **or 31.5 ton / year**

**2.4. Firewood Consumption**

The campus uses about 66,000 Kg of firewood used each year on an average and the $CO_2$ emission is 66,000X 1.9 = 1,25,400 Kg per year. The $COe_2$ emission by firewood in the Campus is **125.4 ton / year** is a part of is emissions is **carbon-neutral it's reduced to ZERO.**

Note: The carbon dioxide released when burning wood (about 1900g CO2 for each 1000g of wood burnt) is balanced by the fact that this carbon was taken up by the tree from the air when it grew. So this part of the emissions is carbon-neutral. However, many other chemicals are produced when wood is burnt, including one of the most potent greenhouse gases, nitrogen dioxide; although the amounts may be small (200 g of CO2 equivalent per kg of wood burnt), the gas is 300 times more potent as a greenhouse gas than carbon dioxide and lasts 120 years in the atmosphere.

**Table.7 The total Carbon foot prints in the campus per year**

| S.No | COe2 Emission of Consumption | Quantity in ton |
|---|---|---|
| 1 | Electrical Energy | **740.64** |
| 2 | Transportation | **NIL** |
| 3 | Generator | **8.75** |
| 4 | UPS/Battery | **595.60** |
| 5 | LPG | **31.50** |
| 6 | Firewood | **NIL** |
| **TOTAL** | | **1376.49** |

**The total Carbon foot prints in the campus per year as by emission COe2 in to the atmosphere per year is 1376.49ton**

## 3. Carbon offset

## Electrical Energy Audit Report

### I. Energy-saving measures and Carbon Footprint Reduction

The Energy Audit Report of the College Campus during the period 2023-24 revealed that the total consumption of electricity was 4,83,037 units. This includes air conditioners which consume about 20% of electricity. The carbon emission is of the form **1376.49** tons of $CO_2$ into the atmosphere.

The management of Cauvery College for Women (Autonomous) is conscious of this damage to the environment and has been implementing various programs/activities to reduce energy consumption on the one hand and increase green energy sources on the other. They are

a) Replacing high energy-consuming lighting system with energy-efficient lighting systems.

b) Installing a 38-KVA pilot solar PV power system through which analysis of $CO_2$ reduction is succeeded.

c) Installing energy-efficient lighting system Based on the recommendations of the Energy Audit conducted last year, the Institution has reduced $CO_2$ emissions indirectly by replacing high energy-consuming electric bulbs with energy-efficient LED lighting systems.

d) Average energy consumption by an incandescent lamp 60 W, and LED 12W max and energy consumed by LED 1,12,200 KWh per Annam or1,12,200 electrical units.

**The following are the $CO_2$ reduction measures adopted in the Institution**.

### I. LED Lamps in the Campus

The Institution has installed LED tube lights in the College campus. The power consumption and carbon footprint reduction are discussed below.

Total units of electricity consumed by LED lamps = 1,25,000 units EU equivalent of (1,25,000 × 0.538 kg coal) = 67,250 kg or 67.25 tons. 1 kg coal emits 2.86 kg $CO_2$ into the atmosphere. At this rate, 6,564 kg coal emits (67,250 × 2.86) = 1,92,335 kg or 192.34 tons of $CO_2$ which is 7% offset achieved in the campus.

**Table.8 The total Carbon foot prints in the campus per year**

| S.No | $CO_2$ Emission of Consumption | Quantity in ton |
|---|---|---|
| 1 | Electrical Energy | **676.53** |
| 2 | Transportation | **NIL** |
| 3 | Generator | **8.75** |
| 4 | UPS/Battery | **595.60** |
| 5 | LPG | **31.50** |
| 6 | Firewood | **NIL** |
| | **TOTAL** | **1376.49** |
| | **Carbon Off-Set** | |
| 7 | By LED fixtures | -192.34 |
| | **NET $CO_2e$ assessed** | **1184.15** |

**Table.9 Net Carbon foot prints in the campus per year**

| Component | Qty in (Ton) |
|---|---|
| Campus $CO_2$ Sequestration | **1376.49** |
| Campus CO2 Offset | -192.34 |
| Net Assessed Value | **1184.15** |

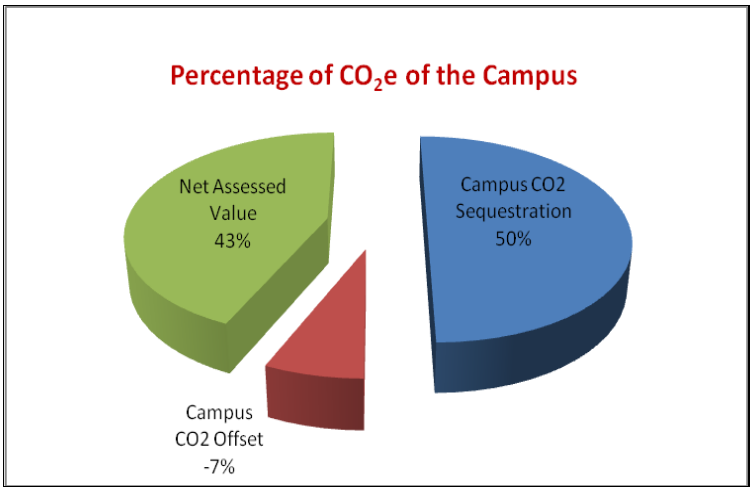


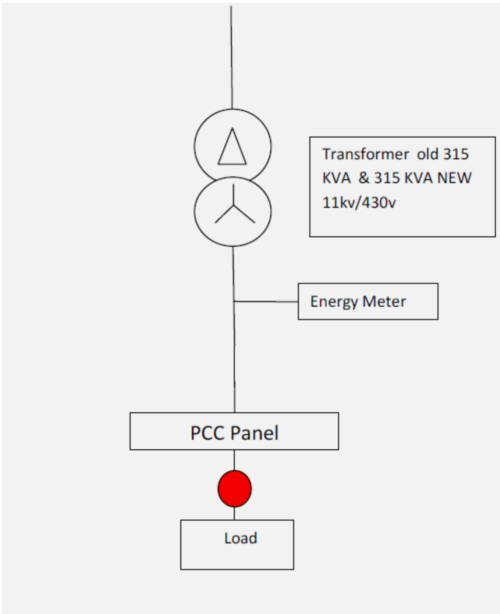

**Fig. 4 Quantitative Assesment of CO2 of the Campus for the Year 2022**

**Conclusion:** The total Carbon footprint of the campus **1184.15 ton** for the year **2023-24.**

# 4. Power Quality Observations & Remedies

## 4.1 Site Description.

The detailed Single Line Diagram is not available with Bon Secoure College. The basic site survey was conducted as per following Single Line Diagram.




## 4.2 Existing Scenario with the Installation under survey

**Table 4.1 Main Transformer details**

| | |
|---|---|
| Transformer | 80 KVA (External) |
| Voltage on LV side | 433 V (4 Nos.) |
| Voltage on HV side | 11 KV (4 Nos.) |

## 4.3 IEEE-519-1992 Consideration and Value for Plant under survey

The said standard id applicable at the PCC (Point of Common Coupling). In above mentioned SLD at Survey Point no.1 is the point of coupling.

As per the standards; the harmonic limits are to be considered at PCC Recommended Limits for these ratios as per IEEE-519-2014 are as here under.

## Table 4.2 Current Distortion Limits for General Distribution Systems (120 V through 69 KV)

| Maximum Harmonic Current Distortion in Percent of IL | | | | | | |
|---|---|---|---|---|---|---|
| Individual Harmonic Order (Odd Harmonic) | | | | | | |
| Isc//L | <11 | 11<h<17 | 17<h<23 | 23<h<35 | 35<h | TDD |
| <20* | 4.0 | 2.0 | 1.5 | 0.6 | 0.3 | 5.0 |
| 20<50 | 7.0 | 3.5 | 2.5 | 1.0 | 0.5 | 8.0 |
| 50<100 | 10.0 | 4.5 | 4.0 | 1.5 | 0.7 | 12.0 |
| 100<1000 | 12.0 | 5.5 | 5.0 | 2.0 | 1.0 | 15.0 |
| >1000 | 15.0 | 7.0 | 6.0 | 2.5 | 1.4 | 20.0 |

Even harmonic are limited to 25% the odd harmonic limits above

Current distortions that result in a offset, e.g. half –wave convertes are not allowed

*All power generation equipment is Limited to these values of current distortion. regardless of actual/sc//L

Where

/sc =maximum short-circuit current at PCC

/L =maximum demand load current (fundamental frequency component) at PCC.

TDD =Total demand distortion (RSS).harmonic current distortion in% of maximum demand load current (15 or 30 min demand).

PCC =Point of common coupling.

### Voltage Distortion Limits

| **Bus Voltage at PCC** | **Individual Voltage Distortion (%)** | **Total Voltage Distortion THD (%)** |
|---|---|---|
| 69 kv and below | 3.0 | 5.0 |
| 69.000 kV through 161kv | 1.5 | 2.5 |
| 161.001 kV and above | 1.0 | 1.5 |

Note: High-voltage systems can have up to 2.0% THD where the cause is an HADC terminal that will attenuate by the time it is tapped for a user.

## Table 4.3 Voltage Current and Harmonic Values

| RMS Voltage Values | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Phase R-Y | Phase Y-B | Phase R-B | Phase R-N | Phase Y-N | Phase B-N | Ph N-G |
| Min Value | 464.66 | 468.49 | 468.61 | 268.93 | 269.07 | 271.30 | 0.24 |
| Ave Value | 464.77 | 468.61 | 468.70 | 268.97 | 269.13 | 271.37 | 0.25 |
| Max Value | 464.82 | 468.73 | 468.77 | 269.01 | 269.18 | 2671.42 | 0.27 |

| RMS Current Values | | | | |
|---|---|---|---|---|
| | Phase R | Phase Y | Phase B | Neutral |
| Min Value | 10.05 | 6.79 | 4.73 | 7.90 |
| Ave Value | 10.25 | 6.97 | 4.98 | 7.99 |
| Max Value | 10.45 | 7.15 | 5.22 | 8.09 |

| PEAK Current Values | | | | |
|---|---|---|---|---|
| | Phase R | Phase Y | Phase B | Neutral |
| Min Value | 25.03 | 19.32 | 16 | 23.54 |
| Ave Value | 25.81 | 20.45 | 17.23 | 24.48 |
| Max Value | 26.68 | 21.83 | 18.67 | 25.55 |

| | HARMONIC LEVEL IN % | | | | | |
|---|---|---|---|---|---|---|
| | Phase R | Phase Y | Phase B | Phase N | As per IEEE in % | As per MSEDCL in % |
| Voltage | **0.85** | **0.90** | **1.1** | 230 | Up to 5% | Up to 5 % |
| Current | 40 | 45 | 75 | 105 | Up to 10 % | Up to 10 % |

| Frequency | |
|---|---|
| Max | 50.02 |
| Avg | 50.02 |
| Min | 50.02 |

### 4.4 Observations

### 80 KVA Transformer

1. Due to unbalanced and non-linear load condition in each phase, harmonics in neutral is 230% and 105% in voltage and current respectively.

2. 3rd and 7th harmonic is present in the system. This is observed due to SMPS ie computer load & electronic ballasts.

3. Current in Neutral is 14.5 amp and 80 amp to maximum level.
4. Voltage harmonics are under permissible limits of MSEDCL and IEEE norm, while the Current harmonics are above the ideal values and these harmonics were induced through machinery.
5. Spikes are observed, no spike protection is provided to the system.
6. Overall Voltage supplied by grid is on HIGHER SIDE.

**4.5 Remedies**

1. For Harmonics of 7th order the APFC panel (automatic power factor control) of 50 KVA with 7.68% detuned reactors and 525v capacitors with thyristerised switching is to be installed.

2. For harmonics of 3rd and 9th order the earthing is to be done .The detailed specification is given below.

- Make proper earthing as per IEC 60364-5-54 to meter as well as control panels.
- It is suggested to install new earthing system the details are as below:

Make OBO Betterman, Germany

- Length of Earth electrode: 1250 mm, Diameter of earth electrode: 14.2mm. Tested as per IEC 60364-5-54.
- Earth conductivity enhancing mineral compound of 5KG
- Total quantity required = 03 no. set (for 80 KVA).

3. Install a Spike Protection Device, for protection from sudden high current spike which occurs due to high voltage. This is to be installed next to Energy Meter; also in each control panel.

**4.6 The Specification for SPD is as follows**

I. For protection against the Lightening surge and Surge through power lines (HT),

- Combi controller = 1 nos. to be connected to transformer LT side. Technology: MOV for L to N and SG for N to PE, Normal line voltage 230/ 400 v, 50Hz.
- Impulse current (10/350 micro sec), 7 KA and 25 KA.
- Response time < 25 nano seconds.
- Voltage protection level 900 volts & 1200 volts.

II. For protection against internal surges.

- Surge Controller = 4 nos. to be installed at each floor east and west side.
- Technology: MOV for L to N and SG for N to PE, Normal line voltage 230/ 400 v, 50Hz.
- Nominal discharge current 8/20 micro sec. = 20 KA & 50 KA.
- Voltage protection level = 1300v and 1200 volt.
- Response time less than 20 nano sec.

**4.7 Effect on system**

1. Circuit will be free from harmonic current.
2. The voltage regulation will be good, which results in low maintenance and saving in units also.
3. Neutral Current will be minimizing so very negligible amount of current will be there.

# 5. Energy Audit Methodology

## 5.1 Electrical Distribution System:

Scope of Work:

- To study existing electrical distribution system
- Measure/ Record the 12 hrs Load distribution
- To suggest various energy efficient measures with first order cost benefit analysis.

## 5.2 Methodology:

A. Census:

1) Find out the electrical normal & emergency loading.

Type of tariff

- Rating of installed transformer
- General hygiene as per standard maintenance practices
- Operating hrs data were collected from respective person

B. Indoor Lighting

**Scope of work**

- To study the existing lighting scenario of facility & verify the building data
- To find out the performance of lighting fixture
- To calculate the ILER (Lux/ watt/ m2) & compare lux with the bench mark /prevailing STD in the facility.
- To suggest various energy efficient measures with first order cost benefit analysis

**Censes**

- Upto 80% of the lighting fixture were inspected for following
- No. of light installed & no of light working.
- Type of lights, General hygiene as per std maintenance practices
- Operating hrs data were collected from respective person.

## 5.3 Computer

**Scope of work:**

- To study existing computer at facility and verify the billing data.
- To find out the power drawn.
- To compare the power drawn with the bench mark or prevailing standard in the facility.

- To identify the causes of deviation in the performance & suggest recommendation for corrective actions.
- To suggest various energy efficient measures with the first order cost benefit analysis

**5.4 Methodology**

**Census:**

- Up to 80% of the computers printers & faxes were inspected for following.
- No of computers printers & faxes installed.

**5.5 Scope of work:**

- To study existing pumping system at facility and verify the billing data.
- To carry out analysis and to find out the performance of the pumping system.
- To compare the operating efficiency with the bench mark or prevailing standard in the facility.
- To identify the causes of deviation in the performance & suggest recommendation for corrective actions.
- To suggest various energy efficient measures with the first order cost benefit analysis.

**5.7 Methodology**

**Census:**

- All water pumps were audited for following.
- Total no of pumps installed.

**5.8 Report Writing**

A detailed report of all the outcomes

i. Observations
ii. Remedies
iii. Census
iv. Data Collections
v. Data Processing
vi. Data Analysis
vii. Results
viii. Summery
ix. Suggestions and
x. Conclusions are repotted in defined format for documentation and further references