

# REPORT OF ENERGY AUDIT

*Submitted to*

**BHARATHIAR UNIVERSITY**  
**Coimbatore - 641 046, Tamil Nadu, India.**

*Date of Audit: 21.04.2018 (Saturday)*

*Submitted by*



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*Motto*

*'Save the Nature to Save the Future' & 'Go Green to Save the Planet'*

## Contents

<b>S.No.</b>	<b>Details of Reports</b>	<b>Page No</b>
1.	Introduction	1
2.	Aims and Objectives of Energy Audit	2
3.	Procedures followed in Energy Audit	2
3.1	Carbon footprint by measuring Carbon dioxide level in the Campus	3
3.2	Physical verification of loads and sources installed in the Campus	3
4.	Energy Audit Process	4
4.1.	Steps involved in an Energy Audit	6
4.2.	Systems studied during the energy audit	6
4.3.	Planning and organizing the audit	6
4.4.	Walk-through Audit	6
4.5	Macro Data collection and observation	7
4.6	Measurements in Energy Audit	7
5.	About the Institution	7
6.	Audit details	9
7.	Observations in the Energy Audit	10
7.1.	Facilities visited during the audit	10
7.2.	Systems Studied during the audit	10
7.3.	Energy consumption and cost profile	11
7.4	Power supply and major loads	12
7.5	Measurement of Carbon dioxide level in the Campus	12
8.	Best Practices followed in the Organization	14
9.	Recommendations for improving the energy efficiency and energy conservation.	15
10.	Conclusions	16
11.	Acknowledgement	16
12.	References	16

## 1. Introduction

An energy audit is a survey in which the study of energy flows for the purpose of conservation is examined at an Organization. It refers to a technique or system that seeks to reduce the amount of energy used in the Organization without impacting the output. The audit includes suggestions of alternative means and methods for achieving energy savings to a greater extent. Conventionally, electrical energy is generated by means of fossil fuels, hydraulic and wind. The availability of fossil fuels and their depletion rate, insist the need for alternate energy systems and conservation of electric energy. In general, the primary objective of an energy auditing and management of energy consumption is to offer goods or services at the lowest possible cost and with the least amount of environmental impact (Backlund and Thollander, 2015). The need for an energy audit is to identify the savings potential and cost reducing methods, understand the ways in which fuel is used, where, the waste occurs and find the scope for improvement.

An energy audit is proposed and conducted to ensure that energy saving practices are implemented and followed in Educational Institutions and Industrial sectors in a sustainable way. Preparation and completion of a questionnaire, physical examination of the campus, observation and examination of documentation, key person interviews, data analysis, measurements and suggestions are all part of the audit process. Energy audit involves several facts including energy savings potential, energy management, finding alternatives, etc. (Cabrera *et al.*, 2010) With these facts in mind, the audit's specific objectives are to assess the competence of the sustainability management and control system, as well as the departments' compliance with applicable rules, policies and standards. It has the potential to have a significant influence on the organization's operational cost as well as the environmental impact (Singh *et al.*, 2012).

Energy Conservation Building Code (ECBC) is established in the year 2017 which provides minimum requirements for the energy-efficient design and construction of buildings across India. It also provides two additional sets of incremental requirements for buildings to achieve enhanced levels of energy efficiency that go beyond the minimum requirements (Gnanamangai *et al.*, 2018). Bureau of Energy Efficiency (BEE) came into force in 2002 towards implementation of energy saving practices in an Organization. Energy-efficiency labels are information affixed to manufactured products and usually communicate the product energy performance (Ingle, 2014). BEE has developed a scheme for energy efficiency labelling of buildings coinciding with the star ratings of the building at accelerating energy efficiency activities. BEE Star Rating Scheme is based on actual performance of the building in terms of specific energy usage termed as 'Energy Performance Indicator' by means of star ratings labelled items used (Mishra and Patel, 2016).

Energy audit programme provide aid in maintaining a focus on energy price variations, energy supply availability and efficiency, determining an appropriate energy mix, identifying energy-saving technology, retrofitting for energy-saving equipment and so on. In general, an energy audit process dealt with the driving conservation concepts into reality by giving technically possible solutions within a specified time limit while also considering the economic and other organizational issues (Asnani and Bhawana, 2015). It also dealt with the uncover ways to cut operating expenses or reduce energy use per unit of production in terms of savings. It serves as a “benchmark” (reference point) for managing energy in the organization for planning more energy-efficient use across the board (Cabrera *et al.*, 2010).

## **2. Aims and Objectives of an Energy Audit**

An energy audit is a useful tool for developing and implementing comprehensive energy management plans of an Organization. The aim of an energy audit is to identify the energy efficiency, conservation and savings opportunities at the premises of the audit sites in a systematic manner. The audit process is carried out as per the following.

- Review of energy saving opportunities and measures implemented in the audit sites.
- Identification of additional various energy conservation measures and saving opportunities.
- Implementation of alternative energy resources for energy saving opportunities and decision making in the field of energy management.
- Creating awareness among the stakeholders on energy conservation and utilization.
- Providing a technical information on how to build an energy balance as well as guidance to be sought for particular applications.
- Suggesting the energy savings opportunities and implementing the energy management practices to the organizations.

## **3. Procedures followed in an Energy Audit**

In order to conduct an energy audit, several methods are adopted in the audit sites. The balance of total energy inputs with total energy outputs and identification of all energy streams in a facility are noted. The amount of energy used by each of its energy streams are calculated as per the methodology mentioned in the Manual of Gnanamangai *et al.* (2018). The top three operating expenses of the Organization are typically observed to be energy (both electrical and thermal), labour and materials. When the cost or prospective cost savings in each of the above components are considered, energy always wins, and the energy management task becomes a key cost reduction area. The energy audit assisted in better understanding how energy and fuel are used in the Organization as well as identifying waste factors and development potential towards energy savings opportunities. Finally after the audit process, the

energy audit included suggestions for energy cost reduction, preventive maintenance and quality control activities, all of which are critical for the utility operations in the auditee (Organization).

### **3.1. Carbon footprint by measuring Carbon dioxide level in the Campus**

The level of Carbon dioxide is measured in different places across the Organization campus using a portable CO<sub>2</sub> Analyzer (Non dispersive infra-red meter). In addition, CO<sub>2</sub> meter is also displayed the readings of atmospheric temperature, relative humidity and dew point in the places, where the level CO<sub>2</sub> is measured. The meter started measurements of CO<sub>2</sub> level in the atmosphere after powered ON and updated the readings every second in the display screen. If the operating environment is changed (example from high to low temperature) which took 30 seconds for CO<sub>2</sub> sensor to respond and 30 minutes for flexibility in relative humidity. The meter features an audible alarm to give warnings when CO<sub>2</sub> concentration exceeds the set limit. It emits beeps (Abt.80dB) when CO<sub>2</sub> level goes over the set value and stops when any key (except SET) is pressed or the readings fall below the set values.

The Carbon footprint per year is calculated ([www.carbonfootprint.com](http://www.carbonfootprint.com)) based on electricity usage per year in which CO<sub>2</sub> emission from electricity and the sum of transportation per year in terms of number of the shuttle buses service operated by the Organization and number of cars, motorcycles and trucks entering in the Organization campus. These factors are multiplied with total number of trips in each day and approximate travel distance of vehicles covered in each day (in kilometers) with a coefficient (0.01) to calculate the emission of CO<sub>2</sub> in metric tons per year.

### **3.2. Physical verification of loads and sources installed in the Campus**

The audit involved visiting the campus and physical verification of the loads and sources installed. The entire campus is divided into different sections and those sections are audited in which electrical fittings and energy supply are monitored. The production process flow is studied and electricity consumption are measured. Location of the electrical machines, conditions of them and their accessories are inspected through physical verification is observed as per the regulation of Indian Green Building Council (IGBC, 2018) and World Green Building Council (WGBC, 2018). The energy bill from the supply utility company (Example: Tamil Nadu Electric Generation and Distribution Corporation Limited, Chennai) is audited and assessed for the load demand requirement and efficient consumption of energy. Stakeholders are interacted with the scope for improvement and energy management during the audit. Potential areas in which the scope of energy conservation and saving opportunities available in the current context have been identified and suggested for implementation to the Organization.

#### 4. Energy Audit Process

Energy audit is a sequence of tasks performed in a planned manner. It requires discussion, survey, collection of data, analysis, and reporting.



##### 4.1. Steps involved in an Energy Audit

- Step 1: Opening meeting among the audit team and auditees
- Step 2: Planning and organizing the energy audit
- Step 3: Conduct a walk-through audit at different sites
- Step 4: Macro data collection and observation
- Step 5: Analysis of data collected from the Organization
- Step 6: Best practices followed in the Organization towards energy savings
- Step 7: Recommendations for further improvement
- Step 8: Exit meeting after the audit to discuss about the audit findings

#### **4.2. Systems studied during the energy audit**

- Physical verification of lighting, fan a/c machines, ventilators load fixtures.
- Verification of installed energy efficient systems.
- Inspection of Solar panel, Generators, Uninterrupted power supply machines.
- Inspect and verify the maintenance aspects of installed Generators and additional backup power sources.
- Analyse the electricity consumption through the supply utility company (Example: Tamil Nadu Electric Generation and Distribution Corporation Limited, Chennai).
- Review the potential usage of alternative energy resources.
- Review the energy conservation awareness among the stakeholders for optimum use of electricity and its savings.

#### **4.3. Planning and organizing the audit**

Planning and organizing are the integral part of the energy audit. An initial visit to the audit sites is organized and the areas to be inspected are listed. Following the listing, information on the energy consumption of various blocks in the recent past is obtained, and a planned analysis is carried out.

#### **4.4. Walk-through Audit**

Simple audit, screening audit or visual audit are the other names, by which walk-through audits are addressed. The main purpose of the walk-through audit is to obtain general information about the sites in which electrical energy is being used at the maximum. More specific information have been obtained from the maintenance and operational people during the time walk-through audit. It also included a walk-through of the facility to become familiar with the building's operation and a brief evaluation of facility utility bills (amount paid for electricity) and other operating data. During the audit the primary problem areas are discovered.

#### **4.5. Macro Data collection and observation**

Current level operation and practices within the campus are assessed and then the data regarding the number of electrical loads connected in each section are collected. The power ratings of each component and their respective hours of operation are also observed and documented for preparing the recommendations to the Organization.

#### **4.6. Measurements in Energy Audit**

An energy audit required measurements, such as the energy identification and quantification, and these quantities necessitate the instruments used in a consistent way. Some of the basic electrical parameters are monitored during the energy audit such as Voltage (V), Current (I), Power factor, active power (kW), apparent power (demand in kVA), reactive power (kVAR), energy consumption (kWH), frequency (Hz), harmonics, illumination level, etc. Temperature and heat flow, radiation, air and gas

flow, liquid flow, speed, air velocity, noise and vibration, dust concentration, TDS, pH, moisture content, relative humidity, flue gas analysis - CO<sub>2</sub>, O<sub>2</sub>, CO, SO<sub>x</sub>, NO<sub>x</sub>, combustion efficiency are the mechanical, thermal and other parameters that are analyzed during the audit depending upon the requirements.

## **5. About the Institution**

The Bharathiar University was established at Coimbatore by the Government of Tamil Nadu in February 1982 under the Bharathiar University Act, 1981 (Act 1 of 1982). The erstwhile Postgraduate Centre of the University of Madras formed the core of the Bharathiar University, which was functioning at Coimbatore before 1982. University Grants Commission (UGC) recognized Bharathiar University in 1985 for grants. The University has 39 Departments, offering 54 post-graduate programs besides offering M.Phil. and Ph.D. programs. The University is an affiliating University. The jurisdiction of the University covers the districts of Coimbatore, Erode, Tirupur, and The Nilgiris with 133 affiliated colleges.

The National Assessment and Accreditation Council have accredited the University with an 'A' Grade in the third cycle assessment. Bharathiar University is marching towards becoming a World Class University by garnering ranking in the International arena. The state-of-the-art facilities available for faculty members and scholars nurture a culture of research in cutting-edge areas. Industry infusion into the curriculum is given prominence by involving industry experts- R&D managers, product development managers, technical managers in the curriculum development as special invitees in the Board of Studies.

Our University is a partner in the MHRD National Knowledge Network. Through UGC - Infonet, and Infilbnet a collection of physical and electronic resources is available. The Intellectual Property Rights Cell of Bharathiar University protects the rights of inventions of faculty and young researchers in the University. The DRDO-BU-Center for Life Sciences was established in Bharathiar University as a joint venture by DRDO, Ministry of Defence, Government of India, as an autonomous research institute to pursue basic and applied research. Bharathiar University Centre for International Affairs (BU-CIA) facilitates admission of international students through study in India (MoU) and Indian Council for Cultural Relations (MEA). BU-CIA operates in liaison with the Association of Indian Universities, the Association of Commonwealth Universities, and Shastri Indo Canadian Institute. With a dedicated team of faculty with vast experience in teaching and research and dedicated and experienced administrative members, the University has emerged as one of the strong pillars of higher education in this region.

Bharathiar University provides high quality education and training in the field of Arts, and Sciences to prepare students to contribute to India's social, technological and economic development. Apart from quality education, the Institute provides training to make students responsible and socially and culturally aware. The Institute is situated in a sprawling 720 acre in Coimbatore city. It is offering various Arts and Sciences, courses at postgraduate (M.A./M.Sc./M.Com./MBA./MCA.) level including M.Phil and Ph.D. degree programmes in various subject domains.



With a campus spread across 720 acres, the campus has a fine infrastructure and adequate state-of-the-art physical facilities which include administrative building, Department building containing classrooms, laboratories, staff cabins and restroom, central library, controller of examination building, DRDO centre, hostels, foot court, auditorium, seminar halls, canteen, playground and other sports, games and gym facilities, bank, ATM, post office, hostel, shed, farm, security cabin, green house and animal house, etc. The Organization provides hostel facility to boy and girl students in the campus facilities. The buildings and other infrastructural facilities are well-maintained and are put to optimum use. The Institution is open to students of all castes and creed, as envisaged in its lofty vision to cater to the higher education aspirations of the socially, educationally and economically marginalized sections of a rural population belonging to different communities, consisting mostly of economically weaker sections of the students. The Institution has a well-defined decentralized and participatory organizational structure to coordinate the academic and administrative functions very effectively.

The dedication of the Management and the Administration section of the Bharathiar University, combined with excellent infrastructural and teaching facilities help to maintain high standards in curricular and co-curricular spheres to the stakeholders like students, staff members and parents. It offers a well-established vision and mission coinciding with global standards to impart high quality of education to the students coming from rural background that lead to the challenges of an emerging India in a globalized world, by bringing in a positive difference in the socioeconomic-educational status of the state and the nation as a whole. Bharathiar University is maintaining more than 80% of green cover area and open unutilized landfills zone after building construction as per the guidelines of World Green Building Council, Indian Green Building Council, Environmental Regulations and Compliances.

## **6. Audit Details**

<b>Date/Day of Audit</b>	<b>: 21.04.2018 (Saturday)</b>
<b>Venue of Audit</b>	<b>: Bharathiar University</b> Coimbatore, Tamil Nadu, India.
<b>Audited by</b>	<b>: Nature Science Foundation,</b> Coimbatore, Tamil Nadu, India.
<b>Audit type</b>	<b>: Energy Audit</b>
<b>Name of ISO EMS Auditor</b>	<b>: Mrs. S. Rajalakshmi,</b> Chairman & ISO EMS Auditor, NSF.
<b>Name of Lead Auditor</b>	<b>: Dr. R. Mary Josephine,</b> Board of Directors, NSF.
<b>Name of Energy Auditors</b>	<b>: Dr. P. Thirumoorthi,</b> Professor in Electrical & Electronics Engineering Kumaraguru College of Technology, Coimbatore <b>Dr. G. Muruganath,</b> Professor and Head, Department of EEE, Ahalia School of Engg & Technology, Kerala

## 7. Observations of the Energy Audit

### 7.1. Facilities visited during the Energy Audit:

**Table 1. Facilities visited during the Energy Audit**

Date	Sections where Energy Audits were conducted
21-04-2018	Administrative Block
	Power House
	Faculty Rooms
	Classrooms
	Seminar Halls
	Auditorium
	Laboratories
	Computer Centres
	Well, Sump and pumps.
	Hostel
	Library

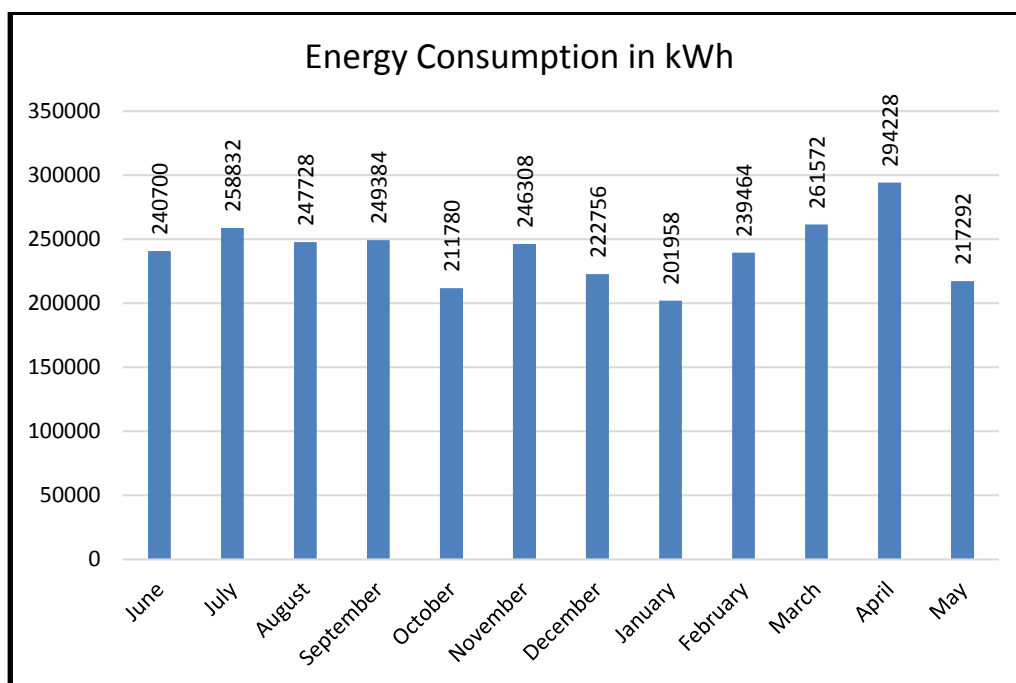
In the sections, the services offered are monitored, verified and analysed on the aspects of energy consumption. In all these areas lighting systems forms the major consumer of electrical energy. Three phase electricity service connections available in the campus are provided by Tamil Nadu Generation and Distribution Corporation Limited (TANGEDCO Sr.Nos. 060, 090,). The electricity consumption charges are audited and studied for the load demand requirement and efficient consumption of energy. Stake holders are interacted and the scope for improvement has been discussed. Potential areas in which scope of energy conservation and saving opportunities available have been identified and suggested for implementation.

### 7.2. Systems Studied during the audit

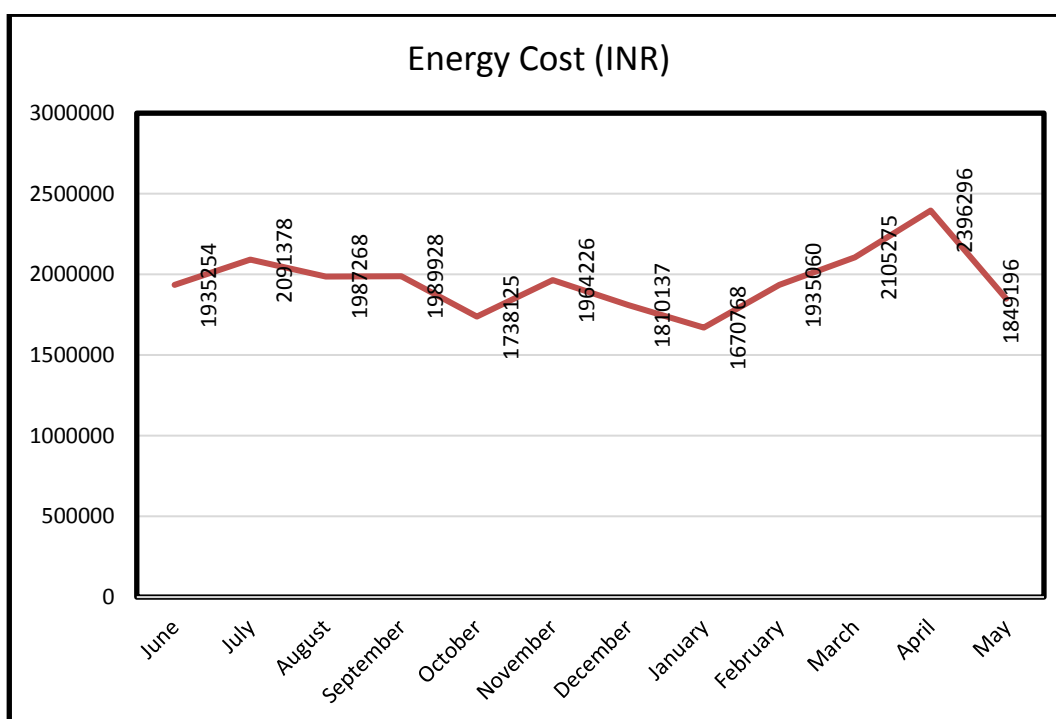
1. Lighting fixtures are verified physically.
2. Installation of energy efficient lighting systems are verified.
3. Verified the installed safety systems.
4. Installed power backup systems (Generators and UPS) are verified on the aspect of maintenance.
5. Electricity consumption through the TANGEDCO bills were analysed.
6. Reviewed the energy conservation awareness among the stake holders for optimum use of electricity and its savings.

### 7.3. Energy Consumption and Cost Profile

The following chart shows the profile of energy consumed and the cost for one year by the college stake holders.



**Energy Consumption Profile**



**Energy Cost Profile**

Average energy consumption per stake holder per month: 23.47 kWh.

#### **7.4. Power supply and Equipment**

Transformer : 250 KVA & 500 KVA  
 Sanctioned MD : 330 KVA & 620 KVA  
 Generator : 250 KVA

**Table 2. Major Equipment**

S.No.	Equipment / Utility	Rating / Capacity	Quantity (Nos)
1.	LED Tube Lights	18 W	505
2.	CFL Lights	9 W	152
3.	Tube Lights	48 W	3552
4.	UPS	30 kVA	327
5.	LCD Projectors	3 W	28
6.	RO Water plant and water purification systems	2000 LPH	15
7.	AC machines	885 TONS	421
8.	Stabilizers	400 V	28
9.	Inverters and Converters	5 W	796
10.	Generators	250 kVA	1
11.	Fans	70 W	2277
12.	Ventilators		19
13.	Exhaust fans	54 CFM	164
14.	Internet Connectivity		1974
15.	Audio systems	30 W	802
16.	Refrigerators	2000 W	146

### 7.5. Measurement of Carbon dioxide level in the Campus

Despite a massive increase in global warming, environmental changes and human population including many commercial activities now-a-days, the amount of carbon in Earth's atmosphere is playing an important role which act as a global indicator for checking the purity of the atmosphere. Using a portable CO<sub>2</sub> Analyzer, the level of carbon dioxide was measured in different places across the Bharathiar University campus. The observation showed that the concentration of CO<sub>2</sub> in the atmosphere is found to be low which did not exceeds the critical limit of CO<sub>2</sub>. It is further revealed that all the selected locations are having pure air with good air exchange which are free from pollutants (Table 3).

**Table 3. Measurement of CO<sub>2</sub> concentration in the Bharathiar University Campus**

S.No.	Different locations of the Organization's campus	Carbon dioxide level (ppm)	Remarks
1.	Library hall	420	CO <sub>2</sub> level is low
2.	Auditorium/ Conference halls	536	CO <sub>2</sub> level is low
3.	Class Rooms	399	CO <sub>2</sub> level is low
4.	Administrative Office	408	CO <sub>2</sub> level is low
5.	Ground Parking Area	389	CO <sub>2</sub> level is low
6.	Open place	387	CO <sub>2</sub> level is low

7.	Department of Botany	474	CO <sub>2</sub> level is low
8.	Department of Chemistry	413	CO <sub>2</sub> level is low
9.	Department of Nanotech	785	CO <sub>2</sub> level is low
10.	Career Guidance Cell	762	CO <sub>2</sub> level is low

### ***Reference of Set values of CO<sub>2</sub> level***

- 350-1000 ppm: Typical level found in occupied spaces with good air exchange along with pure air.
- 1000-2000 ppm: Moderate level associated with complaints of drowsiness and poor air quality.
- 2000-5000 ppm: Critical level associated with headaches, sleepiness, and stagnant, stale, stuffy air. Poor concentration, loss of attention, increased heart rate and slight nausea may present.

### ***Calculation of Carbon Footprint at Bharathiar University with respect to electricity usage***

The Carbon footprint calculation can be conducted based on the stage of calculation as stated in [www.carbonfootprint.com](http://www.carbonfootprint.com), which is the sum of electricity usage per year. The CO<sub>2</sub> emission from electricity

$$= (\text{electricity usage per year in kWh}/1000) \times 0.84$$

$$= (2892002 \text{ kWh}/1000) \times 0.84$$

$$= 2429.28 \text{ metric tons}$$

#### ***Notes:***

Electricity usage per year = 2892002 kWh

0.84 is the coefficient to convert kWh to metric tons.

## **8. Best Practices followed in the Organization**

- Most of places, sign board of 'Switch ON' and 'Switch OFF' were kept towards saving energy measures to the stakeholders.
- Electrical wires, switch boxes and stabilizers were properly covered without any damage which will cause any problems to the staff and student members.
- Installed automatic switches with sensors.
- Air Ventilation and Day lighting facilities were made at Indoor and Outdoor seminar halls, auditorium and stadium for vigorous air circulation.
- Water level controllers were used and Power factor was maintained near to unity with APFC.
- Use of RO system for water filtration towards effective water management.
- Adaptation of drip irrigation to minimize the energy potential.



### **Drip Irrigation method and APFC for effective water management and Sign Board for energy savings at Bharathiar University campus**

#### **9. Recommendations for improving the energy efficiency and energy conservation**

The energy audit included suggestions for energy cost reduction, preventive maintenance and quality control activities, all of which are critical for utility operation in the audit sites. The suggestions and recommendations are as follows

- Install the Roof top solar PV panels for 400 KW power generation which in turn to reduce the cost- benefit ratio to a greater extend.
- Procurement of equipment with energy efficiency during replacement (4-5 star rated equipment) during replacement may be considered.
- Replace old generation computers and TVs with LED monitors and old incandescent (tungsten) bulbs with LED lights and install automatic street solar lights.
- Suggested to protect all Transformer, Generators and UPS with fencing and keep the awareness boards and safety signs on 'Dangers' and 'Warnings, etc. properly.
- Advised to cover Electrical wires, switch boxes, inverters, and stabilizers not to cause any problem to the staff and student members
- Instructed to replace Overhead Projectors with LCD projectors to reduce the power consumption
- Optimal water usage and temperature settings may be used which are coming under automatic process towards energy savings
- Recommended to fit HVLS Fans and Exhaust fans in the Auditorium and Indoor stadium for proper ventilation
- Continuous monitoring and analysis of energy consumption by dedicated team may be planned within the campus.
- Promoting ECON awareness and practice among the stake holders may be conducted periodical through Association, Clubs, Forums and Chapters.
- Value added / Non-formal / Certificate / Diploma course on 'Energy and Environment Management Audits' may be conducted for the benefit of both students and research scholars of different subject domains to become a certified Lead Energy Auditor as an Entrepreneur.

## 10. Conclusions

Considering the fact that the organization is a well-established, long time run establishment with good reputation, there is significant scope for conserving energy and make the campus as self-sustained in it. The energy conservation initiatives taken up by the institution are substantial. Energy efficient lighting schemes, awareness created among stakeholders and necessary power backups are being practiced by the institution. Few recommendations, in addition, can further improve the energy savings of the college. This may lead to the prosperous future in context of Green Campus & thus sustainable environment and community development.

## 11. Acknowledgement

Nature Science Foundation, Coimbatore, Tamil Nadu, India is grateful to the Hon'ble Vice-Chancellor and Registrar and IQAC Coordinator of Bharathiar University, Coimbatore, Tamil Nadu for providing us necessary facilities and co-operation during the energy audit process. This helped us in making the audit a magnificent success. Further, we hope that the best practices on sustainability followed by the Organization and recommendations and suggestions given by the NSF will boost the new generations to take care of the Electrical energy conservation.

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