REPORT OF ENERGY AUDIT

Submitted to

Dr. N.G.P. ARTS AND SCIENCE COLLEGE
Coimbatore– 641048, Tamil Nadu, India.

Date of Audit: 27.06.2018 (Wednesday)

Submitted by

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Motto

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

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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 extend. 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 (Mishraand 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_2 Analyzer (Non dispersive infra-red meter). In addition, CO_2 meter is also displayed the readings of atmospheric temperature, relative humidity and dew point in the places, where the level CO_2 is measured. The meter started measurements of CO_2 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_2 sensor to respond and 30 minutes for flexibility in relative humidity. The meter features an audible alarm to give warnings when CO_2 concentration exceeds the set limit. It emits beeps (Abt.80dB) when CO_2 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) based on electricity usage per year in which CO_2 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_2 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.

Power Room, Oven, PV array at Kamban Arangam in Dr. N.G.P. Arts and Science College

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 asVoltage (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_2, O_2, CO, SO_x, NO_x, combustion efficiency are the mechanical, thermal and other parameters that are analyzed during the audit depending upon the requirements.

5. About the Organization

With a view to providing education to all, Dr. N.G.P. Arts and Science College was established by the Kovai Medical Center Research and Educational Trust, Coimbatore in 1997. The Founder and Chairman Dr.Nalla G. Palaniswami, and Secretary Dr.Thavamani D. Palaniswami are the driving force of the institution. The College began its educational journey with 4 Under Graduate programmes, now it is emerging as the one of the top self-financing colleges in Tamil Nadu.

It is a Co-Educational Autonomous College, affiliated to the Bharathiar University, Coimbatore. Also, it is recognized under 2(f) and 12(B) of UGC act 1956 by University Grants Commission, New Delhi. The college was accredited by the NAAC with "A" Grade with the CPGA of 3.17 in the second cycle, March 17, 2016. The college is consecutively ranked at the national level within 100 ranks by the National Institutional Ranking Framework (NIRF) by MHRD. The College is also granted the DST-FIST to enrich the research facilities. The college, at present offers 26 UG, 13 PG, 8 M.Phil & 9 Ph.D programmes. Our college has an intellectual capital of more than 294 academically well experienced teaching fraternity amongst 91 faculty members are doctorates and they cater to the needs of 6391 students on roll.

The Institution has been granted funds to undertake major and minor research projects, and conduct seminars, conferences and workshops by various funding agencies like UGC, DRDO, ICMR, ICSSR, CSIR, DST, DBT and TNSCST. The College exercises 43 Best Practices to aggrandize the holistic development of the students. Through these practices students have been given space for enhancing employability skills, research culture, and entrepreneurship attitude.

The Training and Placement Cell in the college functions effectively in providing various placement oriented training, value added programmes, company specific training to make them employable in the top MNCs. Every year, more than 90% placement opportunities are achieved. Apart from the placement cell, the Career Guidance Cell, Entrepreneurship Development Cell play vital role in fulfilling needs of the student community. The Management provides scholarships every year to 100s of meritorious students in academics and sports as well. It creates opportunities for many students to excel in education who belong to socially economically weaker section. The College firmly believes that the blend of discipline and education will make the students enter the present phenomenon with the flying colours.

Dr. N.G.P. Arts and Science College is maintaining more than 20 % 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

Audit Details

Date/Day of Audit	**: 27.06.2018 (Wednesday)**
Venue of Audit	**: Dr. N.G.P Arts and Science College (Autonomous)** Coimbatore, Tamil Nadu, India.
Audited by	**: Nature Science Foundation,** Coimbatore, Tamil Nadu, India.
Audit type	**: EnergyAudit**
Name of ISO EMS Auditor	**: Mrs. S. Rajalakshmi,** Chairman & ISO EMS Auditor, NSF.
Name of Lead Auditors	**: Dr. R. Mary Josephine,** Board of Directors, NSF. **Er. B. Vijayalakshmi,** Deputy Director &Certified Energy Auditor, NSF.
Name of Energy Auditors	**: Er. D. Dinesh kumar** BEE Certified Energy Auditor, NSF Certified Lead Eco Auditor **Dr. P. Thirumoorthi,** Professor in Electrical & Electronics Engineering Kumaraguru College of Technology, Coimbatore.
Name of IGBC AP Auditor	**: Dr. B. Mythili Gnanamangai,** IGBC AP, Indian Green Building Council.

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
27-06-2018	Administrative Block
	Power House
	Faculty Rooms
	Classrooms
	Seminar Halls
	Auditorium
	Laboratories
	Computer Centres
	Well, Sump and pumps.
	Hostel
	Library

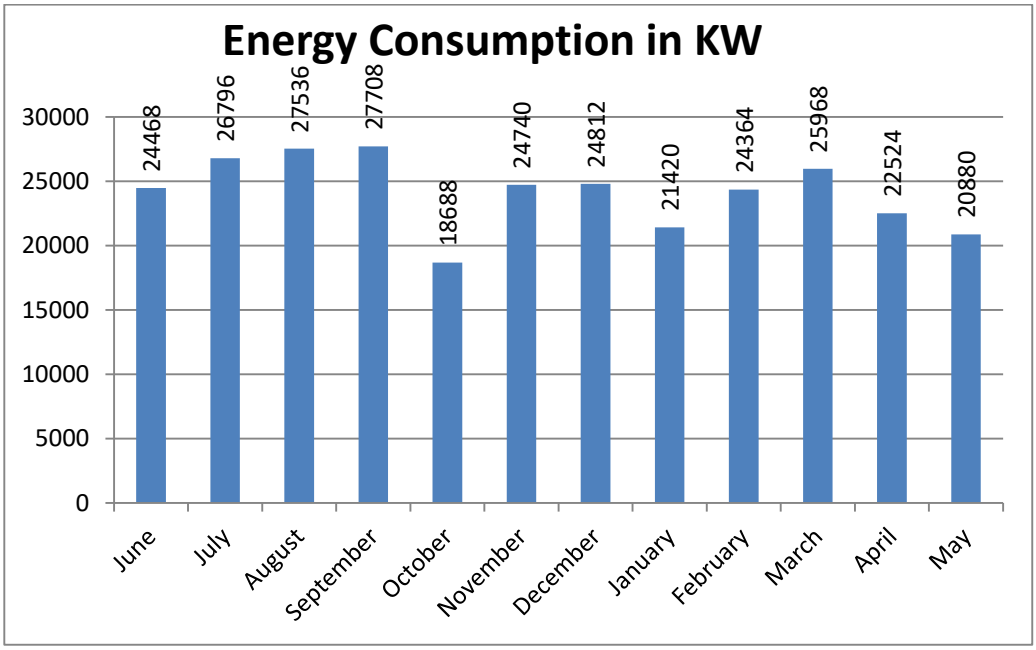
In the sections, the services offered are monitored, verified and analysed on the aspects of energy consumption. In all these areas lighting systems forms the major consumer of electrical energy. Three phase electricity service connections available in the campus are provided by Tamil Nadu Generation and Distribution Corporation Limited (TANGEDCO Sr.Nos. 211,). 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

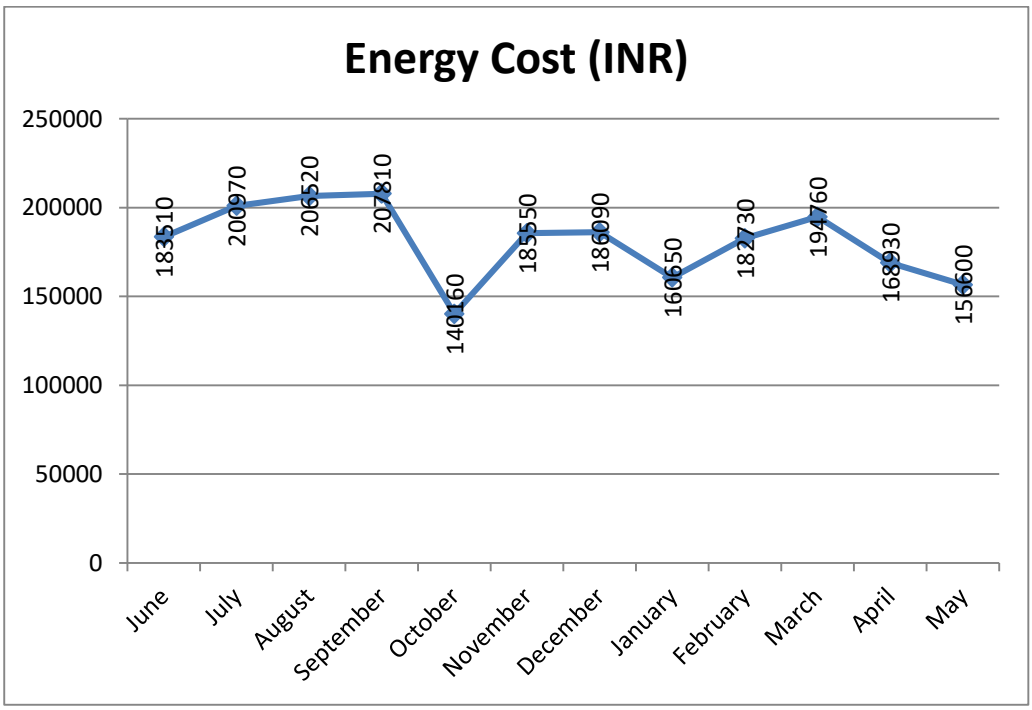
1. Lighting fixtures are verified physically.
2. Installation of energy efficient lighting systems are verified.
3. Verified the installed safety systems.
4. Installed power backup systems (Generators and UPS) are verified on the aspect of maintenance.
5. Electricity consumption through the TANGEDCO 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: 1.85 kWh

7.4. Power supply and Equipment

Transformer : 250 kVA
Sanctioned MD : 112 KW + 48 KW
Generator : 250 KVA + 62.5 Kva

Table 2. Major Equipment

S.No	Equipment/ Utility	Rating/ Capacity	Quantity
1.	Tube Lights	40 W and 28 W	1031
2.	Fan	60W	841
4.	Sodium Vapour Lights	25 W	8
5.	AC	2T	47

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_2 Analyzer, the level of carbon dioxide was measured in different places across the Dr.N.G.P.Arts and Science College campus. The observation showed that the concentration of CO_2 in the atmosphere is found to be low which did not exceeds the critical limit of CO_2. 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_2 concentration in the Dr. NGPASC Campus

S.No.	Different locations of the Organization's campus	Carbon dioxide level (ppm)	Remarks
1.	Class Room 1	490	CO_2 level is low
2.	Classroom 2	435	CO_2 level is low
3.	Staff Room	544	CO_2 level is low
4.	Library	567	CO_2 level is low
5.	Office	456	CO_2 level is low
6.	Computer Science Lab	426	CO_2 level is low
7.	Chemistry Lab	541	CO_2 level is low
7.	Conference Hall	543	CO_2 level is low
8.	Parking	399	CO_2 level is low

Reference of Set values of CO_2 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 Dr. NGPASC with respect to electricity usage

The Carbon footprint calculation can be conducted based on the stage of calculation as stated in www.carbonfootprint.com, which is the sum of electricity usage per year. The CO_2 emission from electricity

= (electricity usage per year in kWh/1000) x 0.84
= (289904 kWh/1000) x 0.84
= 243.51 metric tons

Notes:

Electricity usage per year = 289904 kWh
0.84 is the coefficient to convert kWh to metric tons.

8. Best Practices followed in the Organization

- 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.
- Most of places, sign board of 'Switch ON' and 'Switch OFF' are kept towards saving energy measures to the stakeholders.
- Air Ventilation and Day lighting facilities were made at Indoor and Outdoor seminar halls, auditorium and stadium for vigorous air circulation..
- Adaptation of drip irrigation to minimize the energy potential.
- Energy efficient appliances were used
- Saving Energy by using solar panel

Power distribution and Sign Board for energy savings at Dr N.G.P. 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

- Recommended to fit HVLS Fans and Exhaust fans in the auditorium and Indoor stadium for proper ventilation
- Suggested to protect all Transformer, Generators and UPS with fencing and keep the awareness boards and safety signs on 'Dangers' and 'Warnings, etc.
- Advised to cover Electrical wires, switch boxes, inverters, and stabilizers not to cause any problem to the staff and student members
- Advised to replace old generation computers and TVs with LED monitors and old incandescent (tungsten) bulbs with LED lights and install automatic street solar lights.
- Instructed to replace Overhead Projectors with LCD projectors to reduce the power consumption.
- Suggested to install more Roof top solar power plants
- Replace old generation computers and TVs with LED monitors and old incandescent (tungsten) bulbs with LED lights and install automatic street solar lights.
- 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

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. 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 Management and Principal of Dr.N.G.P. Arts and Science College, 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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