REPORT OF ENERGY AUDIT

Submitted to

St. Joseph's College of Arts and Science for Women
Hosur- 635 126, Tamil Nadu, India.

Date of Audit: 11.09.2021 (Saturday)

Submitted by

NATURE SCIENCE FOUNDATION

(An ISO 9001:2015 Certified Organization)

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Motto

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

Contents

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.*, 2021). 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 buildingin 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.

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 output sand 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.* (2021). 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).

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, 2021) and World Green Building Council (WGBC,

2021). 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.

Figure 1. Solar Water Heater

Figure 2. Power Generators

Figure 3. Air Ventilators

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

5. About the Institution

With the noble goal of higher education for women, St. Joseph's College of Arts and Science for Women (SJCASW), a renowned institution affiliated to the Periyar University, Salem, Tamil Nadu takes the pride of providing sound morality, discipline and overall development of individuals. It carries a rich history, holding the pride of gaining a far-famed reputation under the Periyar University and managed by the FSPM Sisters, Coimbatore. The college was established in 2006 which offers various undergraduate (B.A./B.Sc./B.Com.), postgraduate (M.A./M.Sc./M.Com. / MBA.) and Research courses (M.Phil. and Ph.D.) with a strength of 1642 undergraduate and 74 postgraduate students during the academic year of 2021-22. The College provides high quality education and training in the field of Arts, Science and Management to prepare students to contribute to India's social, technological and economic development. Apart from quality education, the College provides training to make students responsible and socially and culturally aware. The College is situated in a sprawling 10.55 acre in the business hub of Hosur city. Around 80 teaching and 42 non-teaching staff members representing 10 academic Departments are working as on date in the College to enhance the teaching and learning process.

6. Audit Details

Date/Day of Audit	: 11.09.2021 (Saturday)
Venue of Audit	: St. Joseph's College of Arts and Science for Women, Hosur, 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 Auditor	: Dr. R. Mary Josephine, Board of Directors, NSF.
Name of Subject Expert I	: Er. B. Vijayalakshmi Lead Auditor & Deputy Director, NSF
Name of Subject Expert II	: Er. Gaurav Acharya Lead Auditor & Energy Consultant, Pune
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 Audit:

Table 1. Facilities audited.

Date	Section where audit was conducted
11-09-2021	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. 110, 229, 364). 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 bill was 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.

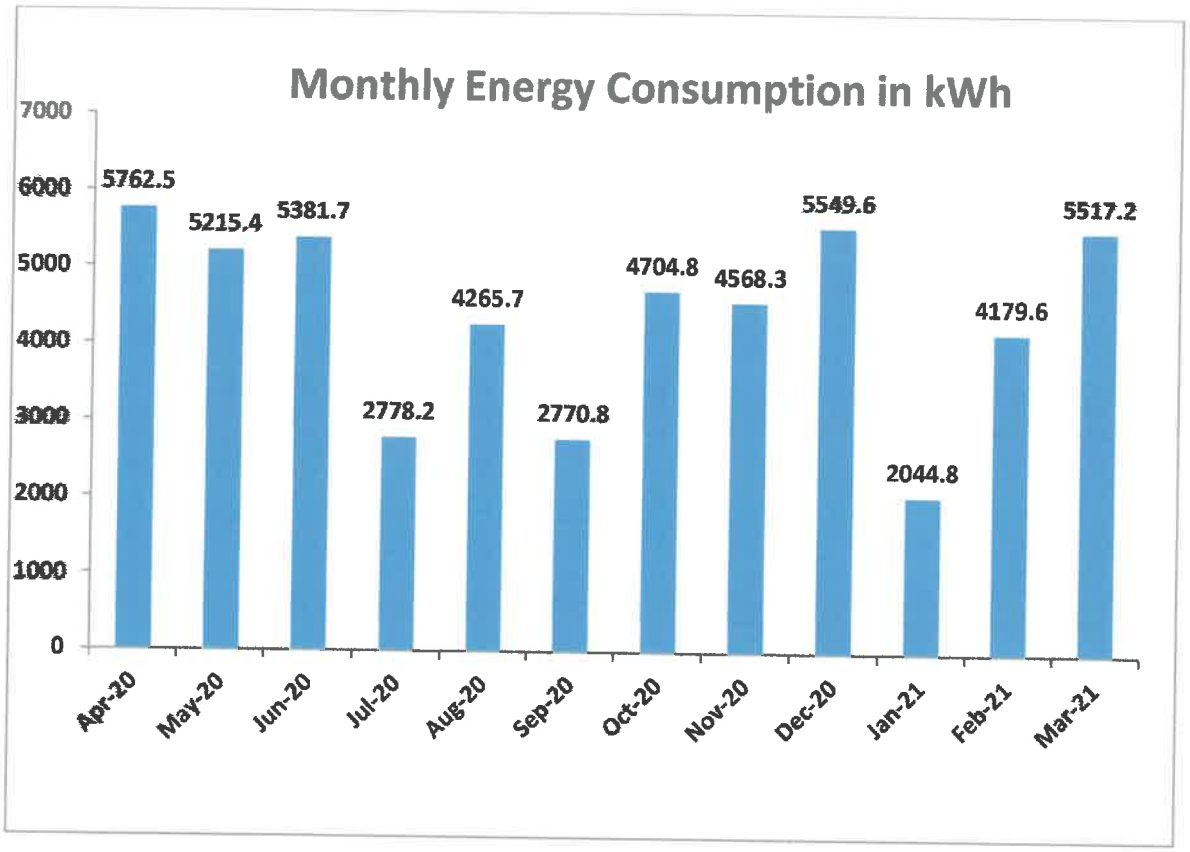

Figure 4. Energy Consumption Profile

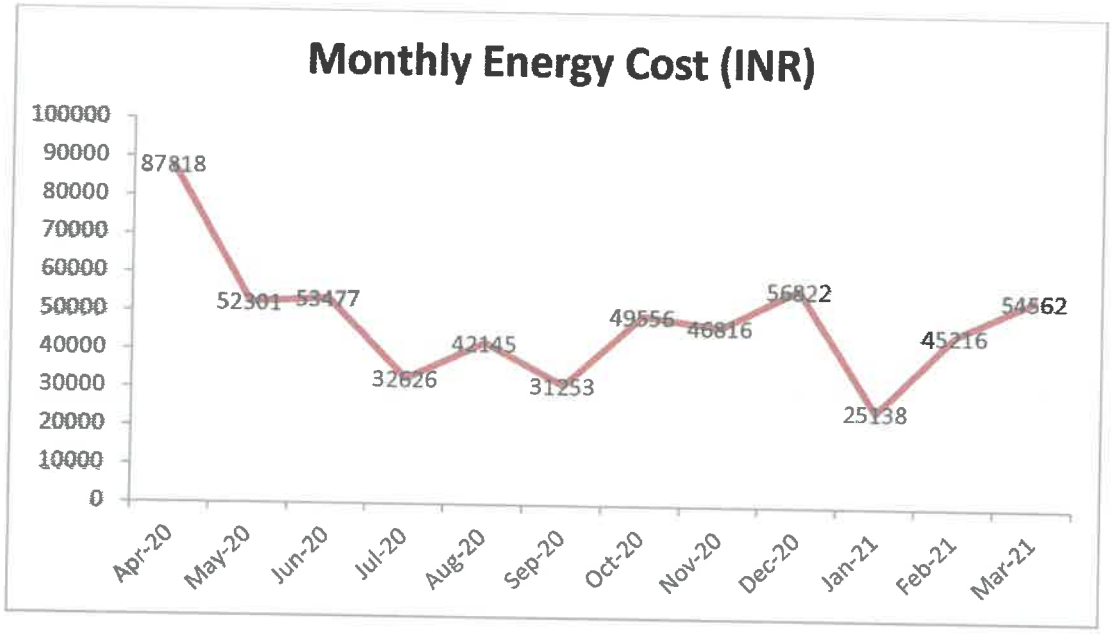

Figure 5. Energy Cost Profile

Average energy consumption per stake holder per month: 2.39kWh.

7.4. Power supply and Equipment

Sanctioned MD : 0.70 kVA + APFC (1) 110 kW + APFC (2) 26kW

Generators : 125 kW

Table 2. Major Equipment

S.No.	Equipment / utility	Rating / Capacity	Quantity (Nos)
1.	LED Tube Lights	20W	13
2.	Halogen Lamps	1000W	1
3.	CFL	18W	71
4.	LED Focusing light	150W	10
5.	Tube Lights	36W	271
6.	Solar Water Heater	500 LPD	6
7.	UPS - 1	10 KVA	2
8.	UPS - 2	7.5KVA	1
9.	UPS - 3	15 KVA	1
10.	UPS - 4	3 KVA	1
11.	UPS - 5	5 KVA	1
12.	UPS - 6	7.5 KVA	1
13.	UPS - 7	1 KVA	1
14.	UPS - 8	2 KVA	1
15.	RO Water use	500 LPH	2
		12 LPH	1
		50 LPH	1
		25 LPH	1
16.	AC	16 Ton	4
		24 Ton	2
		1.5 Ton	2
17.	Fans	80W	248

8. Best Practices followed in the Organization

- Transformer, Generators and UPS were protected properly with fencing and kept awareness boards on 'Dangers' and 'Warnings'.
- 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.
- Solar water heaters were installed.
- Installed automatic switches with sensors.
- Air Ventilation and Day lighting Facilities were made at indoor/outdoor seminar halls, auditorium and stadium.
- Water level controllers were used.
- Power factor was maintained near to unity with APFC.
- Use of RO for water filtration
- Adaptation of Sprinkler irrigation to minimize the energy potential.

Figure 6. Sprinkler Irrigation

Figure 7. Solar Water Heater

Figure 8. RO Water plant

Figure 9. Sign Board for energy saving

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.

- Installation of solar PV panels for 500 kW power generation is needed which in turn reduce the cost-benefit ratio to a greater extend.
- Drip and Sprinkler irrigations may be extended across the campus to reduce the energy consumption.
- Procurement of equipment with energy efficiency (3-5 star rated equipment) during replacement may be considered.
- Optimal water usage and temperature settings may be used which are coming under automatic process towards energy savings.
- Continuous monitoring and analysis of energy consumption by dedicated team may be planned within the campus.
- Promoting ECON awareness and practice among the stakeholders may be conducted periodical through Association, Clubs, Forums and Chapters.

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. There are some best Practices followed on Energy Audit in the Organization like Transformers, Generators and UPS are protected properly with fencing and kept awareness boards on 'Dangers' and 'Warnings'. It is observed that the most of places, sign board of 'Switch ON' and 'Switch OFF' are kept towards saving energy measures to the stakeholders. Electrical wires, switch boxes and stabilizers are properly covered without any damage which will cause any problems to the staff and student members. Adaptation of drip and sprinkler irrigation and solar street-lights in the campus to minimize the energy potential are well appreciated. Few recommendations, in addition, can further improve the energy savings of the Organization. This may lead to the prosperous future in context of Energy Efficiency Campus and thus sustainable environment and community development to the stakeholders in coming years to come.

11. Acknowledgement

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Electrical energy conservation, Energy saving measures and sustainability incompliance with the applicable regulations, policies and standards in the Campus.

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