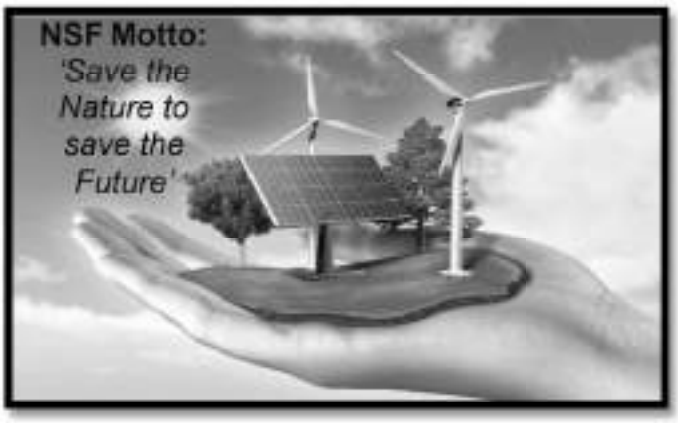
REPORT OF ENERGY AUDIT



Submitted to

Moonray Institute of Pharmaceutical Sciences

Raikal, Shadnagar,N.H – 44 Ranga Reddy – 509202, Telangana, India.

Date of Audit: 01.11.2021 (Monday)

Submitted by

NATURE SCIENCE FOUNDATION

(A Unique Research and Development Centre for Society Improvement)

An ISO 9001:2015 Certified Organization

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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.*, 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 building as well as equipment in terms of specific energy usage termed as 'Energy Performance Indicator' by means of star ratings labelled items used which will be useful for energy savings in a sustainable manner (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. Need for an Energy Audit

In any Organization, the three top operating expenses are often found to be energy (both electrical and thermal), labour and materials. If one were to relate to the manageability of the cost or potential cost savings in each of the above components, energy would invariably emerge as a top ranker, and thus energy management function constitutes a strategic area for cost reduction. Energy Audit will help to understand more about the ways energy and fuel are used in any industry, and help in identifying the areas where waste can occur and where scope for improvement exists. The Energy Audit would give a positive orientation to the energy cost reduction, preventive maintenance and quality control programmes which are vital for production and utility activities. Such an audit programme will help to keep focus on variations which occur in the energy costs, availability and reliability of supply of energy, decide on appropriate energy mix, identify energy conservation technologies, retrofit for energy conservation equipment etc. In general, Energy Audit is the translation of conservation ideas into realities, by lending technically feasible solutions with economic and other organizational considerations within a specified time frame. The primary objective of Energy Audit is to determine ways to reduce energy consumption per unit of product output or to lower operating costs. Energy Audit provides a "bench-mark" (Reference point) for managing energy in the organization and also provides the basis for planning a more effective use of energy throughout the organization.

Eco-campus concept mainly focuses on the efficient use of energy and its conservation including savings opportunities in a sustainable manner. It also focuses on the reduction of contribution to carbon emissions, carbon footprint calculation, procurement of star rated equipment for a cost effective and secure supply of energy, encourage and enhance energy use conservation in all buildings, reduce the organization's energy consumption, reduce wastes to landfill, and integrate environmental considerations into all contracts and services considered to have significant environmental impacts.

Auditing for Energy Management may be studied in terms of energy savings and opportunities. In general, energy cannot be seen, but we know it is there in wire, pipes and other non-living materials because we can see its effects in the forms of heat, light and power. This indicator addresses energy consumption, energy sources, energy monitoring, lighting, vehicle movement, electrical and electronics appliances, and transportation. Energy use is clearly an important aspect of campus sustainability and thus requires no explanation for its inclusion in the assessment. However, energy saving and opportunities may be taken into consideration while energy is extensively used. An old incandescent (tungsten) bulb uses approximately 60W to 100W while an energy efficient light emitting diode (LED) uses only less than 10W which indicated the positive indication on energy savings. Energy auditing deals with the conservation and

Methods to reduce its consumption related to environmental degradation. In addition, suggestions and recommendations might be given after auditing which in turn useful for energy savings. It is therefore essential that any environmentally responsible institution examine its energy use practices at least once in two years using internal and external auditors.

The conduct of energy audit using internal and external energy auditors is playing important role in any organization in terms of energy management. It is able to measure the impact of energy potential in an organization so that we can determine better ways to manage the impact on environment. In addition to the water, liquid and solid wastes, biomedical and electronic wastes energy potential and biodiversity audits, attempts may be made to measure the carbon footprint in the organization based on the amount of carbon emissions created by the electrical appliances, vehicles and human population. It undertakes the measure of bulk of carbon dioxide equivalents exhaled by the organization through which the carbon accounting is done. It is necessary to know how much the organization is contributing towards sustainable development in terms of energy management is being done. It is therefore to recommend to measure the carbon footprint in each organization which may be useful for maintaining the eco-friendly campus to the stakeholders.

3. 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.
- Providing a technical information on how to build an energy balance as well as guidance to be sought for particular applications.
- Detailed analysis on the calculation of energy consumption, analysis of latest electricity bill of the campus, understanding the tariff plan provided by the central and State Electricity Board.
- List ways that the use of energy in terms of electricity, electric stove, kettle, microwave, LPG, firewood, Petrol, diesel and others.
- Analysis of electricity bill amount for the last two to three years, amount paid for LPG cylinders for last one year and amount paid for water consumption for human beings and watering to the plants.
- Use of incandescent (tungsten) bulb and CFL bulbs, fans, air conditioners, cooling apparatus, heaters, computers, photo copiers, inverter, generators and laboratory equipment and instruments installed in the organization (for example- 60 watt bulb x 4hours x number of bulbs = kwh).

- Alternative energy sources / nonconventional energy sources are employed / installed in the organization (photovoltaic cells for solar energy, windmill, energy efficient stoves, Biogas, etc.).
- Creating awareness among the stakeholders on energy conservation and utilization.

4. Benefits of an Energy Audit

- **Reduced Energy Expenses:** The most obvious benefit is that the less energy the Organization uses, the less money that the Organization will have to spend on energy costs.
- **Identify Problems:** An energy audit can also help to identify any issues that the equipment might have. For example, the auditor could find small leaks in the compressed air system. These leaks would cost a significant amount of money if it is not noticed. Auditors can also detect dangerous health risks like the carbon monoxide that's emitted from equipment that hasn't been vented properly. With a regular energy audit, the organization will be able to address these kinds of issues promptly to help ensure the health and safety of the staff members.
- **Increased Employee Comfort:** During the audit, the Organization might learn about changes that have been made regarding insulation and air sealing. Completing these enhancements will help create a more reliable and more efficiently cooled or heated space for the employees. In turn, more comfortable employees tend to be more productive, so not only will the Organization save on energy costs, but may also improve overall well-being.
- **Personalized Recommendations:** Working with an energy expert can help learn about new energy-efficient technologies. The professional will customize a plan, recommending which upgrades will give the most return on investment. These might include updated lighting systems, a new HVAC system, weatherization measures like insulation and air sealing, and more. While some of the recommendations might have a substantial up-front cost that many of them will pay for themselves in a short period of time with significantly reduced energy expenses.
- **Show Environmental Concern:** By taking steps to be more energy efficient, the Organization will be showing the employees and clients that the organization cares about the impact on the environment.
- **Increased Property Value:** Using the recommendations of an energy auditor to make facility more energy efficient could also help to increase its overall worth. Things like solar panels, high-efficiency LED lighting, and weatherization procedures are all things that contribute to a higher property value.
- **Longer Equipment Lifespan:** An energy auditor might recommend to update some of the equipment for maximum energy savings. If the Organization decide to upgrade, it will not only save on energy costs, but also expect the equipment to last a long time. This is because newer, more energy-efficient equipment doesn't have to work as hard as older, outdated units to provide the same level of performance.
- **Energy audit evaluation:** Energy audits will evaluate the Organization "as a whole", the goal is not to evaluate single measures but to consider a wide range of available alternatives (Electrical, Mechanical, Envelope and Water).

- **Energy audit Opportunities:** The audit will not only inform about the opportunities but also provide information with financial analysis. This will enable prioritization based on financial benefit and return on investment. It provides technical information regarding the proposed energy conservation measures.
- **Energy audit quality analysis:** A good quality audit will analyse the historical energy use and find potential issues using statistical methods. Provide information with emissions analysis to help understand the benefits of the decisions from an environmental standpoint. Understand where energy is used and which areas are worth focusing on the most. Provide benchmark information to help understand the energy use performance compared to others.

5. Procedures followed in an Energy Audit

In order to conduct an energy audit, several methods are adopted in the audit sites in which walk-through audit is conducted. The balance of total energy inputs with total energy outputs and identification of all energy streams in a facility are taken into account. 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. During the audit, physical verification of Lighting, Ceiling, Table and Exhaust Fans, A/C machines, Solar panels, Heaters, Generators, Uninterrupted power supply machines and ventilators load fixtures and verification of installed energy efficient system's capacities are carried out. Inspection of 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. The level of carbon dioxide might be measured in different places across the Organization campus using a portable CO_2 Analyzer to calculate the carbon footprint. It may be useful to check where carbon emission is prominent which could be taken into account to reduce.

The audit involves visiting physical position of load & carry out inventory of load. Due measurement of electrical load of equipment & circuit is carried out. Energy bill received from TNEB is audited & studied for KWH requirement & how efficiently energy is used. Various positions are interacted, familiarized with energy audit & involved for successful & result oriented energy audit. Energy conservation & saving opportunities are identified during round & measurement for implementation.

6. Types of Energy Audit

The type of Energy Audit to be performed depends on:

- Function and type of industry
- Depth to which final audit is needed, and
- Potential and magnitude of cost reduction desired

Thus Energy Audit can be classified into the following two types.

I. Preliminary Energy Audit
II. Detailed Energy Audit
III. Potential and magnitude of Energy Audit
IV. Comprehensive Energy Audit

Preliminary Energy Audit Methodology

Preliminary energy audit is a relatively quick exercise to:

- Establish energy consumption in the organization
- Estimate the scope for saving
- Identify the most likely (and the easiest areas for attention
- Identify immediate (especially no-/low-cost) improvements/ savings
- Set a 'reference point'
- Identify areas for more detailed study/measurement
- Preliminary energy audit uses existing, or easily obtained data.

Detailed Energy Audit Methodology

A comprehensive audit provides a detailed energy project implementation plan for a facility, since it evaluates all major energy using systems. This type of audit offers the most accurate estimate of energy savings and cost. It considers the interactive effects of all projects, accounts for the energy use of all major equipment, and includes detailed energy cost saving calculations and project cost. In a comprehensive audit, one of the key elements is the energy balance. This is based on an inventory of energy using systems, assumptions of current operating conditions and calculations of energy use. This estimated use is then compared to utility bill charges. Detailed energy auditing is carried out in three phases: Phase I, II and III.

Phase I - Pre Audit Phase
Phase II - Audit Phase
Phase III - Post Audit Phase

Potential and Magnitude of Energy Audit

A structured methodology to carry out an energy audit is necessary for efficient working. An initial study of the site should always be carried out, as the planning of the procedures necessary for an audit is most important.

Initial Site Visit and Preparation Required for Detailed Auditing

An initial site visit may take one day and gives the Energy Auditor/Engineer an opportunity to meet the personnel concerned, to familiarize him with the site and to assess the procedures necessary to carry out the energy audit.

During the initial site visit the Energy Auditor/Engineer should carry out the following actions: -

- Discuss with the site's senior management the aims of the energy audit.
- Discuss economic guidelines associated with the recommendations of the audit.
- Analyse the major energy consumption data with the relevant personnel.
- Obtain site drawings where available – building layout, steam distribution, compressed air distribution, electricity distribution etc.
- Tour the site accompanied by engineering/production

The main aims of this visit are:

- To finalise Energy Audit team
- To identify the main energy consuming areas to be surveyed during the audit.
- To identify any existing instrumentation/ additional metering required.
- To decide whether any meters will have to be installed prior to the audit eg. kWh, steam, oil or gas meters.
- To identify the instrumentation required for carrying out the audit.
- To plan with time frame
- To collect macro data on major energy consuming centers
- To create awareness through meetings/ programme.

Comprehensive Energy Audit

Depending on the nature and complexity of the site, a comprehensive audit can take from several weeks to several months to complete. Detailed studies to establish, and investigate, energy and material balances for specific plant departments or items of process equipment are carried out. Whenever possible, checks of plant operations are carried out over extended periods of time, at nights and at weekends as well as during normal daytime working hours, to ensure that nothing is overlooked.

The audit report will include a description of energy inputs and product outputs by major department or by major processing function, and will evaluate the efficiency of each step of the Organization. Means of improving these efficiencies will be listed, and at least a preliminary assessment of the cost of the improvements will be made to indicate the expected payback on any capital investment needed. The audit report should conclude with specific recommendations for detailed engineering studies and feasibility analyses, which must then be performed to justify the implementation of those conservation measures that require investments. The comprehensive energy audit may be useful to identify the consuming areas to be surveyed during the audit and to identify any existing instrumentation/ additional metering required. A care should be taken to identify the instrumentation required for carrying out the audit and to plan with time frame including the collection macro data on major energy consuming centers. It will be definitely useful for energy management towards energy savings opportunities.

The information to be collected during the detailed audit includes:

1. Energy consumption by type of energy, by department, by major items of process equipment, by end-use
2. Energy cost and tariff data
3. Generation and distribution of site services (eg. compressed air, steam).
4. Sources of energy supply (e.g. electricity from the grid or self-generation)
5. Potential for fuel substitution, process modifications, and the use of co-generation systems (combined heat and power generation).
6. Energy Management procedures and energy awareness training programs within the establishment.

   Existing baseline information and reports are useful to get consumption pattern. The audit team should collect the following baseline data:

   - Technology, processes used and equipment details
   - Capacity utilisation
   - Water consumption
   - Fuel Consumption
   - Electrical energy consumption
   - Steam consumption
   - Efficiencies / yield

7. 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 with a coefficient (0.01) to calculate the emission of CO_2 in metric tons per year.

Humans contribute an increase of carbon dioxide emissions by burning fossil fuels, deforestation, and cement production. Methane (CH_4) is largely released by coal, oil, and natural gas industries. Human activities are responsible for almost all of the increase in greenhouse gases in the atmosphere over the last 150 years. The largest source of greenhouse gas emissions from human activities is from burning fossil fuels for electricity, heat, and transportation.

The Methodology of the Audit is presented in the following chart:

Flow chart of Energy Audit Methodology

Calculating Carbon footprint

8. 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.

Opening Meeting for the conduct of Energy Audit process


Walk through Energy audit process

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

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.

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.

Walk-through Audit Process

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.

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.

Measurements in the Energy Audit process

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.

9. About the Institution

With a view to providing education to all, Moonray Institute of Pharmaceutical Sciences 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. TheCollege 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) and ARIIA-2019 by MHRD. The College is also granted the DST-FIST and DBT Star scheme for promotion of research. In the Institution, MHRD's Institution Innovation Council (IIC) was established to cater for the innovation and undergraduate research among students. The college, at present offers 32 UG, 16 PG and 25 Research (M.Phil. & Ph.D.) Programmes, 04 PG Diploma, 21 Diploma and 58 Certificate Programmes under 32

well established departments through six variant faculties. Our college has an intellectual capital of more than 300+ academically well experienced teaching fraternity amongst 130 faculty members are doctorates and they cater to the needs of 7500 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.

Moonray Institute of Pharmaceutical Sciences is maintaining more than 25% 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.

10. Audit Details

Date/Day of Audit	**: 01.11.2021 (Monday)**
Venue of Audit	**: Moonray Institute of Pharmaceutical Sciences** Coimbatore, Tamil Nadu, India.
Audited by	**: Nature Science Foundation,** Coimbatore, Tamil Nadu, India.
Audit type	**: Energy Audit**
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.

11. Observations of the Energy Audit

Facilities visited during the Energy Audit

Date	Section where Energy Audit is conducted
01-11-2021	Administrative Block
	Power House
	Faculty Rooms
	Classrooms
	Seminar Halls
	Auditorium
	Laboratories
	Computer Centres
	Well, Sump and pumps.
	Sewage Treatment Plant
	Hostel
	Library

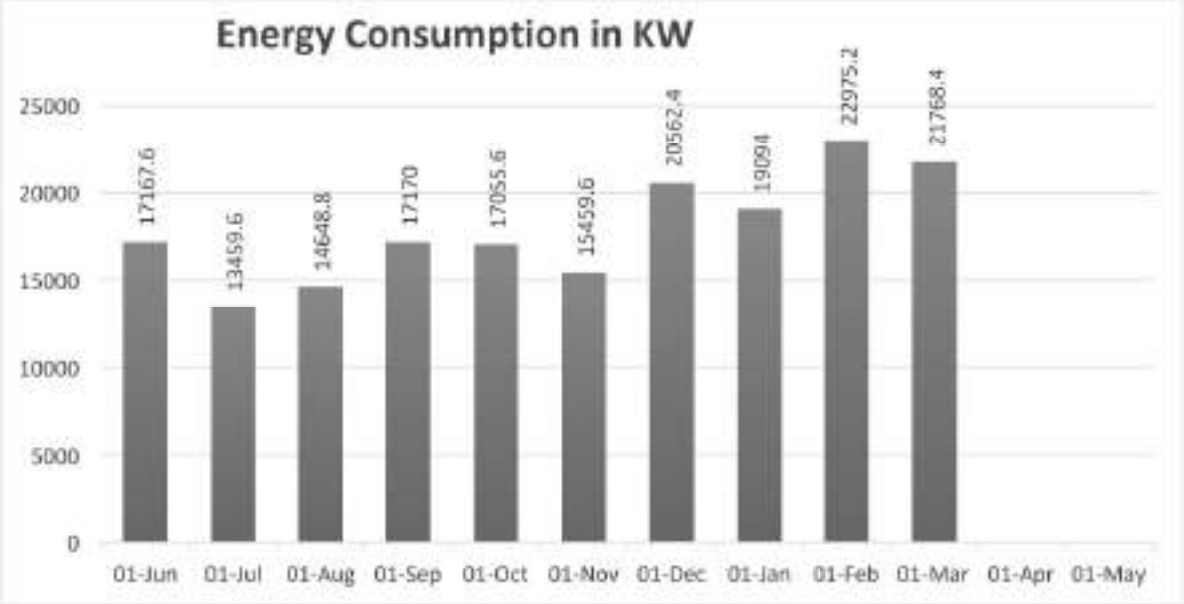
In the sections, the services offered are monitored, verified and analysed on the aspects of energy consumption. In all these areas lighting systems forms the major consumer of electrical energy. Three phase electricity service connections available in the campus are provided by Tamil Nadu Generation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

Systems Studied during the Energy Audit

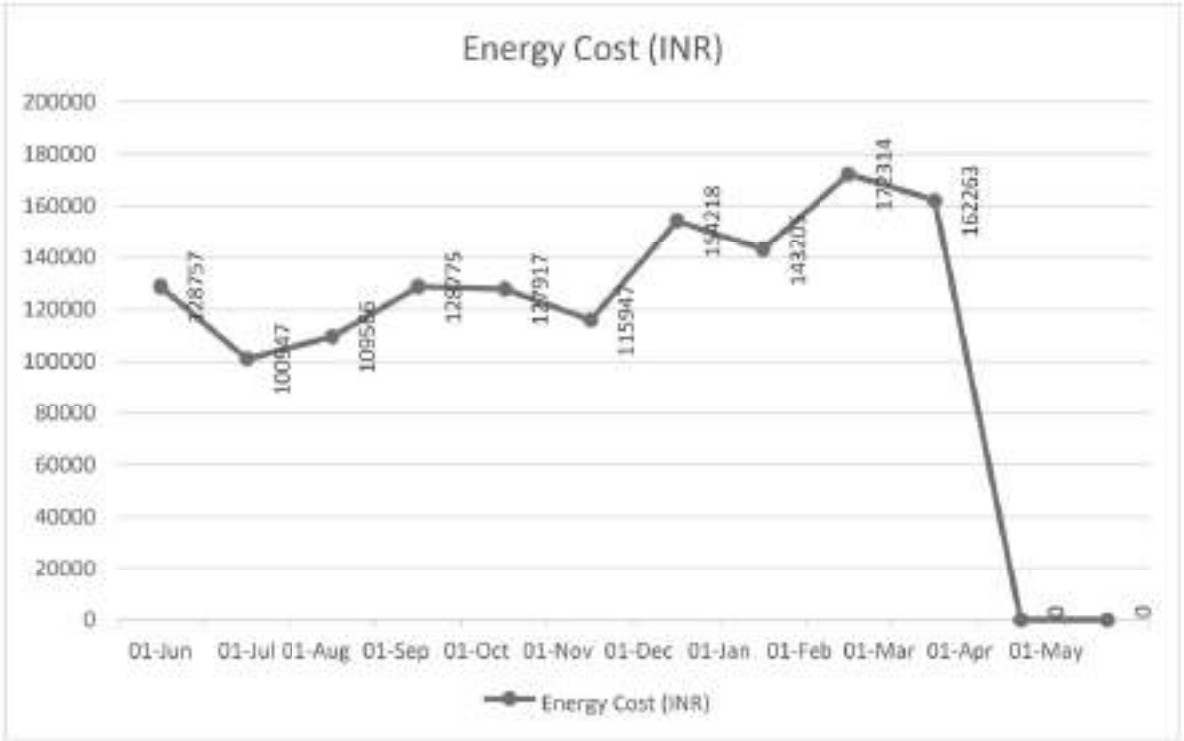
1. Lighting fixtures were verified physically.
2. Installation of energy efficient lighting systems were verified.
3. Installation of safety systems were verified
4. Installation of power backup systems (generators and UPS) were verified on the aspect of maintenance and consumption.
5. Electricity consumption through the TANGEDCO bills was analysed.
6. The energy conservation awareness among the stakeholders for optimum use of electricity and its savings were reviewed.

Energy Consumption and Cost Profile

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



Energy Consumption Profile



Energy cost profile

Average energy consumption per stakeholder per month: 1.79 kWh.

Power supply Equipment and Major Loads

Sanctioned MD : 120 kW
Transformer : 250 kVA
Generator : 250 kVA + 63.11 kVA

Table 1. Major Equipment related to Electrical energy utilization

S.No	Equipment/ Utility	Rating/ Capacity	Quantity
1.	Tube Lights	18 W	1480
2.	LED Bulbs	18 W	250
3.	Fan (Ceiling, Pedestal and Table fan)	60 W	1176
4.	Sodium Vapour Lights	11 W	57
5.	UPS	30 kVA	2
6.	Exide" Tubular battery 12V 6EL66AH	12 V	30
7.	LCD projector	22 W	125
8.	Refrigerators	(2-5 star rated)	19
9.	AC (Split, Window and Centralized AC)		78
	Principal room	2 T	1
	Server	2 T	1
	Secretary	2 T	2
	Board room	2 T	2
	IQAC Presentation	2 T	2
	Biochemistry	2 T	4
	Computer lab	2 T	31
	Biotechnology	2 T	7
	Microbiology	2 T	4
	Suit room	2 T	1
	Catering-Bar	2 T	2
	IQAC	2 T	1
	I-Floor-library	2 T	3
	C1- Ground Floor gallery	2 T	2
	C1-BasementSeminar Hall	2 T	3
	C1-GF-Admission	2 T	2
	COE room	16 HP	1
	COE Office	1.5 T	1
	CDC	2 T	1
	Gym	2 T	2
	Canteen Block	2 T	3
	Canteen Block-I Floor	5.5 T	1
	Canteen Block-I Floor	7.5 T	1
10.	RO Water Facility		12

Quantitative and Qualitative Measurement

S.No.	Requirements and checklists of the audit	Conformity		
		Yes	No	NA
1.	Have internal Energy audit procedures been developed and implemented in the Organization?	☐		
2.	Have programmes for the achievement of energy efficiency and conservation objectives been established and implemented as on today in the campus?	☐		
3.	Has a Management Representative, Electrical Engineer, Staff incharge been assigned for energy savings on power consumptions?	☐		
4.	Have programmes for the achievement of prescribed financial outlay for current bills for each building in the campus towards power consumptions?	☐		
5.	Has the organization ensured that personnel performing environmental specific tasks have the required knowledge on energy audit (e.g. education, training programme, seminar, workshop, camp, etc.)?	☐		
6.	Are objectives and targets documented towards energy audit periodically and any Register is made?	☐		
7.	Any analysis of energy flows for energy conservation in terms of the amount of energy input into the system without negatively affecting the output in buildings	☐		
8.	Implications of alternative energy efficiency measures sufficient to satisfy the financial criteria of sophisticated investors	☐		
9.	Identification of the most efficient and cost-effective Energy Conservation Opportunities (ECOs) or Measures (ECMs) taken by the Management	☐		
10.	Are the following energy efficiency and conservation aspects considered in sufficient detail?			
	a. Fluorescent (tube) lights, Incandescent lamp and sodium vapour lights are replaced with CFL / LED	☐		
	b. Number of Uninterruptible power supply (UPS) and Power generators for power back-up to alternative current supply facility in each building	☐		
	c. Number of solar panels, solar lights, solar water heaters, electric water heater installed	☐		
	d. Automatic sprinkler system used for irrigation purpose	☐		
	e. Ultra-violet lights and any other harmful lights used with safety precautions		☐	
	f. Attempt in reducing the energy expense and carbon footprint	☐		

	g. Disposal facility for hazardous arise from electrical gadgets, equipment and installation	□		
	h. Renewable energy utilization (solar panel, wind mill)	□		
	i. Natural / Mechanical air ventilation at Indoor / Outdoor auditorium, stadium, seminar halls, etc.	□		
	j. Sign boards indicating Switch OFF / ON, Danger at Electrical equipment and Power transformers in the campus	□		
11.	Signing of MoU with Govt. and NGOs to ensure about the energy conservation and efficiency in the campus	□		
12.	Conduction of awareness programmes and outreach programmes on the energy conservation and efficiency	□		
13.	The details of public transport, battery operated / electric vehicles, biofuel use, exhaust fans, boiling water system, chillers and geysers on energy savings mode	□		
14.	Projects and Dissertation works on the energy conservation and efficiency carried out by students and staff members	□		
15.	Steps taken to take care of daylighting, AC machines heat emission and ecofriendly Refrigerators, etc.	□		
16.	Use of water metering, IoT based energy efficiency practices, remote waterlines, automation of electrical fittings and gadgets to save energy	□		
17.	Are all monitoring electrical equipment appropriately maintained and calibrated?	□		
18.	Are any energy conservation technologies and retrofit for energy conservation equipment being implemented?	□		
19.	Skylight roof ratio, fenestration plan and Daylight illuminance in building construction towards energy efficiency*			□
20.	Any Automatic Lighting Shutoff with occupancy Sensors and Timers, Exterior / Interior lighting control facility*			□
21.	Have any rooms and guest suites a master control device at the main room entry that controls all permanently installed luminaires and switched receptacles*			□
22.	Total electricity usage divided by total campus' population (kWh per person)	□		
23.	The ratio of renewable energy production divided by total energy usage per year	1/3		
24.	Total carbon footprint divided by total campus' population (metric tons per person)	□		

25.	Elements of green building implementation as reflected in all construction and renovation policies		□	
26.	Greenhouse gas emission reduction awareness programme to the stakeholders	□		

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 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 6).

Carbon footprint, amount of CO_2 emissions associated with all the activities of the College or other entities like building construction and anthropogenic activity by human beings includes direct emissions, such as those that result from fossil-fuel combustion in manufacturing, heating, and transportation, as well as emissions required to produce the electricity associated with goods and services consumed. In addition, the carbon footprint concept also often included the emissions of other greenhouse gases.

Table 6. Measurement of CO_2 Concentration in Moonray Institute of Pharmaceutical Sciences Campus

S.No.	Different locations of the Organization's campus	Carbon dioxide level (ppm)	Remarks
1.	Class Room 1	469	CO_2 level is low
2.	B.Com (IT) Classroom	580	CO_2 level is low
3.	Ladies Staff Room	485	CO_2 level is low
4.	Library	435	CO_2 level is low
5.	Computer Science Lab	607	CO_2 level is low
6.	Bio-Chemistry Lab	586	CO_2 level is low
7.	Office	534	CO_2 level is low
8.	Conference Hall	497	CO_2 level is low
9.	Chemistry Lab	484	CO_2 level is low
10.	Class Room 2	492	CO_2 level is low
11.	Catering Lab	507	CO_2 level is low
12.	Parking	398	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 Moonray Institute of Pharmaceutical Sciences with respectto 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
= (4304668.8kWh/1000) x 0.84
= 3615.92 metric tons

Notes:

Electricity usage per year = 4304668.8 kWh
0.84 is the coefficient to convert kWh to metric tons.

CO_2 level measurement at various locations of Moonray Institute of Pharmaceutical Sciences

Ways to reduce Carbon Footprint

Understanding the carbon footprint can help limit the impact of your consumption on the environment. Small changes can make a big difference in the long run, for example when it comes to transportation, food, clothing, waste, etc. Here are some tips:

Food

- Consume local and seasonal products.
- Limit meat consumption, especially beef.
- Select fish from sustainable fishing.
- Bring reusable shopping bags and avoid products with excessive plastic packaging
- Make sure to buy only what you need, to avoid waste

Clothing

- Take good care of your clothes
- Try swapping, borrowing, renting or buying second-hand
- Buy responsibly-made clothes, e.g. made from recycled material or with an eco-label

Transport

- Cycle or use public transport
- Be smart about when and how you drive

Energy and waste

- Turn down the heating by 1°, it will already make a difference
- Take short showers
- Turn off the water while you brush your teeth or clean the dishes
- Unplug your electronic equipment and don't leave your phone on charge when the battery is already full
- Select energy efficient products with an "A" label (EU Energy label)
- Limit and recycle your waste.

12. Best Practices followed in the Organization

- Transformer, Generators and UPS are protected properly with fencing and kept awareness boards on 'Dangers' and 'Warnings'.
- 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.
- Installed roof top solar power plant.
- Solar Water heaters are installed and they are functioning well.
- LED lights and Solar street lights are used.
- Installed automatic switches with sensors.
- HVLS Fans are fitted in the auditorium.
- Water level controllers are used.
- Power factor is maintained near to unity with APFC.
- STP is used for water recycling which is functioning well.
- VFDs based Lift and ACs.
- Replaced old generation computers and TVs with LED monitors.
- Availability of e-vehicle inside the campus.

- Adopted Sprinkler Irrigation.
- Use of few star rated equipment

Walk-through Audit conducted in various locations at Moonray Institute of Pharmaceutical Sciences Campus and the Energy Equipment were inspected

Best Practices followed at Moonray Institute of Pharmaceutical Sciences

13. Recommendations for improving the energy efficiency and energy conservation in the Organization

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.

- Procurement of equipment with energy efficiency (4-5 star rated equipment) during replacement may be considered.
- Sub meters in all the buildings for energy monitoring is recommended so that energy load required and energy consumption in each building may be noted.
- 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.
- Turn off electrical equipment when not in use
- Maintain appliances and replace old appliances in all laboratories.
- Use computers and electronic equipment in power saving mode.
- Installation of Biogas plant for hostel kitchen as well canteen.
- Automatic switches with occupancy sensors in common areas
- Monthly use of electricity in the College is very high which may be reduce to a greater extent by means of undertaking a periodical energy audit.
- There are fans of older generation and non-energy efficient which can be phase out by replacing with new energy efficient fans.
- Regular monitoring of equipment in all laboratories and immediate rectification of any problems.
- Value added / Non-formal / Certificate / Diploma course on 'Energy and Environment Management Audits' may be conducted for the benefit of students and research scholars to become a certified Lead Auditor.

14. Recommendations on Carbon Footprint in the Organization

- Establish a more efficient cooking system to save gas in hostel kitchen and canteen.
- More use of generators, inverters and UPS every day should be discouraged.
- Switch off the lights, fan, air conditioners, equipment and instruments when they are not in use.
- Large number of ventilation and exhaust systems may be placed in auditorium, seminar and conference halls to reduce the carbon dioxide level among the participating students, scholars and staff members.

15. Steps undertaken to amend the suggestions given in the previous Energy Audit Report

As per the previous Energy Audit report, the following steps were undertaken to amend the suggestions and recommendations. The last Energy Audit was conducted on 21.04.2018 by the M/s. Nature Science Foundation, Coimbatore, TN.

S.No	Suggestions made during the previous Energy Audit Report	Steps taken to amend the suggestions of the previous Energy Audit Report
1.	Suggested to install Roof top solar power plants and Solar water heaters	Installed Roof top solar power plants almost all buildings and Solar water heaters at both Men and Women Hostels which are functioning well
2.	Recommended to fit HVLS Fans and Exhaust fans in the auditorium and Indoor stadium for proper ventilation	HVLS Fans and Exhaust fans are fitted in the auditorium and Indoor stadium for proper ventilation to the stakeholders for maintaining a proper ecosystem and energy conservation strategies
3.	Suggested to protect all Transformer, Generators and UPS with fencing and keep the awareness boards and safety signs on 'Dangers' and 'Warnings, etc.	Transformer, Generators and UPS are protected properly with fencing and kept awareness boards and safety signs on 'Dangers' and 'Warnings for safety purpose and to draw the attention about safety intervention.
4.	Advised to cover Electrical wires, switch boxes, inverters, and stabilizers not to cause any problem to the staff and student members	Electrical wires, switch boxes, inverters, and stabilizers are properly covered without any damage not to cause any problem to the staff and student members in the campus.
5.	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.	Replaced old generation computers and TVs with LED monitors, most of the places, old incandescent (tungsten) bulb uses with LED lights and installed automatic street solar lights in the campus which indicated the positive indication on energy savings.
6.	Instructed to replace Overhead Projectors with LCD projectors to reduce the power consumption.	Replaced Overhead Projectors with LCD projectors for the effective power consumption and management.

16. 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 sprinkler irrigation 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.

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