

INVESTIGATION OF THE ENERGY AUDIT PRACTICE IN INDIA

¹PANKAJ SHARMA, ²REWAT MAHAJAN, ³YOGESH SHARMA

¹Assistant Professor, ²Assistant Professor, ³Production and Quality Engineer

¹Department of Electrical Engineering

¹Vaishno College of Engineering, Himachal Pradesh, INDIA

²Department of Mechanical Engineering

²Vaishno College of Engineering, Himachal Pradesh, INDIA

³Viney Corporation Limited, Kathua, INDIA

Abstract: Energy is a primary and most universal measure of all kind of work by human being and nature. It is one of the real contributions to the economic development of any nation. On account of the developing nation, the energy sector shows acceptance up to a significant level to expand energy requirements based on colossal investments to meet them. The aim of this report is to describe the indispensability of Energy in the present time based on the bulk utilization of different forms of energies to cater the demands. An Energy Audit is an investigation of a plant or office to decide how and where energy is utilized and to distinguish diverse strategies for energy saving Identification of the areas consuming major energy need prior attention to look for energy saving potential. The energy audit is the most effective tool for optimizing the efficiency of the plant without affecting the output of the system. Most of the country in the world is focused on the improving energy efficiency in the various sector. Energy Audit is the important part of India's effort to improve its energy efficiency, energy quality, and energy intensity. The government of India promoting the energy efficiency in India through Energy Conservation Act 2001. The act instructs the central Government and Bureau of Energy Efficiency to find a way to encourage and advance energy productivity in all area of the economy. Government of India also promoting energy efficiency and awareness at school level by implementing student building capability programme under Energy Conservation awareness scheme for XII five year plan . A gap analysis of India audit programme compared to the international practice is also addressed and focus on the various government policy, energy audit standard, tool and technique applied to the HVAC system and the Lighting system is discussed in this paper. The Energy Auditing for a day is the list of the utilization which standardizes the circumstance of the Energy crisis by giving the conservation plans.

IndexTerms - Energy Audit, Energy Conservation, Indian Government Policy, International Standards, Energy Saving.

1. INTRODUCTION

India today is vastly focusing upon a cleaner energy matrix, indicating not only enhancing Sustainable power source generation yet additionally utilizing it all the more proficiently for an economical utilize. Every step taken towards energy conservation is definitely in the right direction and project allocated to us is a small endeavor towards finding ways and methods of saving Energy to minimize the cost and also to save the depletion of Energy resources. In India, the energy conservation is much fundamental as the demand in the society is expanding day by day. Energy audit comprises of several assignment which can be completed relying upon the kind of audit whether it is conveyed [1]. Owing to increase in population the demand for electricity has also raised which has led to several accidents in large decades. In India, electrical accidents are not as uncommon as insights infer as minor accidents stay unreported causes absence of information about existing electrical safety issues and impede preventive actions The Energy Conservation Act was passed in 2001 with the objective of lessening the energy intensity of Indian economy. Bureau of Energy Efficiency was set up as the legal body on first March' 2002 at the local level to encourage the usage of the Energy Conservation Act. The Energy Conservation Act gives the administrative order to standards and naming of gear and appliances; energy conservation building codes for business buildings; and energy consumption standards for energy-serious ventures. Also, the Energy

Conservation Act charges the Central Govt. Furthermore, the Bureau to find a way to encourage and advance energy efficiency in all areas of the economy. The Energy Conservation Act additionally guides states to assign offices for the execution of the Act and advancement of energy efficiency in the state [2].

The energy audit is an investigation of industry or office to decide how and where energy is utilized and to distinguish strategies for energy savings. There is currently a widespread acknowledgment of the way that new advancements and substantially more prominent utilization of some that as of now exist give the most cheerful prospects to the future. The opportunities lie in the utilization of existing sustainable power source advancements, more prominent endeavors at energy efficiency and the scattering of these advances and choices.

2. INSTITUTION INVOLVED IN ENERGY AUDITING IN INDIA

The techniques used for energy auditing in India are promoted by Ministry of Power [3]; Bureau of Energy Efficiency [2]; Petroleum Conservation Research Association, Ministry of Petroleum & Natural Gas [4], Government of India; Energy Efficiency Services Limited (EESL) [5] and various other institution which promote the energy auditing techniques. These institutes develop incentives and instruments to empower the utilization of energy audit practice as a tool to discover the energy conservation and management opportunities whether it is the commercial or non-commercial sector.

And professional associates of engineers and university have applied energy audit as a project or graduate thesis respectively. In India, there is the limited number of college and university, which promote energy audit programme.

3. GLOBAL ENERGY AUDIT PRACTICE

An energy audit is an important step for an organization wanting to improve its energy efficiency, reduce energy consumption and bring related environmental benefits without affecting the outputs. These audits will bring about cost reduction by changing the inefficient equipment and change task due to identifying the energy management opportunities. In this section provide the international audit practice discussion in term of the international organization of standards, government policy, standards simulation tools.

3.1 Various Government Policies which Promote the Energy Auditing in India

The government of India was passed Energy conservation Act in 2001 with the objective of reducing the energy intensity of Indian economy and the Bureau of Energy Efficiency was set up as the legal body on 1st March ' 2002 at the central level to encourage the execution of the Energy Conservation Act. The Energy Conservation Act gives an administrative order to standards and labeling of equipment and appliances, energy conservation building codes for commercial buildings; and energy utilization standards for energy-intensive industries [2]. In addition, the energy audit is the most effective tool for optimizing the effective optimizing the efficiency of the plant without the affecting the output of the system. The government of India promoting the energy efficiency in India through Energy conservation act 2001. The Act also guides states to designate agencies for the implementation of the Energy Conservation Act and promotion of energy efficiency in the state. The various scheme to promote energy conservation and energy efficiency standard and labeling, Energy Conservation Building Codes, Demand Side Management Scheme etc. [3, 6]

3.2 International Organization for Standardization

Utilizing energy productively enables associations to save money and in addition preserving resources and tackle atmosphere changes. ISO 50001 supports organizations in all sectors to use energy more efficiently, through the development of an energy management system. ISO 50003:2014 identifies requirements for competence, consistency, and impartiality in the auditing and certification of energy management systems for bodies providing these services [7, 8]. ISO 50002:2014 indicates the procedural prerequisites for completing an energy audit in relation to energy execution. It is appropriate to an extensive variety of establishments and organizations, and a wide range of energy and energy usage. It shows the standards of finishing energy audits, essentials for the fundamental systems in the midst of energy audits, and desires for energy audits. It doesn't address the necessities for assurance and evaluation of the ability of bodies giving energy audit organizations, and it doesn't cover the auditing of an

affiliation's energy management structure, as these are defined in ISO 50003. ISO 50002:2014 also gives instructive direction on its utilization [9].

4. VARIOUS INTERNATIONAL STANDARDS USED TO CONDUCT THE ENERGY AUDIT

According to the ASHRAE standard 100-2006, energy audit technique have three assessment stages in order to discover the management opportunities or energy opportunities. Stage: 1, inspection stage: 2, survey and data analysis and stage: 3 is capital management opportunities serious modification is provided [10, 11]. The key purpose of this stages is to find out the potential improvement that will save energy, save cost without affecting the output. ISO 5002:2014 has the new standards for the energy audit. The international standard organization introduced the recent document and international standards to conduct the energy audit which is also the part of the ISO 5001 family for management of Energy system. As indicated by the British Standard Institute (BSI), an energy audit is a systematic inspection and examination of energy utilities and energy utilization of a site, building, framework or association with the expectation to distinguish energy streams and the potential for energy efficiency improvement and reporting them. British Standard Institute introduces the European standards in 2012 for energy audit BSI 16247-1:2012. It describes the energy audit in 7 stages:

- A. Preliminary audit
- B. Kick-off meeting
- C. Collection of data
- D. Field visit
- E. Analysis
- F. Report writing
- G. Final meeting. [12]

5. VARIOUS EDUCATION PROGRAM USED TO HELP ENERGY AUDITING IN INDIA

According to the present scenario, it is more important to the next generation to get awareness about the efficient use of energy resources, when they are taking education in school. In this respects, advancement of energy proficiency in school is being advanced through the foundation of energy clubs. Bureau of Energy Efficiency is executing the Students Capacity Building Program under Energy Conservation awareness scheme for the 12th five-year design and expects to set up the material on Energy Efficiency and Conservation for its proposed participating in the current science syllabi or course books of NCERT for class' sixth to tenth. The following main activities are in progress.

- A. Audit the current science syllabi and science course readings of NCERT for classes and assess the necessity for the level of information on energy efficiency and conservation propose to be incorporated.
- B. Create independent and select draft content module (English and Hindi version) for energy efficiency and conservation to be incorporated into science syllabi and science reading material of NCERT for classes' sixth to the tenth standard.
- C. Development of preparing module (English and Hindi version) and leading preparing for teaching staff

Through this project recommendations, NCERT will also update or modify the science textbooks of the class's seventh to ninth standards to introduce the relevant chapters on the topic of energy efficiency in the syllabus. [13]

As a major aspect of the Government's endeavors for advancing energy conservation, Minister of State (I/C) for Power, Coal and New & Renewable Energy, Shri Piyush Goyal interfaced with school kids the nation over through video conferencing. Hon'ble Minister Shri Piyush Goyal also launched a web portal called 'Energy Savers' (www.energysavers.co.in) at the National Energy Conservation Day function on 14th December 2014 [14].

6. PAT SCHEME

The main objective of this scheme to improve the effectiveness of energy efficiency. PAT is an innovative, declared by the government of India in 2008 under the National Mission on Enhanced Energy Efficiency in National Action plan on Climate

Change. Participating are mandatory for the designated consumer under the energy consumption Act. In PAT scheme 11 sectors are included. The sectors are Chlor-alkali, Fertilizer, Iron and Steel, Cement, Pulp and Paper, Textiles, Thermal power plants, Aluminium, Railways, Refineries, and Electricity Distribution Companies (DISCOMs) [15]. The Government of India develop a baseline and establish the trading platform, provide monitoring, verification protocols and set up an accreditation system for verifiers. Three cycles are carried out by a cadre of energy professional i.e. Accredited Energy Auditors who are impaneled with Bureau of Energy Efficiency. The three PAT cycle are Cycle-I (2012-13 to 2014-15), Cycle –II (2016-17 to 2018-19), Cycle –III (2017-18 to 2019-20). In Cycle I the overall energy saving target are 6.6686 mtoe (77758.18kwh) but the actual energy saving was 8.67 mtoe (100832.1kwh) which is 30% greater than the target energy saving in Cycle I. In Cycle II the overall energy saving target achieve an overall energy consumption reduction of 8.87 mtoe (103146.47kwh). There are 721 designated consumer (621 DCs of Cycle II and 116 DCs of Cycle III) participating under PAT scheme In Cycle III new 116 designated consumers to consume energy about 35 mtoe (407050kwh) while the energy saving target of 1.06mtoe (12327.8kwh) at the end of the cycle at 2019-2020[16].

7. ESCO MODEL

The ESCO model was introduced to implementing more energy efficient strategies onto commercial and industrial properties for recouping the savings. ESCOs model have four features. Firstly, an ESCO assurance energy savings and the arrangement of a similar level of energy benefit at a lower cost through the usage of an energy efficiency projects. This execution assurance can rotate around the real flow of energy savings from a project, stipulate that the energy savings will be adequate to compensate month to month obligation benefit costs for an efficiency project or ensure that a similar level of energy benefit at a reduced cost. Secondly, the compensation of the ESCO is straightforwardly attached to the energy savings accomplished and along these lines performance. Thirdly, an ESCO normally specifically finances, or assists in arranging to back, for the installation of the efficiency or energy project to be actualized by giving a saving ensure. Lastly, but not least, an ESCO has a tendency to hold an on-going operational part in estimating and checking the savings over the financing term. Broadly, the ESCO model can be particularly attractive to those considering the structural restoration of existing structures that additionally focus on energy efficiency retrofit [17].

8. ENERGY AUDITING EXPERIENCE IN HEATING VENTILATION AND AIR CONDITIONING SYSTEM

IS:655-2006 cover the constructional and materials requirements for the air ducts used for air conditioning and ventilation system (including gas exhausting system)[18]. In new and existing, commercial and non-commercial buildings, any mechanical or electrical load condition ought not to influence the comfort of occupants. In such a manner, Heating Ventilation and Air-conditioning System forms must be coordinated into an effective control structure. Most open doors for energy savings are in characterizing the required size of a Heating Ventilation and Air-conditioning System framework figuring the pinnacle heating and cooling load in the audited building. Diverse sub-frameworks of the Heating Ventilation and Air-conditioning System frameworks should be controlled to accomplish the right size. For instance, fan control and runtime, heating control and runtime, set-focuses, cycles of the economizer and their designs require control in a coordinated base. Never-the-less, the control methodologies in Heating Ventilation and Air-conditioning System frameworks are generally hard to conjecture due to the non-direct qualities on a worldly premise of the framework. Habitually, the most noteworthy practical choice to enhance energy proficiency in a building is a proficient Heating Ventilation and Air-conditioning System control framework. An ongoing study in non-commercial buildings in Australia demonstrated that approximately 70% of the energy consumption is committed to Heating Ventilation and Air-conditioning System frameworks and 15% to lighting. Another study in Turkey shows that Heating Ventilation and Air-conditioning System frameworks are in charge of up to 60% of the aggregate energy use in a current building. In Italy, non-commercial energy audits found that Heating Ventilation and Air-conditioning System frameworks are the essential energy saving concentration in the modern division. A study from the USA's Department of Energy found that 31.2% of the energy utilized by commercial segment was by Heating Ventilation and Air-conditioning System frameworks. By and large, general upkeep programs, standard controls, itemizing operational strategy and sufficient size are the best energy proficient utilization of Heating Ventilation and Air-conditioning System

frameworks [9]. This information demonstrates a vital chance to decrease energy consumption in Heating Ventilation and Air-conditioning System gear in commercial and non-commercial sectors [10].

9. ENERGY AUDITING IN LIGHTING SYSTEM

The Indian Standard Code (IS: 6665-1972) and Code of Practice for Interior Illumination (IS: 3646-1992) cover the principal and practices leading good lighting for the various commercial and non-commercial premises [19, 8]. It is prescribed the level of illumination and quality prerequisites be accomplished by the general rule of lighting. Illumination is the most financially savvy procedure to lessen energy in commercial and non-commercial premises. Numerous innovative advances have made extensive contrasts between energy employments of customary lighting and current technologies. Lighting controls have permitted the extensive lessening of the measure of energy to squander, streamlining illumination frameworks. Thusly, legitimate controllers can diminish energy consumption in lighting frameworks [10].

The huge generation of more efficient bulbs has incited aggressive costs with a specific end goal to substitute customary lighting for more successful ones. LED bulbs are offered in a wide range of lights. LED bulbs have more efficient energy consumption contrasted and incandescent bulbs. Another case is elite fluorescent tubes, which deliver higher measures of lumens contrasted and old outlines. Turning lights off when they are a bit much is a capable technique to diminish energy consumption. Tragically, it relies upon inhabitation conduct, so sparing can be eccentric. Along these lines, inhabitation sensors and light diminishing frameworks can keep places lit up just when it is essential. The use of these electronic devices can lessen extensively the energy consumption in lighting frameworks in commercial and non-commercial premises [20].

10. LACK OF APPROPRIATE INSPIRATION FOR ENTERPRISES TO CONDUCT ENERGY AUDITS

Companies are not totally mindful of the profits of an energy audit. The lack of intrigue is because of cheap energy costs. Enterprises, for the most part, consider energy auditing an additional use and not an open door for investment in energy-bill savings. This is a direct result of the impression of long payback periods for the initial investment. Consequently, proper economic feasibility analysis of the recommendations and results after energy audits is required. On the other hand, there is no policy to request energy auditing as a compulsory requirement. In India, energy savings and efficient use of energy is not a rule for enterprises, and thus, an energy auditing is not compulsory in order to identify energy waste in commercial and non-commercial sectors. Furthermore, there are no economic reports from energy service companies to guarantee savings after the implementation of recommendations made in an energy audit report. Therefore, Indian policies should consider energy audits as compulsory activities followed by appropriate analysis of the economic benefits of implementing recommendations of energy auditing reports.

11. CONCLUSION

The present study was aimed to analyses the Indian policies and program on energy auditing practices with data gathered from various paper, standards and organization websites.

- A. As a part of the Indian Government's endeavours for advancing energy conservation, Minister of State (I/C) for Power, Coal and New and Renewable Energy Shri Piyush Goyal, interacted with school youngsters the nation over from 18 urban communities in particular Bhubaneswar, Hyderabad, Shimla, Patna, Itanagar, Jalandhar, Lucknow, Pune, Bhopal, Raipur, Thiruvananthapuram, Bangalore, Agartala, Gandhinagar, Puducherry, Port Blair, Kavaratti, and Haridwar took an interest in the interactive session through video conferencing.
- B. According to Energy Auditing experiences in the field of HVAC and lighting system supported by new lighting technologies and simulation tools with its respective controllers are the most key energy savings in commercial and non-commercial buildings.
- C. Indian Government techniques, the nonappearance of enterprises inspiration and the lack of tools to conduct energy auditing are the principal gaps between the real situation in Indian and global practices. Long-term and escalated

techniques to increment legitimate national level organization and norms to regulate energy audits across the nation are required. Likewise, the limited training is evident in most of the dedicated institutions.

- D. PAT scheme is the unique scheme for developing countries. Since creating a market for energy efficiency through a tradable certificate called ES Cert... In PAT Cycle overall energy saving target are 6.6686 mtoe (77758.18kwh) but the actual energy saving was 8.67 mtoe (100832.1kwh) which is 30% greater than the target energy saving in Cycle.

REFERENCES

- [1]. Kumar, Awanish, Shashi Ranjan, M. Bharath Kumar Singh, Priyanka Kumari, and L. Ramesh. "Electrical Energy Audit in Residential House." *Procedia Technology* 21 (2015): 625-630
- [2]. The Bureau of Energy Efficiency listed on its website <https://beeindia.gov.in/>
- [3]. The Ministry of Power listed on its website <https://powermin.nic.in/>
- [4]. The Petroleum Conservation Research Association, Ministry of Petroleum & Natural Gas, Government of India listed on its website <http://www.pcra.org/>
- [5]. The Energy Efficiency Service Limited listed on its website <https://www.eeslindia.org/EN/Aboutus/AboutEESL/>
- [6]. Sahoo, Sarat Kumar, Payal Varma, Krishna Prabhakar Lall, and Chanpreet Kaur Talwar. "Energy efficiency in India: Achievements, challenges and legality." *Energy Policy* 88 (2016): 495-503.
- [7]. The Campus Environmental Resource Center listed on its website www.campuserc.org/
- [8]. The International Organization for Standardization listed on its website www.iso.org
- [9]. The International Organization for Standardization, for Energy Management listed on its website <https://www.iso.org/iso-50001-energy-management.html>
- [10]. Moya, Diego, Roberto Torres, and Sascha Stegen. "Analysis of the Ecuadorian energy audit practices: A review of energy efficiency promotion." *Renewable and Sustainable Energy Reviews* 62 (2016): 289-296.
- [11]. The Standards 100-2015—Energy Efficiency in Existing Building listed on its website <https://www.ashrae.org/technical-resources/bookstore/standard-100/>
- [12]. The British Standard Institute introduces the European standards listed on its website <https://www.bsigroup.com/en-GB/standards/>
- [13]. The Government of India, Ministry of Power listed on its website Powermin.nic.in
- [14]. As 2018, the Energy savers listed on its website www.energysavers.co.in
- [15]. The Industrial Efficiency Policy Database listed on its website Iepd.iipnetwork.org
- [16]. The PAT Scheme listed on its website <https://beeindia.gov.in/content/pat-cycle>
- [17]. *The Energy Service Company (ESCO) Model* listed on its website http://www.c40.org/case_studies/energy-service-company-esco-model
- [18]. As 2006, the Bureau of Indian Standards, IS 655: Specification for Air Ducts are listed on its website <https://archive.org/details/gov.in.is.655.2006>
- [19]. As 1972, the Bureau of Indian Standards, IS 6665: Code of practice for industrial lighting listed on its website <https://archive.org/details/gov.in.is.6665.1972>
- [20]. Biswas, Biswajit, Sujoy Mukherjee, and Aritra Ghosh. "Conservation of Energy: a Case Study on Energy Conservation in Campus Lighting in an Institution." *International Journal of Modern Engineering Research (IJMER)* www.ijmer.com 3, no. 4 (2013).