

Applying electronical devices to save electrical

Auditoria energética a un campus universitario

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Abstract

Saving energy and improving energy efficiency are important challenges that must be faced in the short term. Any company, industrial or service, must consider whether their facilities and processes respond to an optimized design from the energy point of view. Appropriate energy management leads to the efficient use of energy and, consequently, the reduction of energy costs. An energy audit should be part of the energy efficiency programs or plans of any company, as well as any educational institute that wishes to do so. These plans must include those actions aimed at achieving maximum efficiency in energy consumption, maximum savings and knowledge of the energy behavior of their facilities. The objective of this document is to carry out an energy audit in a Higher Education School located in the City of Linares, Nuevo León. Said audit can serve as a model for carrying out energy audits in other types of institutions.

Audit, Energy, Savings

Resumen

El ahorro de energía y la mejora de la eficiencia energética son desafíos importantes que se deben afrontar en corto plazo. Toda empresa, industrial o de servicios, deben plantearse si sus instalaciones y procesos responden a un diseño optimizado desde el punto de vista energético. Una gestión energética adecuada conlleva el uso eficiente de la energía y, por consiguiente, la reducción de los costes energéticos. Una auditoría energética debe formar parte de los programas o planes de eficiencia energética de cualquier empresa, así como también de todo instituto de educación que lo desee. Dichos planes deben comprender aquellas actuaciones encaminadas a lograr la máxima eficiencia en el consumo de energía, los máximos ahorros y el conocimiento del comportamiento energético de sus instalaciones. El objetivo de este documento es la realización de una auditoría energética en una Escuela de Educación Superior situado en la Ciudad de Linares Nuevo León. Dicha auditoría puede servir de modelo para la realización de auditorías energéticas en otros tipos de instituciones.

Auditoria, Energéticos, Ahorro

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Introduction

The context of energy saving, especially electricity, is currently a very important point for the development and comfort of mankind. It is therefore necessary for people to be more interested in the efficient use of energy, whatever it may be, to prevent a shortage that adversely impacts the daily work of any organization, private or service. In addition to the above, the implementation of energy audits provides an adequate parameter to diagnose energy consumption, which gives access to establish energy saving strategies of any kind through the efficient use of energy.

In addition, the care of energy is an area with great job growth, so it is necessary that people have knowledge about this area, based on practical theoretical teaching that provide a broad vision (Torres & Perez, 2019).

And based on the above, it is necessary to carry out integrative projects at the university level, where it is investigated how to solve scenarios that may present the inefficient use of energy of any type in an organization, always looking for energy savings, which represents probable decreases in expenses and conservation of energy resources.

And as Rojas & Contreras (2019) point out, in higher education it is important to use elements that allow a practical teaching, with the simple objective of preparing engineers in an effective way and bringing them closer to real work environments.

The application of energy audits, as described above, is precisely the point that can be carried out according to the characteristics of any organization, since there are different levels, depending on the resources required to invest, from basic to strenuous, with a simple methodology of implementation and monitoring as appropriate.

In the same way, it can be pointed out that the use of energy audits gives access to locate transforming and inexpensive solutions to existing problems in an organization, as is the case of saving electricity on a campus, allowing the development of a comprehensive process among those involved, simple and easy to develop.

Therefore, we propose the development of a study to eradicate the excessive consumption of electricity within the different areas of a university campus, which will be achieved by conducting an energy analysis of all equipment and systems that are part of it, to find areas of opportunity within them that allow us to carry out energy savings, and likewise propose solutions for improvement in the field, and the incorporation of new energy options that are technically and economically viable for an organization.

Rivera (2019), suggests that the Project Method orients to obtain in an established way, activities that allow not only to find and to be aware of new methods, but jointly to experience the taste of an evident result for the same one.

2. Objectives

2.1 General Objective

Through the use of the energy audit to establish a simple process of implementation, that allows to find areas of opportunity for the creation of strategies that allow the saving of electric energy inside a university campus, with the purpose of making more efficient the use of the same one.

2.1 Specific Objectives

- a. To make a proposal for a plan of savings and
- b. To make a proposal for a savings and performance plan for the campus, in order to reduce the environmental impact in our community.
- c. To reduce the use of different appliances in order to reduce costs and have a better economy.
- d. Make an improvement plan to encourage to turn off the equipment that is not being used in the different classrooms.
- e. Analyze the possibility of integrating renewable or alternative energy installations in the facilities.

3. limitations

The campus does not have an efficient use of one of the causes of this is when the lighting and air conditioners are kept on all day or most of the day, even when not in use, in order to prevent these inappropriate uses.

An energy audit is proposed, where the consumption will be reflected as well as the areas where the use of this electricity has to be optimized, which has an administrative cost.

To prevent these inappropriate uses, an energy audit is proposed, which will reflect the consumption as well as the areas where the use of this electrical energy, which has an administrative cost, must be optimized. These costs can be used in other ways, such as improving classrooms, improving the quality of buildings, and even promoting the use of renewable energies, which have a lower environmental impact.

Therefore, it must necessarily be taken into account that, although an energy audit can help improve energy efficiency, the lack of long-term vision of the staff of an organization, may mean a rejection in the early stages of the work proposal, coupled with the resistance of people, factors that must be considered in depth. Therefore, it is important to be aware that, when developing any proposal, it is necessary to implement teamwork among students and teachers of the campus.

4. Background

The energy audit is a procedure with which the energy flows in a system or process are examined, recorded and analyzed (Morales et al., 2016).

The importance of carrying it out in an organization lies mainly in finding areas of opportunity that help to optimize energy consumption, reducing energy consumption or finding viable alternatives, without affecting the output of an organization's system (Bellido, 2022).

In this context, in 2015, the United Nations (UN) approved the 2030 Agenda for Sustainable Development, in which 17 Sustainable Development Goals (SDGs) are established as an action plan in favor of people, planet and prosperity. Sustainable Development Goal 13 (SDG13) is precisely to "take urgent action to combat climate change and its impacts", while Goal 7 (SDG7) refers to "ensure access to affordable, secure, sustainable and modern energy".

Since then, the SDGs have been present in policies, both government and business, as it is part of environmental social responsibility (García & Quintana, 2012; González et al., 2020). In addition, the sustainable development goals constitute an area of research that has experienced exponential scientific growth (Sianes et al., 2022), factors that guide the efficient use of any available energy, naturally or alternatively.

Likewise, Higher Education Institutions have also declared their commitment to the SDGs (Lozano et al., 2013). For example, the Tecnológico Nacional de México (TecNM) includes sustainability as part of its mission.

Energy audits are conducted in seven stages: authorization management, review of previous diagnostics, billing analysis, survey, measurement of electrical parameters, energy indicators and approach of corrective measures (Morales et al., 2016).

For the realization of this work, only one of the seven stages mentioned above was performed, the "survey"; that is, a format was designed in which the electrical parameters (power, voltage and current) and usage (hours per day and days per week of use) of two categories were recorded: lighting and air conditioning. This is comparable to what (Morillón et al., 2015) define as a "level one or basic" audit, which consists of a visual inspection of energy consuming equipment, without making measurements, so it has the advantage of identifying, in a general way, the possibility of energy savings at a low cost.

Only these two categories (lighting and air conditioning) were evaluated because they consume the highest percentage of energy (Morales et al., 2016).

5. Problem statement

The constant problem today is the inefficient use of currently is the inefficient use of energy (electricity, diesel, gas, water, etc.) that an organization uses for its processes or services, and at the same time, the lack of interest on the part of those involved and the lack of knowledge of practical diagnostic tools to know their status with respect to their energy flow, such as energy audits (Poveda, 2007).

Likewise, within the educational program of the Electromechanical Engineering career of the Tecnológico Nacional de México, the subject of Energy Saving is taught, which relates topics oriented to know, face and solve in detail the problems focused on the use of energy. In this subject, a practical development of an energy audit is designed, at the discretion of the teacher, not standardized.

Therefore, it is necessary, from a professional perspective, to promote among students and teachers, an appropriate work structure, depending on the situation, to correctly carry out an energy audit, and to understand its process, importance and impact on an organization based on results. correctly an energy audit, and that they understand its process, importance and impact on an organization based on results.

Therefore, in order to cover this need, an integral strategy of Energy Saving was formulated; which allows to optimally develop an energy audit of a company.

The proposal was mainly oriented to a professional environment within the electromechanical engineering career at the Instituto Tecnológico de Linares, where students used the proposed project structure to develop a work process to find areas of opportunity to improve the use of energy within the institution of study, focusing mainly on electricity consumption.

Based on the above, the objective was to establish whether the proposed work structure to carry out an energy audit in an organization, provides a tool that is sufficient to find points that optimize the use of energy, as is the case of electricity in an educational institution.

6. Methodology

The present study contemplated a approach to elaborate and implement in a practical way a work structure for an energy audit in an educational institution, as part of the didactic and professional process of the sixth semester students of the electromechanical engineering career in the Technological Institute of Linares, to promote its application and recognize its benefits.

In the same way, the following process was established to carry out the corresponding inquiries:

- For work process, the students of the energy saving subject of the electromechanical engineering career of the January - June 2023 semester were selected.
- The students were instructed on the proposal for the practical development of an energy audit.
- For convenience, they opted for electrical consumption devices, such as lighting and air conditioners.
- Working groups were established for the implementation of the energy audit.
- Selection of buildings within the Instituto Tecnológico de Linares to carry out the study.
- Analysis of results.

The following is the structure of practical work to perform the energy audit:

- Initial recognition of the organization, to establish its context with respect to energy and diagnosis.
- Elaboration of Project Charter, of the energy audit plan.
- Objectives (general and specific) of the energy audit project.
- Problem definition.
- Selection of specific work area.
- Create a work plan.
- General inventory of devices.
- Measurement of the consumption characteristics of the devices considering the way the organization works.
- Elaboration of a preliminary rational energy use program.
- Detect areas of opportunity based on points where energy gains and losses occur.
- Economic study of the energy consumption of the devices, including current consumption and historical data of the organization.
- Load factor, demand factor and power factor calculations (in the case of electrical systems).
- Analysis of collected data.
- Proposals and evaluation of their impact on the system or service.

- General results.
- Conclusions and recommendations.

7. Results

The initial diagnosis of the study organization included an analysis of the way of working in the process and service, in order to detect the areas of opportunities that could be presented to improve energy consumption, in this case, electricity.

The needs of the organization with respect to energy savings were correctly delimited in order to prepare the Project Charter, which set out the goals, responsibilities, work dates and commitments of those involved. It clarified the objectives, problems and risks of the energy management project.

The work areas were identified and the work plan was developed according to the space, inadequacies, the organization's way of working and the The work areas were identified and the work plan was developed in accordance with the spaces available, the organization's work methods and the project's restrictions.

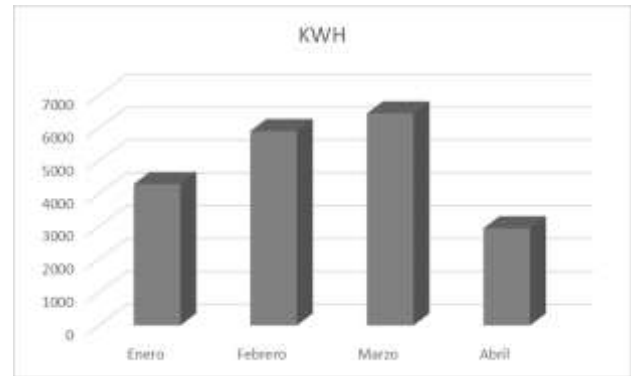
The equipment inventory took into account consumption characteristics, conditions, operating times and maintenance.

Table 1 shows the buildings selected for the energy audit, active power and effective power (considering working periods of a normal day).

Area	Active power (KW)	Effective power (KWH)
Building H	46.412	172.992
Cafeteria	8.888	35.124
Electromechanics laboratory	14.728	45.512
Computer Center	5.838	46.704
Address	21.799	126.275
Library	46.539	217.474
School building	62.540	205.120
Building G	13.350	41.650
Building C	21.320	84.080
Engineering Building Industrial	67.625	268.645

Table 1 Data of information collected

Table 2 shows the average consumption in January, February, March and April 2023.



Graph 1 Average consumption

As a parallel result of the monitoring of consumption during the four months, the way the organization works and the use of electrical devices (lighting and air conditioners) was known, which allowed the development of a preliminary rational energy use program, whose main feature is to propose short-term strategies to improve the use of energy, at low or no cost to the organization.

Problematic	Strategy
Doors open with air conditioners on	Create a regulation of use for users
Air conditioners on with no students or staff in work areas	Create a regulation of use for users
Laminarias always on where there are no students or staff	Create a usage regulation for users
Some doors do not close properly	Maintenance of pistons and door gaskets
Some windows are not tinted or without blinds	Schedule installation
Lack of maintenance on some air conditioners	Schedule maintenance
Inadequate gauges for air conditioners.	Change the wiring and place the appropriate one to avoid overheating.

Table 2 Rational energy use program

The preliminary simple energy analysis of the work areas determined that there are a large amount of electrical energy losses in the different devices, either due to misuse or lack of maintenance, based on a measurement of the temperature in the systems at peak working hours and the Joule effect in the conductors in general. With reference to the current economic study against the organization's history, there was no great difference with the four months of observation, which shows that the consumption monitoring was carried out correctly with the current tariffs.

The load factor and power factor calculations for the selected areas showed results ranging from 9.23% to 13.19% for the load factor. And from 0.92 to 0.99 for the power factor.

8. Conclusions

The development and application of an energy audit is in itself a useful instrument for the reduction of energy consumption, in this case electricity, since it provides in a solid way enough information to declare if the energy of an organization is being used in an efficient way, regardless of the type of energy used energy consumption of an organization, regardless of the line of work. Therefore, it can be stated that with a correct implementation of the same can create areas of opportunity for energy savings and therefore decrease direct and indirect costs. In addition, it allows the creation of a database for future savings strategies in an organization, since it already has a history of firm consumption.

In the same way, it can be observed in the results obtained before, with the established work technique, that the lack of awareness of the personnel with respect to energy saving is a point that must be addressed with the same way in which better use is made of the work equipment.

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