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Engineering assessment for ISO 50001 implementation

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Abstract.- This paper recommends implementing an integrated management system based on the NTE INEN-ISO 50001 standard. ISO 50001 certification is an international standard that establishes the requirements for implementing an organization's energy management system (EMS). This standard focuses on improving energy efficiency, optimizing resource use, and reducing the environmental impacts associated with energy consumption. Some benefits of obtaining an ISO 50001 certification are Improved energy efficiency, cost savings, regulatory compliance: ISO 50001, innovation, employee participation, risk reduction, and process optimization. The objectives of the standard are described, which are the rationalization of energy consumption and preservation of energy resources and the improvement of productivity and competitiveness through the reduction of costs for efficient use of energy.

Keywords: Certification, optimization, efficiency, energy.

Evaluación técnica para la implantación de la norma ISO 50001

Resumen: El presente trabajo proporciona recomendaciones para la implementación de un sistema de gestión integrado en base a la normativa NTE INEN-ISO 50001. La certificación ISO 50001 es un estándar internacional que establece los requisitos para la implementación de un sistema de gestión de la energía (SGE) en una organización. Este estándar se centra en mejorar el rendimiento energético, optimizar el uso de los recursos y reducir los impactos ambientales asociados con el consumo de energía. Algunos de los beneficios de obtener una certificación ISO 50001 son: Mejora en la eficiencia energética, ahorro de costos, cumplimiento normativo: ISO 50001, innovación, participación de los empleados, reducción de riesgos, optimización de procesos. Se describen los objetivos de la norma, que es la racionalización del consumo energético y preservación de recursos energéticos, el mejoramiento de la productividad y la competitividad a través de la reducción de costos por uso eficiente de la energía.

Palabras clave: Certificación, optimización, eficiencia, energía.

I. INTRODUCTION

ISO 50001 is an international standard that sets out the requirements for an effective energy management system (EMS). The standard aims to help organizations calculate and improve energy efficiency, reduce costs and greenhouse gas emissions, and promote sustainable energy-related practices.

In Ecuador, the implementation of ISO 50001:2019, with its translation for Ecuador of NTE INEN-ISO 50001, second edition, 2019-07, is mandatory as of January 2025 according to Official Register 449-Supplement and its execution will depend on national energy policies and regulations, as well as the sustainability initiatives and objectives of organizations [1]. As mentioned above, the purpose of the Law is to establish the legal framework and operating regime of the National Energy Efficiency System – NEES, promote the efficient, rational, and sustainable use of energy in all its forms, and increase the country's energy security.

The scope of this Law is limited to all activities of a public or private, institutional or personal nature, for which a transformation and consumption of energy is carried out in any way and for any purpose if we talk about companies classified as "Large Consumers" the standard is mandatory and must report to the Ministry of Energy and Non-Renewable Natural Resources the indicators that the company has selected for certification with the standard in question. This standard provides a framework for establishing energy policies, objectives, goals, and processes that enable organizations to take concrete steps to improve their energy performance.

II. DEVELOPMENT

Some of the key elements covered by ISO 50001 are:

Establish an energy policy, identify energy aspects, establish objectives and targets, plan and action, edit and monitor, system review, and energy administration. In Ecuador, they are certifying bodies: Bureau Veritas Ecuador S.A., International Quality of Certifications CICAYBECE S.A., and Cergestcal América Certification Group S.A., among others. It is recommended to have a quarterly periodicity for internal audits and an annual for external audits. This periodicity must be tied to the number of improvement opportunities found during the audits. The standard promotes continuous improvement of the energy management system and the organization's energy performance in correlation with one of the organization's purposes. In the beginning, certification is not necessarily many requirements. The most critical and complex thing to achieve is that at the time of recertification, it must be demonstrated that there is an improvement, which is maintained over time [2].

Importantly, ISO 50001 is designed to be adaptable to different types of organizations, regardless of size, sector, or geographical location. Its implementation can provide several benefits, such as reducing operating costs, optimizing processes, improving the environmental reputation of the organization, and obtaining incentives from the government.

Industries consume much energy in various areas to carry out production processes and operations. The primary energy items consumed in sectors vary according to the type of industry and its specific methods. Still, some of the most common include electricity, one of the leading energy items consumed in virtually all industries. Generally, this item is among the four most important things.

At present, energy meter systems allow real-time control of the KW-hour. It is important to emphasize that the electricity rates of the distributors have an hourly value, where the cost is lower, even almost half, during the hours of low consumption that correspond to the night and weekends. The network meters allow you to keep track of consumption and demand on an hourly basis, and together with the information of the controls based on programmable logic controllers, you can have consumption indicators of KW-h per unit of product.

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Fossil fuels such as oil, natural gas, and coal are used in many industries for heat generation and thermal power. It is advantageous to implement liter counters readily available in the market to keep track of the fuel consumed per hour or unit of product produced. On the other hand, keeping track of the combustion equipment's calibrations and the boilers' performance curves is crucial since a wrong air/fuel mixture adjustment implies poor performance. There are wood dust burners that allow to replace the combustion of petroleum derivatives, the results are significant, and the costs are recovered in less than a year. An inventory of all the processes that consume oil and its products must be carried out, and the biomass substitution analysis must be carried out.

In addition to the fuels mentioned above, there is steam, in whose equipment it is crucial to carry out an efficiency analysis based on pressure and to work preferably at the lower pressure limits where losses are minimized. On the other hand, renewable energy, which, in some cases, industries can also use renewable energy sources, such as solar and wind, to generate part of their energy. This may include the installation of solar panels or wind turbines at industrial facilities.

In regions with access to adequate water sources, hydropower can be a principal source of electrical energy for industries. On the other hand, in specific sectors, such as food and biomaterials, biomass can be used as an energy source to generate heat or electricity.

It is imperative to know the generation costs to make the proper selection since the prices of hydraulic energy fluctuate between USD 0.05 to USD 0.06, wind generation costs are around USD 0.08, and photovoltaic USD 0.12, biomass energy costs are close to USD 0.08. It is an excellent alternative for isolated processes of the National Interconnected System [3].

Generally, energy ministries in different countries usually establish regulations, policies, and guidelines related to production, distribution, efficient use, and energy conservation. These requirements can cover various aspects, including politics and energy, and the Ministry of Energy can establish energy policies that address issues such as diversification of energy sources, promotion of renewable energies, energy security, and efficiency. In the country at the moment, hydroelectric generation is encouraged, guaranteeing the purchase by the state with a favorable price of USD 0.062 with prioritization of payment, photovoltaic generation is stimulated with the acquisition by the state at values higher than the costs of age, and forms of interconnection and consumption that allow generating in the day and consuming at night to make a daily crossing of accounts with the distributor of energy, as well as it is allowed to have a different delivery point and point of consumption within the same concession area of the distributor [4].

There are specific rules and regulations about the generation, transmission, distribution, and consumption of energy, as well as in areas such as granting permits and licenses for energy projects. These regulations stimulate the management of the load curve, encouraging consumption in hours and days of lower demand.

The NTE ISO 50001:2018 standard indicates the objectives of the application of this [5]:

(a) Rationalizing energy consumption and preserving renewable and non-renewable energy resources.
(b) Improved productivity and competitiveness through reduced energy efficiency costs.
(c) Promotion of clean energy and reduction of greenhouse gas emissions.
(d) Fostering a national culture oriented towards efficiently using energy resources.
(e) Transparency and adequate information for consumers and decision-makers.

III. METHODOLOGY

In this article, a case study is carried out to achieve the objectives of the standard, which allow the rationalization of energy consumption and preservation of energy resources, the improvement of productivity and competitiveness through the reduction of costs for efficient use of energy. The minimum activities to be developed and the minimum requirements are described. Recommendations are proposed that help create the certification and actions to demonstrate the continuous improvement that is very important for the recertification process.

IV. RESULTS

To meet these objectives required by the standard, it must tend to the execution of the following activities in the company: Promotion of Renewable Energies, and energy efficiency, energy conservation, ostensible development, research, and development.

To save energy in the industry, it is essential to implement a series of actions that promote energy efficiency in all aspects of the operation. Some activities can be considered: Energy Audit, setting goals and objectives, education and awareness, efficient lighting, process optimization, regular maintenance, efficient technologies, heat recovery, thermal insulation, compressed air management, monitoring, and control, turn off unused equipment.

Use renewable sources: If possible, incorporate renewable energy sources such as solar panels or wind turbines. It is vital to know the costs of hydroelectric power generation that fluctuate from US $ 0.05 to US $ 0.06. Wind generation costs are around US $ 0.08, and photovoltaic US $ 0.12. Generation costs based on burning fossils exceed US$0.15 and constitute non-renewable sources [6].

Waste management: Implement efficient waste management practices to reduce the amount of waste generated.

Optimizing water use: Efficient water use can also contribute to energy savings, as hot water often requires energy to heat it.

Foster a culture of energy saving: Motivate employees to participate in energy saving and recognize achievements actively.

Review and continuous improvement: Regularly evaluate actions and results, adjust strategies as needed, and look for opportunities for constant improvement.

Remember that every industry is unique and may require specific energy-saving approaches. Conducting a detailed analysis of the operations and adapting the actions according to the needs and possibilities is essential.

Figure 1 compares the behavior of two industries with and without energy management systems.

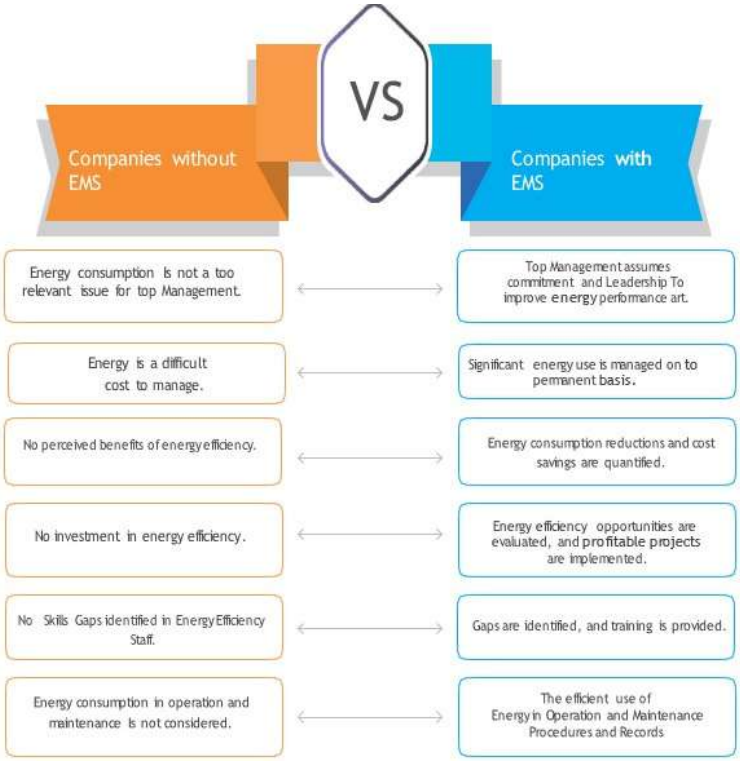

Figure1. Comparison of the behavior of two industries with and without energy management systems. Source: De Laire, M. Fiallos, Y. [7].

Being a mandatory regulation from January 2025 for all industries classified as Large Energy Consumers, it must start at least one or two years in advance since the control policies that will surely be through fines are not yet defined, so it is advisable to start with due anticipation and start with the minimum requirements required by the regulations, Within the written documentation that must be kept in the organization are:

1. Motivation of senior management.

In the initial implementation phase, and to demonstrate the minimum requirement, it is convenient to develop an agreement between the Ministry of Energy and a Trained Technician to implement a standardized energy management system in a specific industry. In this case, the beneficiary company of the advice. The agreement is based on improving energy efficiency in the Ecuadorian sector and seeks to identify savings in energy consumption and more efficient processes. It establishes that the Ministry of Energy will oversee the implementation process and details how monitoring and evaluation will be carried out, including delivering reports and products in specific timeframes. The agreement establishes the conditions and responsibilities to implement an energy management system in the industry to improve energy efficiency and competitiveness. The clauses detail the processes, commitments, and measures to be taken in case of contingencies.

2. Training of the work team.

The delegation and appointment of responsibilities must be carried out, and their disclosure in the company must be guaranteed.

3. Review of the process map.

Within the process map, information related to the flow of inputs must be maintained, as well as the consumption of electricity and fossil fuels in different areas or processes of the industrial facility.

The document will show the cumulative energy use in different areas or processes of an industrial facility. Data are presented in energy units and percentages concerning the total.

This report should describe the energy consumption in the different processes or areas of the industrial plant, using both electricity and fossil fuels and process indicators should be defined in terms of percentage consumption and specific units, such as tons of raw material or units produced, that is, control of consumption and variability. These total values are added up for all systems or processes considered within the organization. Figure 2 shows an example of a process map.

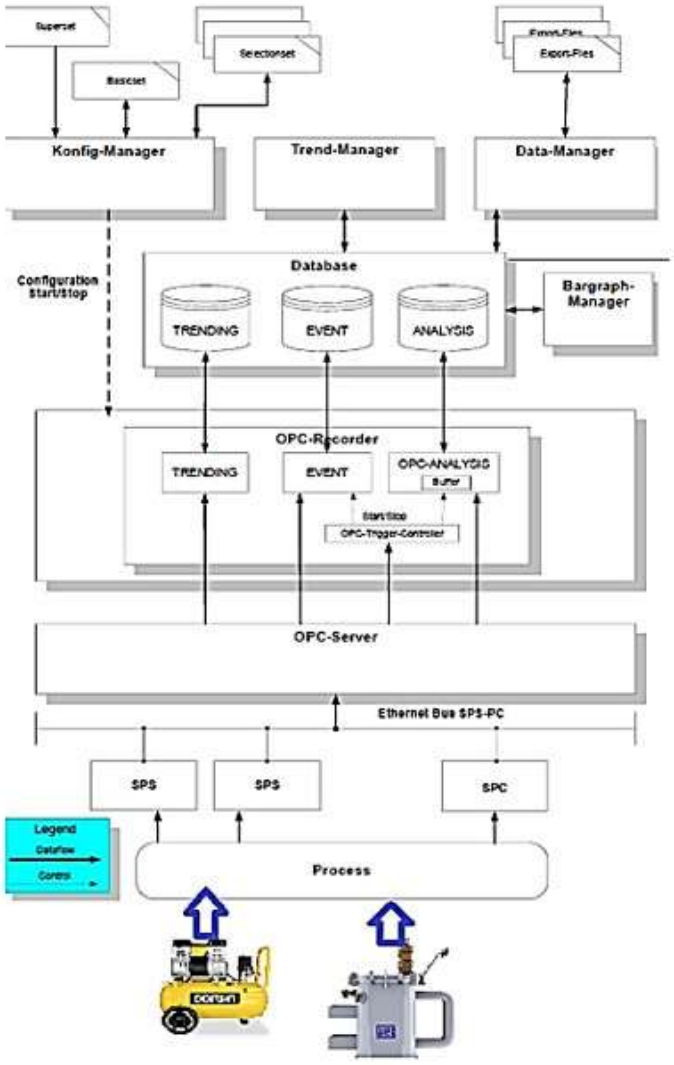

Figure 2. Process map example.
Source: Research Team.

4. Review of the organizational structure.

It is a diagram or matrix of organizational roles and responsibilities that should be disseminated and well-known throughout the organization.

The organizational structure will also define the work team for its energy management; this team will be responsible for measuring, improving, and reporting indicators.

Figure 3 shows an example of a typical scheme of the activities of a production process.

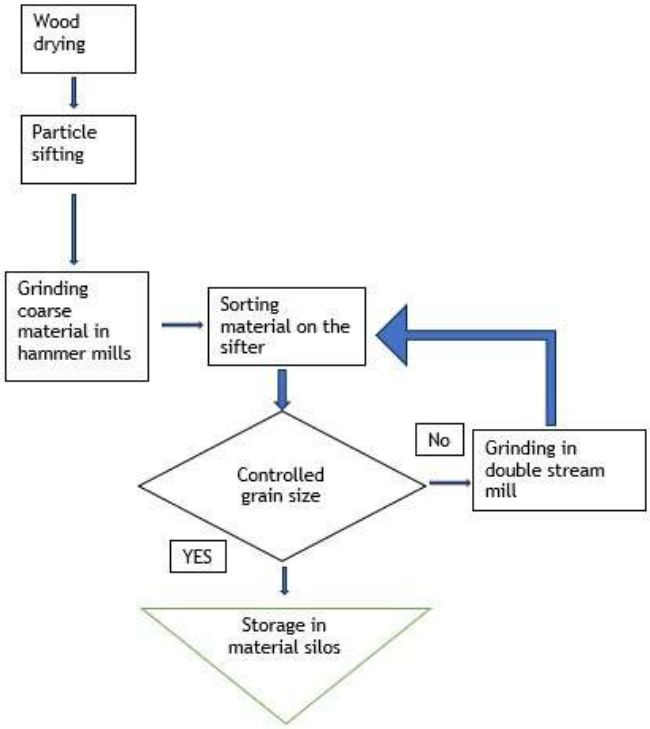

Figure 3. Example of a typical outline of the activities of an established process.
Source: Research Team.

5. Review of the documentary structure.

A matrix must be prepared with the minimum legal requirements required. Its permanent updating must be guaranteed. Each document must be assigned the items of the standard to which they are related.

Figure 4 shows an example of a table of the energy consumption of a computer.

	ATLAS 1: Atlas Copco GA160			
	MEDIA A	MEDIA B	MEDIA C	TOTAL ENERGÍA
05/07/2023 18:40:00	63.95	56.12	57.13	177.20
05/07/2023 19:00:00	64.18	56.43	57.66	178.27
05/07/2023 20:00:00	64.13	56.38	57.59	178.09
05/07/2023 21:00:00	63.31	55.48	56.79	175.59
05/07/2023 22:00:00	64.58	56.71	57.96	179.25

Figure 4. Example consumption table.
Source: Research Team.

6. Estimation of resources, deadlines, and costs.

You must have an allocation of resources, both human and budget; you must demonstrate that the company invests in achieving improvements. The implementation timelines of an average EMS vary from 6 to 12 months and are developed through 4 major stages [8]:

- Gap analysis and action plan.
- Design of energy management model.
- Implementation of energy management systems.
- Comprehensive verification of the energy management system.

The implementation times will depend on whether the company has previously implemented management systems (ISO 9001, 14000, and 18000).

To calculate the costs of implementing an EMS, the hours of work required for the development of each stage of implementation of the EMS must first be estimated, which will depend on the members of the organization that will participate in each of the stages of implementation of the EMS.

7.- Change Management.

Human behavior change: One of the biggest challenges in implementing an EMS is the change in human behavior. This includes raising awareness among employees about the importance of energy management and motivating them to adopt more efficient practices in their daily work. Education and effective communication are critical to achieving this change.

Leadership and commitment, senior management's participation, and various company levels. The formation of a diversified and multidisciplinary energy management team is essential. As common resistance to change is natural and part of human behavior, it must be worked on breaking the paradigms of the company.

Focus on continuous improvement; a successful EMS depends on medium-term results and maintaining the Deming circle of Plan, Do, Verify, Act in each of our processes. The fundamental principle of sustainability is increasingly to reduce losses and support continuous improvement and is a fundamental pillar of the ISO 50001 certification processes.

8. Definition of energy policy

Inventories of the leading equipment of the production processes and energy consumption must be carried out, and measurements and analysis of hourly, daily, and monthly consumption will be available according to the importance. It must always be remembered that everything is susceptible to change and improvement. A process that needs to be measured cannot be improved. The measurements of consumption parameters and quality standards are imperative in any process. ISO 50001 defines that we must measure and control energy consumption permanently to improve them at all times. Figure 5 shows an example of energy consumption analysis for different compressor operating conditions.

Figure 5. Example of measuring flow vs. rated power of a compressor.
Source: Research Team.

Figure 6 shows a graph of the percentage of energy consumed by each component unit of a production line, showing the consumption rates of the total process.

TOTAL CONSUMPTION [KW]	2.093.868,00
CHIPPING MDF	27920
MDF Transf. Old	957960
MDF Transf. New	204252
MDF SERIES	1.193.060
SAWMILL	116
SOLID WOOD	65.180
AGL 100	29352
AGL 140	33984
AGL 200	28672
AGL 300	53808
AGL 380	2052
AGL 400	40287
AGL 450	46860

Figure 6. Example of measurement of energy balance by production processes.

Figure 7 shows each of the lines' energy consumption of each of the lines as a percentage of the total consumption of the industry.

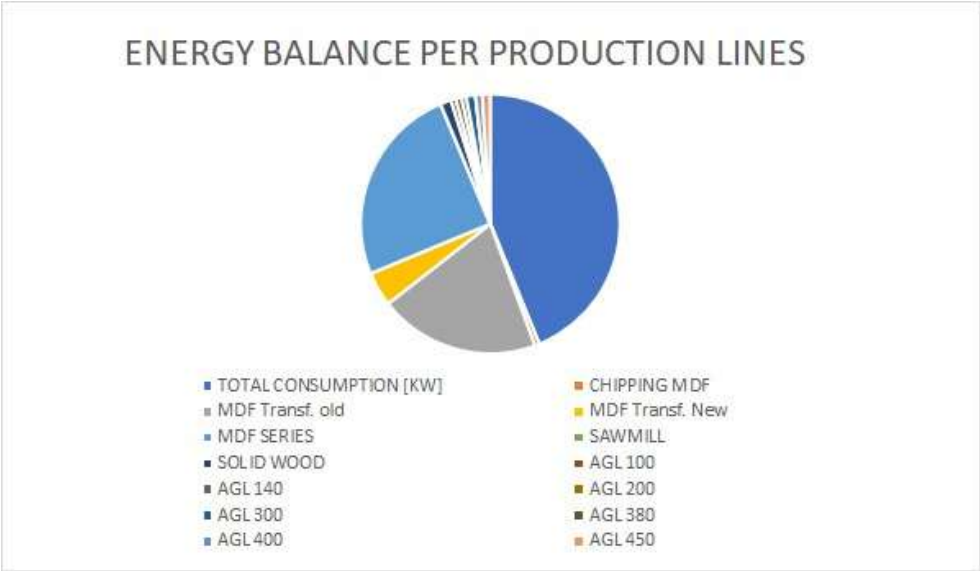

Figure 7. Energy balance by production lines.
Source: Research Team.

Once the inventory of energy consumption has been made, a Pareto analysis must be carried out that will allow us to identify the equipment with the highest energy consumption and the greatest impact (20% of the most significant equipment in the industry consumes 80% of energy resources), this analysis will allow us to devote greater attention to the equipment with the highest energy consumption, guaranteeing us an effective control without the need to analyze trivial equipment. Figure 8 shows an example of a Pareto Chart, a tool for defining improvements.

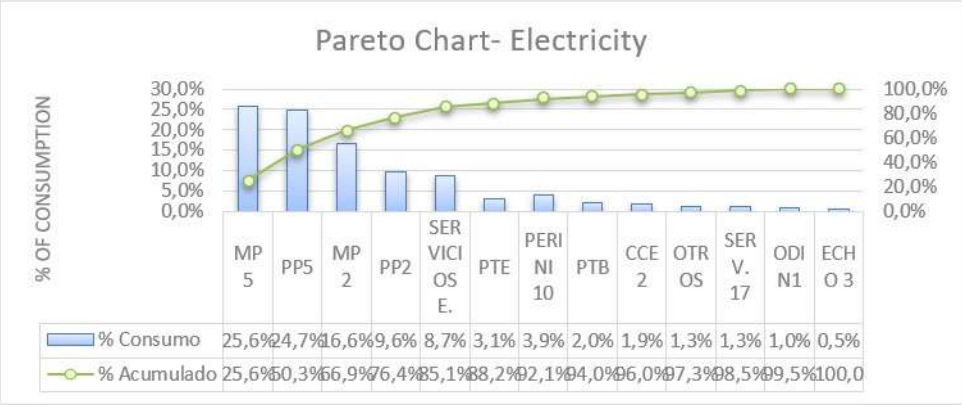

Figure 8. Pareto chart example to define improvements. Source: Research Team.

CONCLUSIONS

Once the equipment with the highest energy consumption has been determined, we must apply continuous improvement tools emphasizing reducing energy consumption, which will optimize production processes.
It will report a detailed description of the energy consumption in different systems or processes within the industrial facility, along with specific indicators to evaluate the performance of each process in terms of energy consumption per relevant unit of measure.

ISO 50001 certification offers many benefits, from economic savings and environmental improvements to improving the organization's image and employee involvement.

REFERENCES

[1] Official Register No. 449. Supplement. "Organic Law on Energy Efficiency." Article 16. Tuesday, March 19, 2019.
[2] NTE INEN-ISO 50001: 2018, IDT. "Energy Management Systems". 2019. Second edition.[3] (2022, November 2022) "Electrification Master Plan – ARCONEL."
[Online]. Available in: https://www.regulacionelectrica.gob.ec/plan-maestro-de-electrificacion/.
[4] Official Register No. 449. Supplement. "Organic Law on Energy Efficiency." Article 3. Tuesday, March 19, 2019.
[5] NTE INEN-ISO 50001: 2018, IDT. "Energy Management Systems". 2019. Second edition.
[6] (2022, November 2022) "Electrification Master Plan – ARCONEL."
[Online]. Available in: https://www.regulacionelectrica.gob.ec/plan-maestro-de-electrificacion/.
[7] De Laire, M. Fiallos, And. (2023, August 8). " Benefits of Energy Management Systems based on ISO 50001 and success stories". Chile. Journal of the Chilean Agency for Energy Efficiency. Fourth edition. 2017. Available in: https://guiaiso50001.cl/guia/wp-content/uploads/2017/05/Casos_exito_correccion9.pdf.