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Methodology for the Successful Integration of an Energy Management System to an Operational Environmental System

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Abstract: Despite the fact that the implementation of ISO 50001 has helped organizations to successfully accomplish energy saving policies, there is still a significant disparity in the number of companies certificated under ISO 50001 compared with other standards such as ISO 14001. Considering the compatibilities between both standards, a potential sector is identified for the integration of ISO 50001 in organizations that operate under ISO 14001 systems. The cost and time associated with the development and implementation of the Energy Management System are identified as being amongst the most important obstacles, restricting the number of companies that are inclined to this energy certification. As an attempt to overcome this limitation, in this work, both standards were analyzed in detail and their coincidences identified and organized to propose a novel methodology that allows companies to naturally integrate an Energy Management System based on ISO 50001 into an ISO 14001 already in operation. The results provide evidence of a strong compatibility among the energy and environmental management systems, allowing enterprises to integrate the former with minimum investment and resources. In order to validate the proposed methodology and to demonstrate the agreement between both programs, these procedures were applied in a manufacturing company of the automotive sector, considered as a high energy consumer according to the classification made by the National Commission for the Efficient Use of Energy in Mexico.

Keywords: ISO 50001; ISO 14001; integration; energy savings; high energy consumption

1. Introduction

Market competition encourages companies to be more efficient through operational and processing cost reduction. It is estimated that in some Energy Intensive Industries (EII), energy expenses can account for more than 30% of the final production cost [1–4]. The continuous increase in oil prices, along with electricity, gas and other energy carriers has a tremendous impact on the economy of Manufacture Industries (MI), but at the same time, provides a window of opportunity for improvement and savings.

Reduction of energy consumption in the industrial sector is recognized as one of the most effective strategies to enhance competitiveness and increase revenue by helping organizations to be protected against scenarios of uncertainty and financial instability. Through the implementation of energy saving programs, the following benefits can be achieved [1,5–8]:

- Better access to certain markets and product differentiation. By implementing energy saving strategies, companies can achieve certifications that will improve their social perception, gaining recognition over the competition and allowing their products to enter in more exclusive markets.
- Decrease the risk and market uncertainty. In a manufacturing plant, the focus is on reaching the production goals and the energy efficiency is rarely observed, frequently causing increments in the manufacturing costs and reducing profits. Saving energy promotes healthier finances, helping companies to avoid temporary recessions.
- Environmental protection. Over the last 15 years, many energy regulations and economic incentives have been introduced in the UK, the E-Union, the USA and many other countries. Some of these regulations and incentives introduced are climate change agreements, EU emissions trading, Carbon Reduction Commitments (CRC), energy efficiency directives or renewable energy obligations. The increased number and strengthening of the environmental regulation have forced organizations to mitigate their environmental impact in order to reach or keep their presence in some regions of the world. Moreover, environmental impact is one of the most publicized topics, meaning that improving environmental performance could result in a rise in demand from "green" customers, who appreciate ecological products.

In 2011, the International Standard Organization (ISO) published the Energy Management System ISO 50001 directed at the implementation of energy saving and energy efficiency strategies. ISO 50001 defines requirements for establishing, implementing, maintaining and improving the Energy Management System (EnMS). Using a structured methodology, it allows organizations to systematically assess and continually improve energy efficiency performance [9].

In recent years, the implementation of ISO 50001 has allowed organizations all over the world to accomplish energy performance improvements, helping companies to achieve environmental regulations, fiscal benefits, selling CO_2 credits and promoting competitiveness [10–14].

Despite the advantages of ISO 50001 implementation, companies tend to focus on reducing their environmental impact through the implementation of the Environmental Management System (EMS) ISO 14001, mainly because of the tightening of international environmental standards [15–18]. In 2015, 319,324 ISO14001 certificates were issued, but in the same year, only 11,985 accreditations in ISO 50001 were issued (despite a remarkable increment of 77% compared to 2014) [19].

The main reasons why companies decide not to invest in an EnMS are related to:

- Energy is not considered as a business strategic opportunity. The International Energy Agency, (IEA) on its report International Energy Outlook 2013 [20] states the following regarding this topic: "In most sectors and countries, energy is a relatively minor component of the calculation of competitiveness, but energy expenditure may be of major importance in energy-intensive industries". This limited energy vision and its potential influence on business productivity, puts energy out of the strategic context of the business.
- EnMS is not considered as a profitable investment. The time and cost associated with the development, implementation and certification processes of an EnMS are relatively high, and are perceived as an expense, not as an investment. This still common thinking in the global industrial environment, clouds a more accurate and realistic vision, in which many companies are already achieving significant economic benefits through the operation of an EnMS.

It has been recognized that ISO 50001 shares a number of compatible requirements related to ISO 14001. Previous works have pointed out the advantages of integrating ISO 50001 into ISO 14001, emphasizing the number of common elements shared and other authors have established comparisons between the standards [21–23]. Nevertheless, due to its particular nature, ISO 50001 includes specific demands that challenge those enterprises planning to introduce the standard, and to the best of the authors' knowledge there is currently no methodology that provides a path to accomplish the integration. To overcome this limitation, in this work, the requirements of both ISO

50001 and ISO 14001 were analyzed in detail and summarized in order to offer a clear outlook of their compatibilities, then a step by step integrating methodology is proposed that allows companies to naturally migrate from the environmental to the combined environmental–energy management system with little investment and resources by performing only minimum adaptations to the infrastructure already designed for ISO 14001.

2. Materials and Methods

Based on the similarities identified in the ISO 50001 to the ISO 14001:2004 management system, a methodology with well identified procedures was developed for the successful and economic integration of the EnMS ISO 50001 to the EMS ISO 14001:2004 already in operation. In order to validate the proposed methodology and to demonstrate the compatibility between both programs, these procedures were applied in a manufacturing company of the automotive sector, considered as a high energy consumer according to the classification made by the National Commission for the Efficient Use of Energy (CONUEE) in Mexico [24].

Based on the information provided by the International Standard ISO 50001 in Annex "B": "Correspondence between ISO 50001:2011, ISO 9001:2008, ISO 14001:2004 and ISO 22000:2005" [25], where the equivalence between chapters of the more akin standards to ISO 50001 are listed, a more thorough and meticulous analysis was performed, oriented to determine the requirements obligations established by the norms ISO 50001 and ISO 14001, to find not only the correspondence, but also their detailed compatibility; differentiating those that "Match", from those that "Partially Match" and finally the "Not Match" requirements.

As a result of the in-depth examination of both standards, the conclusions were summarized in Table 1 as a Compatibility Analysis. This document reveals in detail the affinities and coincidences between the requirements of both standards, and allowed the design of an easy-to-follow methodology, intended to develop the requirements of the EnMS within an EMS already in operation. This methodology is outlined in the Results section, through a diagram that summarizes the plan of actions to carry out the integration, called Integration Diagram. This document presents a general plan that describes the proposed methodology, outlined through the main actions to execute, pointing out the actions that only require the modification of elements already present on EMS from the ones that do not exist and should be generated.

The results of the Compatibility Analysis also allowed the creation of the Documentary Compatibility (described in Results), which summarizes the EMS documentation that is compatible with the requirements of the EnMS. This format reveals the particular documentation that will be modified when applying the methodology proposed in the integration diagram.

Following the indications of the Integration Diagram and the information of the Documentary Compatibility format, the proposed methodology was developed and implemented in a high energy consumption company, the benefits were analyzed and quantified in order to determine the easiness and the energetic impact of the integration of both standards.

3. Results and Discussion

A novel methodology was developed and implemented for the integration of an EnMS ISO 50001 into an EMS ISO 14001 already in operation, in order to take advantage of the benefits presented by the compatibility between the requirements of both standards. The results obtained are shown below.

The in-depth analysis of the requirements of the ISO 50001 and ISO 14001 standards concluded with the creation and completion of the Compatibility Analysis, allowed to know the detailed agreement of the common requirements and thus to quantify the requirements that "Match", those that "Partially Match" and "Not Match". Table 1 lists the number of requirements in each of the seven major sections of Chapter 4: "Energy Management System Requirements" of ISO 50001, classified according to their compatibility with the requirements of ISO 14001.

Table 1. Summary of the compatibility analysis performed between the ISO 50001 and ISO 14001.

Compatibility Analysis of ISO 50001:2011 vs. ISO 14001:2004					
ISO 50001 Requirements			Compatibility with ISO 14001		
Section	**Title**	**Requirements**	**Match**	**Partial Match**	**No-Match**
4.1	General requirements	3	3	0	0
4.2	Management Responsibility	20	10	6	4
4.3	Energy Policy	10	8	0	2
4.4	Energy Planning	42	13	0	29
4.5	Implementation and Operation	38	30	0	8
4.6	Checking	34	26	2	6
4.7	Management Review	16	11	1	4
	Total	**163**	**101**	**9**	**53**

These first results highlight the fact that 101 out of 163 requirements of the EnMS (62%) are compatible with the EMS requirements. The requirements of ISO 50001 have a total of 80 "shall do" statements, which represent an established obligation for the system. Of these, 65% fully match with the requirements of the ISO 14001 EMS, emphasizing the reality of a strong compatibility.

In conformity with the Integration Diagram, the requirements of seven sections were analyzed and classified according to its compatibility degree. This diagram shows in white those requirements that are the same for both systems. Also, in light gray, the requirements that are partially compatible, in which a complement should be incorporated in order to fulfill both systems; and finally, in dark gray, the ISO 50001 requirements that are not included in ISO 14001 and thus should be completely developed.

When analyzing the high correspondence displayed in the Integration Diagram, it is easy to see that a strong coincidence is found along all requirements, only with a marked exception in the requirements related to Energy Planning (Energy Review, Energy Base Line and Energy Performance Indicators) and those applied to the Implementation and Operation (Design and Energy Procurement) which are not included in the EMS due to the nature of the standard. Figure 1 shows a flow diagram of the procedure to develop an energy management system, taking advantage of the existing environmental management system.

After completing the compatibility analysis and having the results breakdown, the Documentary Compatibility format presented in Figure 2 was designed, which intends to make a selection of the operational EMS documentation that is compatible with the EnMS requirements. The aim is to decrease the amount of efforts and resources necessary to develop and implement the new EnMS.

The effectiveness of the methodology proposed was validated through the application in a high energy consumption company, where the process of development and implementation of the requirements of ISO 50001 was applied and successfully validated by the certification ISO 50001 obtained by the company in 4 months, with minimal use of human resources.

In order to measure the magnitude of the benefits obtained by implementing the EnMS within the EMS in the company case study, the savings were quantified in terms of the generation of new documents and/or modification of documents already existing in the EMS in operation, made to comply with the requirements of ISO 50001 and the energy saving per produced unit. The analysis focused on dimensioning the modifications in the documentation by quantifying the change in the number of words in the documents involved.

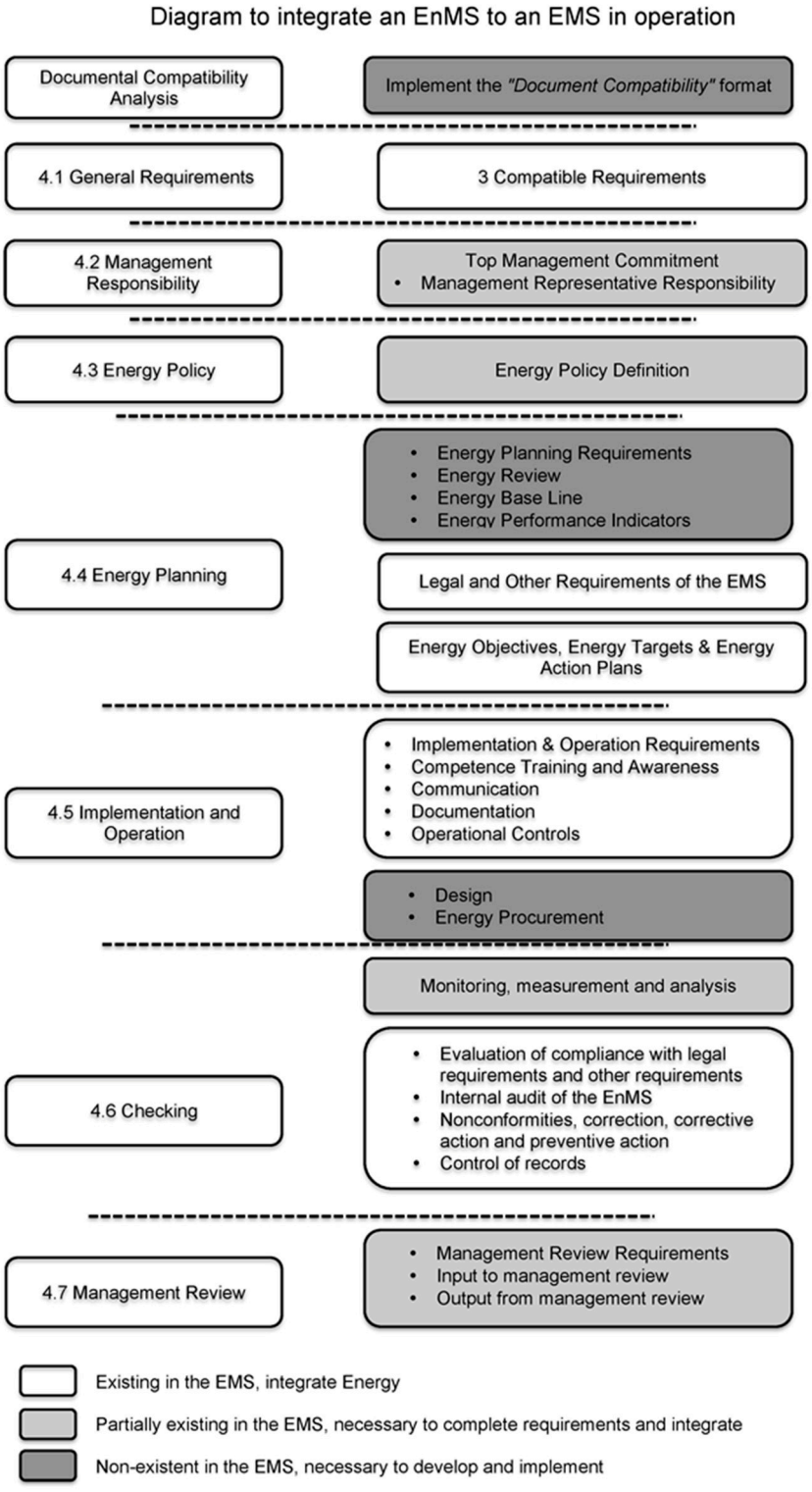

Figure 1. Integration diagram that summarizes the methodology for the integration of the Energy Management System (EnMS) into an operating Environmental Management System (EMS).

The results of the Analysis of Changes in Documentation, shown in Table 2, highlight the benefits in terms of the documentation needs of the EnMS since it has been using the existing documentation in the operating EMS; the achieved savings were of 81.30% in the EnMS documentation.

(1) Those derived from the maturity of the EMS. Developing and implementing the new EnMS in the structure of a mature EMS, facilitates the deployment, understanding and robustness of the new system.

(2) Advantages in the implementation. Making use of the already functional mechanisms, systems, processes and procedures and in the operation of the EMS significantly facilitates training, awareness, implementation, verification and control of the new EnMS.

(3) Savings in the resources for the administration. Management systems require resources for daily operation in both systems such as trainers, document controllers, internal auditors and management representatives. Having a single integrated system, resources are used more efficiently.

(4) Benefits to avoid duplicity of documentation. The integration of the EnMS into the operating EMS avoids duplication of documentation, especially in the one developed to cover common requirements between both systems. Operating the systems separately generates duplicity.

(5) Reduction of time and resources required for development and implementation. As demonstrated in the enterprise case study, by integrating the EnMS with the operating EMS, a high percentage of the requirements are already developed and in operation.

(6) In the first semester after the ISO 50001 integration, an immediate energy saving of 7.88% was measured when the energy consumption per produced unit decreased from 14.60 to 13.45 kW/h, with an estimated monetary saving of $26,500 USD during that period.

Documentary compatibility among ISO 50001: 2011 WITH ISO 14001: 2004

ISO 50001:2011			ISO 14001:2004						
Section	Title	Requirement	Requirement	Title	Section	Manuals / Procedures	Formats	Work Instructions	Others
4.1	General Requirements	1. Shall establish, document, implement, maintain and improve an EnMS.	shall establish, document, implement, maintain and continually improve an EMS	General Requirements	4.1				
		2. Shall define and document the scope and boundaries of its EnMS	shall define and document the scope of its EMS.	General Requirements	4.1				
		3. Shall determine how it will meet the requirements of this standard.	Shall determine how it will fulfil these requirements.	General Requirements	4.1				
4.2.1	Top management (TM), (4.2 Management Responsibility)	Top management shall demonstrate its commitment with EnMS by:							
		1. Defining, establishing, implementing and maintaining an energy policy	Top management shall define the organization's environmental policy	Environmental Policy	4.2				
		2. Appointing a management representative and approving the formation of an energy management team	The organization's top management shall appoint a specific management representative(s)	Resources, Roles, Responsibility and Authority	4.4.1				
		3. Providing the resources needed to establish, implement, maintain and improve the EnMS and the resulting energy performance	Management shall ensure the availability of resources essential for EMS	Resources, Roles, Responsibility and Authority	4.4.1				
		4. Identifying the scope and boundaries to be addressed by the EnMS	shall define and document the scope of its EMS.	General Requirements	4.1				
		5. Communicating the importance of energy management to those in the organization	Shall establish, implement and maintain a procedure(s) to make persons working for it or on its behalf aware of the importance of conformity with the EMS	Competence, Training and Awareness	4.4.2				
		6. Ensuring that energy objectives and targets are established	shall establish, implement and maintain and documented environmental objectives and targets	Objectives, Targets and Programme(s)	4.3.3				
		7. Ensuring that EnPIs are appropriate to the organization							
		8. Considering energy performance in long-term planning							
		9. Ensuring that results are measured and reported at determined intervals	Shall establish, implement and maintain a procedure(s) to monitor and measure, on a regular basis, the key characteristics of its operations that can have a significant environmental impact	Monitoring and Measurement	4.5.1				
		10. Conducting management reviews	Top management shall review the organization's EMS	Management review	4.6				

Figure 2. Documentary compatibility.

Table 2. Results of the analysis of changes in documentation.

Analysis of Changes in the EMS Documents to Integrate the EnMs				
Quantity	**Document**	**Number of Words in the Document**		
		Original Document	**Integrated Document**	**Difference**
1	Manual	6763	7488	725
23	Modified procedures	39,857	42,800	2943
16	Formats	23,160	24,257	1097
3	Work instructions	4771	5061	290
1	New procedures	Non-existent	2053	2053
7	New formats	Non-existent	2227	2227
3	New work instructions	Non-existent	4608	4608
	Total	**74,551**	**88,494**	**13,943**
	New documents or changes due to integration			**18.7%**

4. Conclusions

(1) The proposed methodology to develop and implement an EnMS integrated into an EMS already in operation is effective and fulfills the function for which it was designed, achieving important benefits for the organizations.

(2) In the company case study, it was shown that, at the document level, a saving of 81.30% of the documentary requirements of the EnMS can be achieved by making use of the proposed methodology, derived from the compatibility with the EMS.

(3) The effectiveness of the methodology was demonstrated when the certification in EnMS ISO 50001:2011 was achieved in four months even with limited resources.

(4) The energy savings accomplished as a result of the integration of the EMS allow the recovery of the costs of implementation and certification in less than a year.

(5) There are currently more than 319,324 ISO 14,001 certificates issued worldwide; the organizations holding such certificates are suitable candidates to make use of the proposed methodology for the integration of the EnMS ISO 50001. These may be interested in knowing the benefits that could be obtained when developing and implementing a new SGEn integrated to its operating GHS and making use of the proposed methodology.

(6) Promoting the advantages associated with the integration of energy and environmental management systems in organizations certified in ISO 14001 could further increase the number of certifications in ISO 50001, especially in those organizations classified as high energy consumers.

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Abbreviations

EII, Energy Intensive Industries; MI, Manufacture Industries; CRC, Carbon Reduction Commitments; CEN, European Committee for Standardization; EnMS, Energy Management System; EMS, Environmental Management System; IEA, International Energy Agency.

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