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Contribution to Energy Management of the Main Standards for Environmental Management Systems: The Case of ISO 14001 and EMAS

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Abstract: The adoption of Energy Management Systems (EnMSs) based on international standards has gained momentum since the ISO 50001 standard was launched in 2011. Before that, the potential to improve the energy management with Environmental Management Systems (EMSs) based on ISO 14001 and EMAS was identified in the literature. However, no in-depth analysis reported in the literature has explored this claim. The need for research is now even more evident with the development of new versions of the standards for environmental management—ISO 14001:2015 and EMAS III. Since many companies that already have a certified EMSs might be uncertain whether to adopt an ISO 50001 based EnMSs, the present work aims to shed light on the contribution of ISO 14001:2015 and EMAS III to energy management. Furthermore, the work summarizes the results of an empirical exploratory study carried out in eight Spanish organizations, four with an EMS implemented and certified based on ISO 14001:2015 and four more with an EMS registered to EMAS III. The findings show that both ISO14001 and EMAS certified organizations carry out energy management practices, even though they have no formal EnMSs implemented. Implications for managers and policy makers are discussed, together with avenues for further research.

Keywords: energy saving and efficiency; energy management; energy management systems; environmental management systems; ISO 14001; Eco-Management and Audit Scheme (EMAS); ISO 50001

1. Introduction

Energy management and efficiency in organizations have been important in the institutional policies of most developed countries in recent years. Energy management and energy efficiency issues are increasingly attracting attention in the academic literature [1–4]. Energy management is also a priority for practitioners as organizations strive to reduce energy waste, meet regulatory requirements, and improve their corporate image [5]. Energy efficiency is linked to commercial and industrial competitiveness, to the benefits of energy security and also to the savings obtained by reducing CO_2 emissions [6]. According to Bondoni [7], energy management is understood as a sensible and effective use of energy, minimizing costs, maximizing profits and improving the competitive position of the company. This is a strategy to adjust and optimize energy consumption, using systems and procedures to reduce energy requirements for each unit of production, while other costs remain constant or are reduced.

Energy is essential to all the operations of an organization. It can represent an important cost in all spheres of activity. The use of energy in a company's supply chain involves transformations from raw materials to recycling [8]. As a result, energy management focuses on optimizing the use of energy with the objective of rational and efficient use without reducing the level of performance.

Through energy management, an organization can find opportunities for improvement in various aspects such as the quality and safety of energy systems. They can identify high consumption points for achieving high levels of energy efficiency. Energy management often contributes to establishing short, medium and long-term goals oriented to optimize the use of energy resources using some or all of the following techniques [9]:

- Use of renewable energy sources
- Replacement of some energy sources
- Analysis of the energy savings of the actions carried out
- Thermal insulation
- Waste management
- Analysis of the environment
- Study of new techniques to produce and save energy
- Economic analysis of management

Many organizations have problems related to energy consumption, including those indicated by the Colombian Servicio Nacional de Aprendizaje SENA [10]:

- Lack of awareness of the impact of energy costs on production costs
- The consideration of energy as expense instead of input
- The lack of planning of energy consumption in the company
- The use of energy control indicators (EnPIs) or, if applicable, the use of a single general indicator such as energy consumption in kWh/ton produced
- The lack of instrumentation necessary for energy control
- Difficulty finding funding to investment in the implementation of energy saving measures and programs
- Lack of benchmarking of energy consumption and efficiency
- The predominant maintenance actions are corrective

To improve all these aspects, the adoption of Energy Management Systems (EnMSs) based on international standards has gained momentum since the ISO 50001 standard was launched in 2011 [11–19]. An EnMS system is frequently confused with the efforts by the companies to save energy, but it has to be taken into account that the concept of energy management is a wider concept that involves many other aspects such as the control, monitorization and conservation of energy in both the public and private sectors of activity [20].

As highlighted in SENA [10], EnMSs help organizations to establish the systems and the necessary processes to improve their energy performance, increasing their energy efficiency and reducing their consumption. In addition, EnMSs contribute to the reduction of greenhouse gas emissions, energy costs and other costs related to environmental impacts. On the other hand, it is very important for organizations to change their culture, as it is difficult to implement energy management without a strategic decision in the company. According to Bondoni [7], the necessary actions for the implementation of an EnMS are:

- Study the standard (including necessary training)
- Conduct research on the subject
- Analyze the specific installations, understanding the standard
- Develop the necessary procedures: energy audit, baseline, energy performance indicators, energy monitoring and control mechanisms and internal audit of the system
- Raise awareness and train staff and external workers

Similarly, the objectives of implementing an EnMS, according to Bondoni [7], in the case of a business organization are:

- Mitigate the problems of energy supply, allowing the company to defer investments.
- Download electricity generation, transmission and distribution systems to increase reserve levels and reduce maintenance frequency, improving the availability.

- Reduce the emission of greenhouse gases.
- Create a more responsible awareness among company employees, external workers and their families.
- Reduce energy costs for companies (direct costs) and for society (subsidies).

The launch of ISO 50001 in June 2011 was a milestone in the promotion of EnMSs as it has international recognition and legitimation due to the previous success of both ISO 9001 and ISO 14001 [21]. As a result, in a very brief period, ISO 50001 is the global reference standard to adopt and certify an EnMS [17]. Previously, the potential to improve the energy management with Environmental Management Systems (EMSs) based on international meta-standards such as ISO 14001, and EMAS (Eco-Management and Audit Scheme) was identified in both the scholarly and the practitioner literature. As underlined in the more recent literature about this subject it has been recognized that the new ISO 50001 standard shares a number of compatible requirements related to ISO 14001 [4]. However, there has been no in-depth analysis reported in the literature that has explored this issue. The need for research is now even more evident following the publication of more developed versions of the standards for environmental management (i.e., ISO 14001:2015 and EMAS III). Considering this potential, the present work aims to shed light on the way in which these two environmental standards promote energy management.

For that purpose, the remainder of this paper is arranged as follows. After the Introduction, a review of energy management standards and energy in environmental standards is presented. The methodology used in the content analysis is then briefly described. The results of the theoretical qualitative analysis carried out on environmental standards are then presented. Then, the findings of an exploratory study aimed at shedding light on the implications for Energy Management of both ISO 14001:2015 and EMAS III are summarized. Lastly, the conclusions are given, and the original contributions of this research are identified.

2. Energy Management Standards and Energy Management in Environmental Standards

First, it is important to emphasize that ISO 50001 is not the first energy management standard in the world. It had been preceded by:

- AS 3595: 1990 and AS 3596: 1992 Energy Management Programs (Australia)
- SS 627750: 2003 (Sweden)
- SenterNovem: 2004 (Netherland)
- VDI 4602-1 Energy management (Germany)
- DS 2403: 2001 (Denmark)
- IS 293: 2005 (Ireland)
- ANSI/MSE 2000: 2008 (USA)
- PAS 99: 2006 (United Kingdom)
- KSA 400: 2007 (Korea)
- SANS 879: 2009 (South Africa)
- China GB/T-xxx 2000x ICS 03.120.10
- STB 1777–2009 (Belarus)
- EN 16001: 2009 (Europe, replaced by ISO 50001 and withdrawn in April 2012)
- BIP 2187: 2009 Principles of Energy and Practice Management: A companion of BS EN 16001 standard: 2009 (British Standard Institution (BSI))

In the proper ISO 50001 standard, an EnMS is defined as a "set of interrelated or interacting elements to establish an energy policy and energy objectives, and processes and procedures to achieve those objectives" [22]. An EnMS requires organizations to [23]:

- Continually improve energy performance, including energy efficiency, energy use and consumption.
- Review energy use, consumption and efficiency at defined intervals.

- Document the methodology and criteria used to develop the Energy Review considering facilities, equipment, systems or processes.
- Establish an energy baseline and identify EnPIs (Energy Performance Indicators) appropriate for monitoring and measuring its energy performance.
- Establish, implement and maintain documented Energy Objectives and Targets.

Nowadays, ISO 50001 has worldwide recognition and it is the global reference meta-standard to adopt an EnMS. ISO 50001 is compatible with ISO 9001, a widely disseminated global standard to adopt Quality Management Systems. Likewise, it is compatible with the ISO 14001 aimed to implement EMSs. Therefore, the ISO 50001 standard could be rather easily adopted with other analogous ISO management standards due to its structure [23]. Even though this ISO standard to adopt EnMSs is suitable for any type of company or organization whatever its size, sector or geographical location, it is notably interesting for companies operating in energy intensive industries. In Table 1, the most important divergences between ISO 14001 and ISO 50001 are shown. It has to be taken into account that the ISO 50001 gives more relevance to the continual improvement of the performance, efficiency, use and consumption of energy [23].

Table 1. Comparison of the ISO 50001:2011 and the ISO 14001:2015 meta-standards.

Index	ISO 50001	Index	ISO 14001	Comments
1	Scope	1	Scope	ISO 50001 focuses on energy performance, including energy use, energy efficiency and energy consumption.
2	Normative references	2	Normative references	Not cited in ISO 50001.
3	Terms and definitions	3	Terms and definitions	ISO 50001 is focused on energy and the standard proposes a set new definitions such as energy performance indicators (EnPIs), energy review, energy baseline or energy consumption.
4	EnMS requirements	4	Context of the organization [2]	ISO 50001 focuses on energy management systems.
4.1	General requirements	4.3	Determining the scope of the environmental management system	-
4.2	Management responsibility [1]	-	-	-
4.2.1	Top management [1]	-	-	-
4.2.2	Management representative [1]	-	-	ISO 50001 puts more clarity on Senior Management Responsibilities; moves Roles and Responsibilities "up front".
4.3	Energy policy	5.2	Environmental policy	ISO 50001 is quite similar to the Environmental Policy and the two can be easily integrated; ISO 50001 focuses on the need for a specific policy in relation to energy which is clearly resourced, documented and reviewed, with the aim to gain energy performance improvements rather than the improvement of environmental performance and the prevention of some problems such as pollution.
4.4	Energy planning	6	Planning	Energy Review (audit) Energy Baseline.
4.4.1	General requirements [1]	6.1.2	Environmental aspects	-
4.4.2 4.4.3 4.4.4 4.4.5 4.4.6	Legal and other requirements Energy review [1] Energy baseline[1] Energy performance indicators [1]	6.1.3 6.2.	Compliance obligations Environmental objectives and planning to achieve them	ISO 50001 underlines that an energy planning process might be consistent with the energy policy. ISO 50001 is more detailed as it includes a review of the past, present and expected energy consumption.
4.5	Implementation and operation	7	Support	-
4.5.1	General	7.1.	Resources	Objectives, targets and management plans must be consistent with the energy policy and the significant energy uses and opportunities rather than related to all environmental aspects.
4.5.2	Competence, training and awareness	7.2. 7.3.	Competence Awareness	-
4.5.3	Communication	7.4.	Communication	-
4.5.4	Documentation	7.5.	Documented information	ISO 50001 emphasizes that the degree of documentation can vary based on the unique condition of different organizations, e.g., scale, types of activities, process complexity, etc.
4.5.5	Operational control	7.5.3	Control of documented information	-
4.5.6	Design [1]	8.1	Operational planning and control	-
4.5.7	Procurement of energy services, products, equipment and energy [1]	8.2.	Emergency preparedness and response	-
4.6	Checking	9.	Performance evaluation	ISO 50001 is more demanding with regards to the stipulation of a minimum set of requirement to be analyzed, measured and, monitored.

4.6.1	Monitoring, measurement and analysis	9.1.	Monitoring, measurement, analysis and evaluation	-
4.6.2	Evaluation of legal requirements and other requirements	9.1.2.	Evaluation of compliance	-
4.6.3	Internal audit of the EnMS	10.2.	Nonconformity and corrective action	-
4.6.4	Nonconformities, correction, corrective, and preventive action	-	-	ISO 50001 strengthens the requirement for the verification of actions taken (i.e., the established energy objectives and targets; and the improved energy performance); and reporting of the verification results.
4.6.5	Control of records	9.2.	Internal audit	
4.7	Management review	9.3.	Management review	ISO 50001 sheds light on the real outputs expected from the Managerial Reviews.
4.7.1	General	-	-	-
4.6.2	Input to management review	-	-	-
4.6.3	Output from management review	-	-	-

[1] Novel parts of ISO 50001 Standard; [2] Novel parts of ISO 14001:2015 Standard with respect to ISO 14001:2008; Source: Own elaboration based on BSI [24], Duglio [25], and Welch [26].

EMAS was developed and launched by a public body, the European Commission, for firms and other organizations to assess, report, and try to improve their environmental performance. EMAS is open to sectors of activity and is applicable worldwide, even though it is focused on the EU [27]. ISO 14001:2015 and EMAS III standards are compared in Table 2. The analysis includes the annexes of both standards.

Table 2. Comparison of the ISO 14001:2015 and the EMAS III meta-standards.

System Element	ISO 14001:2015	EMAS III
Context of the organization	4./4.1./4.2.	Annex I and Annex II part A
Environmental management system	4.4.	Annex II part A
Leadership	5.	Annex II part A
Environmental policy	5.2.	Annex II part A and B1
Organisational roles, responsibilities and authorities	5.3.	Annex II part B2
Planning, environmental aspects and obligations	6./6.1.2./6.1.3.	Annex II part A, part B3 and B4
Environmental objectives and targets	6.2./6.2.1.	Annex II part A and B5
Environmental management programme	6.2.2.	Annex I part A5
Organization and personnel	7./7.1./7.2./7.3./7.4./7.4.1./7.4.2./7.4.3.	Annex I part A, B6 and B7
Manual and documentation	7.5./7.5.1./7.5.2.	Annex II part A
Operational planning, control and emergency preparedness	8.1./8.2.	Annex II part A
Monitoring, measurement, analysis and evaluation	9.1./9.1.1.	Annex II part A
EMS audits	9.2./9.2.1./9.2.2.	Annex II part A and Annex III
Management reviews	9.3.	Annex II part A
Nonconformity and corrective action	10.2.	Annex II part A
Environmental Statement	Not applicable	Annex IV
Sectoral Reference Documents	Not applicable	Article 46

Source: Own elaboration based on ISO 14001 [28] and EMAS [29].

In the academic literature, the contribution of EMSs (ISO 14001 and EMAS) to energy management is an issue that has rarely been studied. Before the introduction of the new ISO 50001, most practitioner and scholarly works underlined the potential of ISO 14001 for energy management but there has been no in-depth analysis reported in the literature that explored that claim. O'Conner [30] and McManus and Sanders [31] indicated in their research that ISO 14001 helped the company (ABB Automation and Honda Transmission Manufacturing) to reduce the costs of energy and of hazardous waste handling and disposal. Moreover, Kirkpatrick and Pouliot [32] stated that integrated programs of pollution prevention can save companies money by improving efficiency and reducing the cost of energy. Similar outcomes have been evidenced in an empirical study carried out in Hong Kong [33]. With regard to EMAS, Morrow and Rondinelli [34] stated that German EMAS registered companies identify the aim to improve the environmental performance. However, the main focus of the cited works was not a comparative analysis and they were based on the initial outcomes of the dissemination of ISO 14001 and EMAS.

Therefore, a research gap is even more evident now, as there are very recent and more developed versions of the standards for environmental management—ISO 14001:2015 and EMAS III. As many companies that already have a certified EMSs might be doubtful about the adoption of an ISO 50001 based EnMSs to improve their energy management practices, the present work aims to shed light on the contribution of the main standards for EMSs—ISO 14001 and EMAS—to energy management.

3. Methods

Research of a descriptive, mainly exploratory, nature was planned, to facilitate greater understanding of the subject.

First, qualitative content analysis was selected for this study [35]. This methodology aimed to systematically analyze text material is appropriate to carry out an in-depth examination of both standards. Official (i.e., institutional), scholarly and practitioner documents for both the ISO 14001 and the EMAS standards were analyzed in depth. In the case of ISO 14001, the main reference and practitioner books that have analyzed the standard were examined (for this purpose, the literature reviews by Heras-Saizarbitoria and Boiral [21] and Boiral et al. [36] were used as a basis). In the case of EMAS, the same procedure was followed (the literature review was based on Testa et al. [37] and Heras-Saizarbitoria et al. [38]). The Spanish and English versions of ISO 14001:2015 and EMAS III were used in the analysis, together with scholarly and practitioner works that have analyzed and compared both the standards (e.g., [34,39,40]). Similarly, institutional documents were also analyzed. In the case of EMAS III, the qualitative content analysis focused on the Sectoral Reference Documents (SRD), including reference documentation and benchmarks for best environmental management practices for different sectors. The introduction of these SRD was a result of the process of review of EMAS III, adopted in regulation (EC) No. 1221/2009, which went into force on 11 January 2010. These SRDs are prepared for sectors identified as priorities for EMAS regulation based on their environmental impact and/or their suitability for the adoption of EMAS III. To date only two SRDs have been published for the Tourism and Retail trade sectors. Best practice reports have also been produced and SRDs are being prepared for Construction, Food and Beverage Manufacturing, Public Administration, and Agriculture. For other sectors, the best practice reports and SRDs are still being prepared, but preliminary documents exist which may be used as a source of information on the scope and development process. Those sectors are Car manufacturing, Manufacture of electrical and electronic equipment, Manufacture of fabricated metal products, Waste management, and Telecommunications. Those documents are on the website of EMAS [27]. The mentioned reference standards for EMS are analyzed in the basis of their specific requirements because, as it has been underlined in both the practitioner and scholarly literature (e.g., [21,36]), reference standards for EMS are implemented and certified in the basis of their specific requirements, even though some organizations could go beyond those requirements.

Figure 1 summarizes the research framework and the main specific documents analyzed in our study to follow better the analysis that was carried out and the outcomes of that analysis.

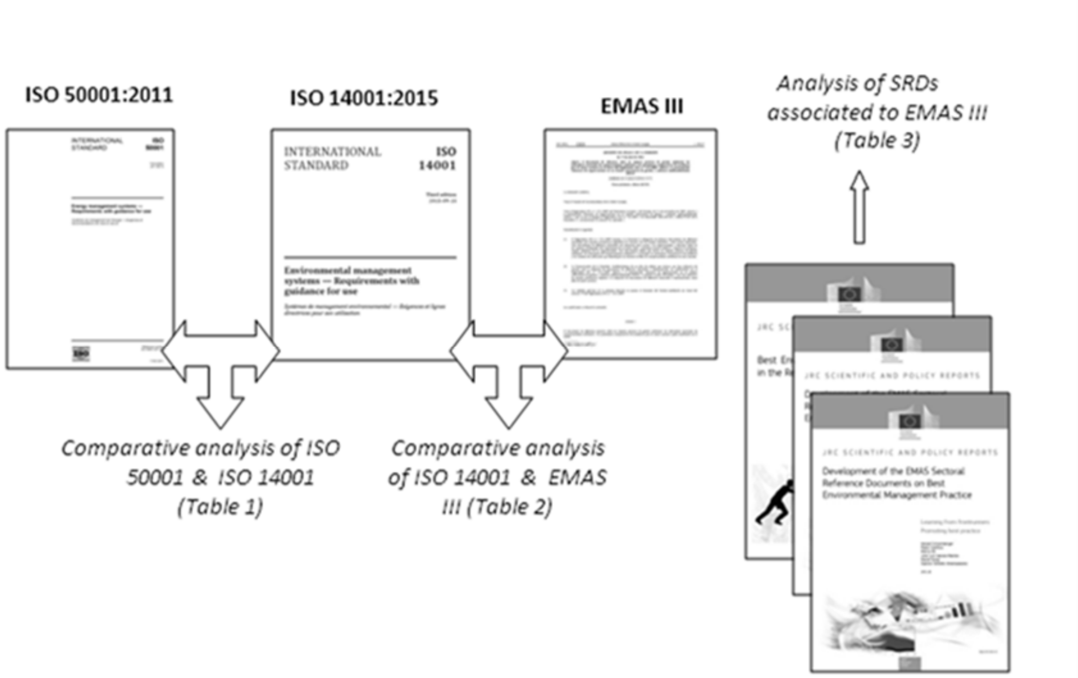

Figure 1. Summary of the research framework, main specific documents analyzed and main findings.

Second, an exploratory study aimed at facilitating greater understanding of the implications for Energy Management of both ISO 14001:2015 and EMAS III was designed. More specifically, eight case studies focused on the Hospitality sector were analyzed: four hotels with an EMS implemented and certified based on ISO 14001:2015 and four more hotels with an EMS registered to EMAS III. The Hospitality sector and hotels were selected due to the relevance of this economic sector in the country were the study was carried out and due also to the relevance of Energy Management in this sector (see Section 4.1.2.12). To maintain the anonymity of the participant organizations, all the firm names in this fieldwork are replaced with numbers. The fieldwork was carried out in Spain, and was developed between May 2017 and October 2017. Interviews were conducted with the managers in charge of the EMSs. Interviews were carried out face to face and by phone were needed in order to adapt to the availability of the respondents. Similarly, a broad range of corporate documentation related to the implemented and certified or registered EMSs were analyzed in depth. Documentation such as the environmental policy of the organizations, their environmental statements, brochures, website and internal audit reports were analyzed, among many others.

4. Results

4.1. Content Analysis of ISO 14001:2015 and EMAS III

4.1.1. Energy Management Aspects in ISO 14001:2015

Although energy could be included as an aspect in the majority of organizations with a certified EMS based on ISO 14001:2015 [28], the standard makes little reference to the use of energy. Generally speaking, energy aspects are often overlooked and organizations concentrate on the more obvious environmental aspects, such as chemicals, water and waste.

Some specific aspects have to be underlined. In ISO 14001:2015 there are direct and indirect references to the use and saving of energy. In Section 3.2.7 of the standard—Prevention of pollution, the standard states that: "Use of processes (3.3.5.), practices, techniques, materials, products, services or energy to avoid, reduce or control (separately or in combination) the creation, emission or discharge of any type of pollutant or waste, in order to reduce adverse environmental impacts (3.2.4)". The footnote to this section remarks that, "Prevention of pollution can include source reduction or elimination; process, product or service changes; efficient use of resources; material and energy substitution; reuse; recovery; recycling, reclamation; or treatment". The standard suggests reducing energy consumption in processes to minimize environmental impact, eliminating or replacing it with clean energy.

In addition, in Section 5.2—Environmental Policy, the standard states that: "…b) includes a commitment to the protection of the environment, including prevention of pollution and other specific commitment(s) relevant to the context of the organization". The footnote to this section remarks that, "Other specific commitment(s) to protect the environment can include sustainable resource use, climate change mitigation and adaptation, and protection of biodiversity and ecosystems". In this part, the standard also promotes the use of renewable energy.

In Section A.6.1.2—Environmental aspects, it states that: "When determining environmental aspects, the organization considers a life cycle perspective. This does not require a detailed life cycle assessment; thinking carefully about the life cycle stages that can be controlled or influenced by the organization is sufficient. Typical stages of a product (or service) life cycle include raw material acquisition, design, production, transportation/delivery, use, end-of-life treatment and final disposal. The life cycle stages that are applicable will vary depending on the activity, product or service". The following information is included in this section: "When determining its environmental aspects, the organization can consider: (a) emissions to air, (e) use of energy and (f) energy emitted (e.g., heat, radiation, vibration (noise), light), between others". In this case it is also clear that the standard recommends controlling the use of energy to minimize emissions.

Finally, in Section 8.1—Operational planning and control, the standard states the following: "The organization shall ensure that (an) outsourced process (es) is (are) controlled or influenced. The type and extent of control or influence to be applied to the process (es) shall be defined within the environmental management system. Consistent with a life cycle perspective, the organization shall consider the need to provide information about potential significant environmental impacts associated with the transportation or delivery, use, end-of-life treatment and final disposal of its products and services". In this case, the standard suggests controlling all the processes from the raw materials to the end of life of the product. Energy is one aspect of this control.

4.1.2. Energy Management Aspects in EMAS III

EMAS has evolved in an interesting way. As other global meta-standards (e.g., ISO 14001), the EMAS scheme has been updated and there are some relevant modifications that perhapr go beyond a rather simple restyling of the standard for EMSs. In the more recent version of 2010 (EMAS III), perhaps one of the most relevant new requirements of the meta-standard is related to the need to establish a set of core indicators of environmental performance [29]: Energy efficiency; Material efficiency; Water; Waste; Biodiversity; and Emissions. Aspects relating to energy appear in the SRDs. In the following paragraphs, the most important sections have been synthesized, because energy appears indirectly in many sections. Table 3 shows the energy efficiency indicators and Table 4 the best practices or specific best practices of each sector.

4.1.2.1. Retail Trade Sector

In the SRD for Retail Trade [41], energy has a specific part in Section 2 of the document, best environmental management practices. Section 2.1 of the SRD is titled "Best environmental management practices to improve the energy performance of the retail trade sector". This subsection is divided into six parts and, in the last, specific reference is made to best energy management practices. For example, topics about the retrofitting the building envelope for optimal energy performance (2.1.6.1), the design of new and existing premises for Heating, Ventilation and Air Conditioning systems (2.1.6.2), the use of integrated design concepts for buildings (2.1.6.3), the integration of refrigeration and heating, ventilation and air conditioning (HVAC) (2.1.6.4), the monitoring of stores in the energy management system (2.1.6.5), efficient refrigeration (2.1.6.6), efficient lighting (2.1.6.7), simple secondary measures for reducing energy consumption (2.1.6.8) and the use of alternative energy sources (2.1.6.9) are included. In addition, in the section on transport and logistic operations, sub-sections such as green procurement and environmental requirements for transport providers (2.3.4.1), efficiency monitoring and reporting for all transport and logistic operations (2.3.4.2), integrating transport efficiency into sourcing decisions and packaging design (2.3.4.3) and the shift towards more efficient transport modes (2.3.4.4) are included.

4.1.2.2. Tourism Sector

The SRD for the Tourism sector [42] includes a specific section on energy management in general, Section 7. There are some specific subsections such as minimizing energy consumption in accommodation buildings which has subsections about the energy monitoring and management systems (7.1), improvements in building envelope (7.2), the optimization of HVAC systems (7.3), the efficient application of heat pumps and geothermal heating/cooling (7.4), the efficient lighting and electrical equipment (7.5) and renewable energy sources (7.6). Moreover, the document has a set of subsections about restaurant and hotel kitchen best environmental management practices (in Section 8), campsite best environmental management practices in (in Section 9) and best references for micro, small and medium sized enterprises (in Section 10). These sections contain relevant subsections that directly and indirectly deal with energy management aspects such as "optimized dish washing, cleaning and food preparation (8.3), optimized cooking, ventilation and refrigeration (8.4), campsite efficiency and renewable energy installation (9.3) and alternative financing of energy efficiency measures for SMEs (10.4).

4.1.2.3. Construction Sector

The SRD of Construction Sector [43] is not a finished document, and the latest draft version dates from 2011. Energy aspects can be found in several parts. For example, in the section devoted to building design (Section 2), there are a set of subsections such as building envelope (3.4.1.), good examples like Passive House approach (3.4.2), heating, ventilation, air conditioning (3.3.3.3), lighting (3.3.3.4) and the use of renewable energy sources (3.4.5) that are very relevant guidelines for energy management. Similarly, in Section 5—Construction and refurbishment, there is a subsection about the improving energy efficiency and reducing pollution from engines (5.6.2.8). Although there are some indirect references to energy, the last direct mention is in Section 6, Building operation and maintenance—more specifically, in the subsection related to the energy demand (6.3.1.).

4.1.2.4. Public Administration Sector

The Public Administration SRD [44] is also a work in progress; the latest version is dated June 2015. It has a specific section about best environmental management practices for sustainable energy and climate change, Section 3. There are some subsections such as energy efficient street lighting (3.2.1), energy efficiency of public buildings (3.2.2), efficiency of social housing (3.2.3), energy performance and monitoring (3.2.5) and the implementing on-site renewables (3.2.7), among others. In Section 4, there are best environmental management practices for mobility and fostering cycling and walking (4.2) to reduce fuel consumption.

4.1.2.5. Agriculture Sector

Another document that is in draft, the latest version dating from 2015, is the Agriculture sector [45]. In this case, there is no specific section for energy. The document is divided by product groups and farm types, and there is information about energy aspects in each part. For example, energy management is addressed in subsections such as energy and water efficiency (3.5.) in Section 3—sustainable farm and land management, in energy efficiency measures in protected horticulture (12.1) in Section 12—protected horticulture. Although concepts related to energy can be found throughout the document, some specific subsections provide information about energy management in real cases. For example, there are subsections titled embed benchmarking in environmental management (3.2), select lower impact synthetic fertilizers (5.4) and anaerobic digestion of organic waste (9.2).

4.1.2.6. Food Beverage Manufacturing Sector

The latest draft of the SRD for the Food Beverage Manufacturing Sector [46] is from June 2015. In Section 3, which is general, there is a specific subsection about energy, deploying energy management and energy efficiency throughout all operations (3.8). The next parts of the document are for different products such as coffee (Section 4), olive oil (Section 5), soft drinks (Section 6), beer (Section 7), meat and poultry meat products (Section 8), fruit juice (Section 9), cheese (Section 10), bread, biscuits and cakes (Section 11) and wine (Section 12). There are many references to the use of energy, in subsections such as reduction of energy consumption through the use of green coffee pro-heating in batch coffee roasting (4.4.1), reducing energy consumption in worth boiling (7.4.2), CO_2 recovery in beer production (7.4.4), minimizing energy consumption for baking (11.4.2), and reducing water use, organic waste generation and energy use in the winery (12.4.1).

4.1.2.7. Car Manufacturing Sector

The latest version of the SRD for Car manufacturing sector [47] is from December 2016. In the Section 3, best environmental management practices for car manufacturers and suppliers, there is a subsection on energy management (3.2). In this subsection topics addressed include implementing detailed energy monitoring and management systems (3.2.1), increasing the efficiency of energy-using processes (3.2.2), the renewable and alternative energy use (3.2.3), the optimization of lighting in automotive manufacturing plants (3.2.4), the rational and efficient use of compressed air (3.2.5) and the optimization of electric motor usage (3.2.6). As in other SRD, there are several references to energy throughout the document, in topics about transport, Life Cycle Assessment (LCA) and the handling of end-of-life vehicles.

4.1.2.8. Electrical Equipment Manufacturing Sector

The SRD for Electrical and electronic equipment manufacturing sector [48] is still in draft, the latest version dating from December 2016. Some direct references to energy are made in the subsection energy and climate change (2.4.5) within environmental aspects (2.4). Several subsections make direct reference to energy, such as energy-efficient clean room technology (4.2.1), energy-efficient cooling (4.2.2), energy-efficient reflow soldering (4.2.3) and use of renewable energy (4.2.9). Indirectly, the subsection rational and efficient use of compressed air (4.2.7) could also be associated with energy management.

4.1.2.9. Fabricated Metal Product Manufacturing Sector

The latest version of the SRD for Fabricated metal product manufacturing sector [49] is from December 2015. In Chapter 2—Best Environment practice, more specifically in the subsection titled Best environmental management practices for the supporting processes (2.2), some aspects of energy are analyzed: energy management (2.2.5), efficient ventilation (2.2.6), optimal lighting (2.2.7), energy and water savings of cooling circuits (2.2.8), efficient use of compressed air systems (2.2.9) and reduction of standby energy of metal working machines (2.2.10). Similarly, in the subsection Best environmental management practices for the manufacturing processes (2.3), more subsections about energy such as hybrid machining as a method to reduce energy consumption (2.3.7) or reduce the energy for paint booth HVAC with predictive control (2.3.9) can also be found.

4.1.2.10. Waste Management Sector

The draft SRD for the Waste management sector [50] is from May 2016 and the background report has also been published. There is no specific section about energy, but, throughout the document, there are references to energy management. For example, the following subsections could be highlighted: renewable energy (2.3), life cycle assessment of waste management options opportunities (2.4), bioenergy, residual waste and recycling/energy recovery (3.5.1), fuel consumption in transport (3.9.7) and energy recovery in incineration (3.11.2).

4.1.2.11. Telecommunications and ICT Sector

The last SRD refers to Telecommunications and ICT Services Sector [51], and the background report was published in October 2016. In this document there are also some guidelines for energy management. In Section 2—cross-cutting measures, there are subsections about energy such as optimizing the energy consumption of end-user devices (2.4) and the use of renewable and low-carbon energy (2.5). In Section 4—telecommunication networks, there are subsections such as improving the energy management of existing networks (4.2) and selecting and deploying more energy-efficient telecommunication network equipment (4.4).

4.1.2.12. Summary of Energy Management Aspects in EMAS III

Considering the content analysis carried out, it should be noted that EMAS III gives importance to energy management aspects. EMAS III proposes energy efficiency indicators for the different sectors of activity (see Table 3). In almost all sectors of activity, main Sector Units (SUs) are mentioned, together with Energy Efficiency Indicators (EEIs) and Benchmarks of excellence/Specific benchmarks (BE). The content analysis of the SRDs, and best/specific practices of each sector of activity are summarized in Table 4.

Table 3. Summarizes the main aspects related to Energy efficiency in the mentioned SRDs.

Sector	Sectoral Units (SU)—Energy Efficiency Indicator (EEI)—Benchmarks of Excellence/Specific Benchmarks (BE)
Retail Trade	SU: per m^2 of sales area. EEI: MJ/tkm; diesel consumption l/tkm; diesel consumption of HGVs: l/100 km per Transport mode and major route. BE: ≤40 kWh/m^2yr (new buildings); ≤55 kWh/m^2yr (existing buildings); heat consumption of 0 kWh/m^2yr; consumption of centralised refrigeration of 3000 kWh/m^2yr; power consumption <12 W/m^2 for supermarkets and <30 W/m^2 for specialist stores; net zero energy building.
Tourism	SU: guest-night; kg textile; passenger-km. EEI: W/lumen (lighting equipment). BE: Total electricity consumpt. ≤80 kWh m^2yr; ≤2.0 kWh per guest-night (For campsites); for existing buildings → HVAC and water heating ≤75 kWh, or total final energy consumption ≤180 kWh, per m^2 heated and cooled area per year; installed lighting capacity <10 W per m^2 or lighting electricity consumption <25 kWh/m^2yr (heated and cooled floor area); total laundry process energy consumption ≤2.0 kWh per kg.
Construction	SU: m^2; employee. EEI: Lumens per m^2. BE: Building design: the building (new) is designed according to the Passive House → <15 kWh/m^2yr for heating and cooling and <120 kWh/m^2yr of primary energy demand; the building (existing) is retrofitted according to the Passive House: <25 kWh/m^2yr for heating and cooling and less than 120–132 kWh/m^2yr. installation for heating or cooling <10 W/m^2; net zero energy building; specific lighting planning (y/n).
Public Administration	SU: employee/annum; floor area and year; inhabitant; street kilometer. EEI: Lamp (luminous) efficacy (lm/W); Photometric luminaire Efficiency (%); ULOR (%); Luminous power (klm/km); Percentage of water heating provided by on-site renewable heat generation (%); Modal share of journeys (% of journeys made by car, motorbike, public transport, cycling and walking). BE: Non-residential Passive house: Total specific primary energy demand ≤120 kWh/(m^2/annum), specific space heating demand ≤15 kWh/(m^2/annum) or alternatively: heating load ≤10 W/m^2, specific useful cooling demand) ≤15 kWh/(m^2/annum); annual energy consumption for street lighting <6 MWh/street km yr; for new buildings: Passive House → heating and cooling <15 kWh/m^2yr and a total primary energy use <120 kWh/m^2yr; for existing buildings: heating and cooling <25 kWh/m^2yr and a total primary energy use <132 kWh/m^2yr.
Agriculture	SU: kg/tonne product—year; m^2; yield; animal. EEI: Tractor fuel (diesel) use (L/ha/y). BE: Combined energy consumption for heating, cooling, lighting and manufacture of carbon dioxide (if applicable) must consist of at least 80% of renewable energy sources, on an annual basis.
Food and Beverage	SU: m^2/yr; kg net product; m^3/pallet; t. EEI: Coefficient of performance (COP). Coefficient of service performance (COSP); Energy efficiency ratio (EER); % of truck empty runs; % of deliveries carried out through; Number of brews before cleaning the boiling system again; Evaporation rate (%) in wort boiling (different in case of one-phase or two-phase). BE: Use 100% natural refrigerants in all sites (Y/N); HGV average fuel consumption ≤30 L/100 Km; install a wort pre-heating system with recovered heat from wort vapour condensing; implement on-site or nearby renewable energy generation for specific suitable manufacturing processes (Y/N); process technologies are adapted to better match the supply of heat from renewables (Y/N); temperature-controlled warehouse insulation is optimised (Y/N); evaporation rate during wort boiling is <4%.
Car manufacturing	SU: functional unit per year; plant. EEI: average efficacy of luminaires (lm/W). BE: Implementation of improved positioning, energy-efficient lighting (% of lighting areas within a site, % of total sites); number of facilities with implemented certified EnMSs (%); number of facilities with adequate energy monitoring systems (%)—Reduction in energy consumpt for customers: percentage of 1st tier (direct) suppliers (by number or by purchasing budget/value) that comply with required standards according to internal or external audits; self-assessment questionnaires are sent to direct high risk suppliers (Y/N); direct supplier development and training is undertaken (Y/N); % of electric motors with VSD installed; % of pumps with VSD installed; [average] pump efficiency (%);
Electrical and electronical manufacturing	SU: m^2 of preceed printed circuit board; kWc/cm^2 of silicon wafers; unit of turnover (€); m^2 of PCB. EEI: Air Change Rate (number/hours); water conductivity (μS/cm); air leakage index (Nl/min); coefficient of Performance (COP) for individual cooling equipment. Coefficient of System; kg of nitrogen/m^2 of PCB). BE: Electricity use of the compressed air system per unit of volume at the point of end use <0.11 (kWh/m^3) for installations working at 6.5 bar effective; normalised Emission Rate for perfluoro compounds emissions <0.22 (kg CO_2eq/cm^2); use of cooling cascades (Y/N); use of free cooling (Y/N); use of heat recovery ventilators (Y/N); use of absorption chillers (Y/N); minimisation of the PFC emissions by applying one of the following techniques: applying process optimisation focused on CVD chamber cleaning (Y/N), substituting of PFC gases with lower global warming potential (Y/N), installing remote plasma cleaning technology (Y/N), using POU abatement techniques (Y/N).

Fabricated metal product manufacturing	SU: product; m^3; ton of product; working hours. EEI: KWh/m^3/min at a stated pressure level; % of LED/low consuming light bulbs; % of the lighting controlled by sensors. BE: The overall leakage level 10%; rain-water collection (Y/N).
Waste management	SU: tonne of waste fraction collected. EEI: Cumulative Energy Demand (CED) (MJ/tonne).
Telecommunications and ICT Services	SU: unit of turnover (€); network traffic (Terabyte); m^2); rack Power Usage Efficiency (PUE) (for data centres); WEEE generation (kg or tonnes/unit of turnover (€); Server PUE (SPUE) = (Server Input Power)/(Computation Useful Power). EEI: Energy Reuse Factor (ERF) (Total energy—Reused Energy)/IT energy; Energy Reuse Effectiveness (ERE) = Reuse energy/Total energy centre waste heat; Annual energy savings (kWh) of Clients; Total carbon emissions compensated (in tCO_2eq.). BE: adopt the Clean Development Mechanisms (CDM); share of suppliers that have an environmental management system or energy management system in place (e.g., EMAS verified, ISO 14001 or ISO 50001 certified); share of staff trained at least once on energy savings.

Source: Own elaborated based on the SRDs [41–51].

Table 4. Summarized some Best/specific practices of each sector, mentioned in SRDs.

Sector	Best Practices of the Sector/Specific Best Practice of the Sector
Retail Trade	Stop of selling incandescent light bulbs >75 watt to consumers; end of incandescent light bulb sales; increase the share of CFLs (number) from 10.7% in 2007 to 25% in 2009 and 35% in 2011; increase "A" categories for domestic appliances; explore innovative refrigeration system design and operating practices; use of heat recovery system from in refrigeration plants.
Tourism	Monitoring energy consumption; install efficient automated low-energy lighting systems; use heat pumps and renewable energy options; build or retrofit efficient building envelopes.
Construction	Increasing the performance of insulation; use techniques to improve the performance of walls; use the best options for glazing; improve the environmental performance of roofs
Public Administration	The new residential areas should be within 900 m to a bus or train station; improve street lighting (high pressure sodium—HPS lamps) and use LED traffic lights; ESCO project: 165.000 m^2 building area of energy renovation, include electrical installations and climate envelope; energy retrofit of void social housing.
Agriculture	Farm ploughing trials showed 20% fuel savings by running tyres at the correct pressure; match tractor size to each job; use fuel metering systems and specifying new tractors with on-board fuel monitoring; training days are important to inform operators of the torque curves of the tractors they use; maintenance is importance, for example to keep air filters clean; use of a pre-cooler to reduce the energy requirements of cool storage [52].
Food and Beverage	Performed an LCA to identify hotspots in its processes; produce all of its beer from 100% renewable energy; recommending that customers reduce the time they cook their pasta for, and the amount of water used; use of biological agents instead of traditional detergents; enzymatic CIP procedure; use of ozone in a non-CIP system.
Car manufacturing	Energy demand is measured every 15 min at some 700 monitoring points; implement an EnMS solution from an external provider which monitors all energy and material flows; Energy consumption can be assigned to the respective cost units on a usage-related basis; Plant staff analyse data several times per day and senior management review it every week.
Electrical and electronical manufacturing	Improving the management of the cleanroom and reducing the cleanliness requirements from class 10,000 to class 100,000 (i.e., from ISO Class 7 and ISO Class 8 respectively); better control of the temperature and humidity in the cleanroom; installing a CHP plant (based on natural gas) together with absorption cooling technology, a compressor chilling unit, but also purchasing electricity from the public grid and natural gas heating can be substituted; new VFDs components were installed setting properly the speed according to the load of the cleanroom.
Fabricated metal product manufacturing	Efficient ventilation deals with the minimisation of the ventilation needs; optimal lighting adapted to the specific needs of the production line, storage rooms, utility rooms, offices, etc.; efficient use of compressed air systems by minimising pressurised air needs and optimising the system's design and use; energy and water savings of cooling circuits deals with the systematic approach of reducing the cooling needs, using and optimising the cooling design; the implementation of smart tools (switches, software, PLC steering, etc.) on machines.
Waste management	Use biogas electricity generation; use of recycled aggregate; hub location, route planning and driver training to minimise distance travelled; extra effort of separation at the collection vehicles is greatly reduced; recycling of the manifold mentioned waste fractions; data necessary for LCA of material recycling chains, informing design of the circular economy; incorporate one or more environmental metrics, such as cumulative energy demand and/or CO_2 emissions, into network design and route optimisation algorithms; install an alternative collection system, such as a pneumatic system in urban areas.
Telecommunications and ICT Services	Optimisation of the number of devices used through the use of multifunction devices (such as printers that also makes copies, faxes and scans); multifunction devices consume 50% less energy than the consumption of four separated devices [53]; select more energy efficient equipment such as: chillers with high Coefficient of Performance equipment with variable speed (or frequency) controls for compressors, pumps and fans direct liquid cooled devices.

Source: Own elaborated based on the SRDs.

4.2. Exploratory Study

Table 5 summarizes the main findings obtained in the exploratory work. The exploratory study carried out in eight Spanish Hotels confirms that the certified organizations take advantage of their EMSs to improve their energy management and efficiency, whatever is their motivation to implement and certify the EMS. These results would confirm the previous evidences of the specialized scholarly literature such as the findings of the works carried out by Amundsen [54] and Wagner [55] in the sense that adoption of EMSs proves to be a significant factor in energy management activities.

Nevertheless, in general terms of the implementation and certification, EMS has provided a rather heterogeneous approach to the analyzed firms in terms of improvement in their energy management and energy efficiency and has had also provided a quite diverse indirect effect on the improvement of the environmental performance of the case organizations. As shown in Table 5, this is perhaps more evident in the case of the four organizations where the EMSs were implemented according to ISO 14001 as the reference standard, compared to the cases where the EMSs were implemented against EMAS. The mentioned claim is for example obvious if the main initiatives for energy management that were analyzed in the fieldwork are considered—these main initiatives were obtained from the SRD for EMAS III of the sector of activity of the case organizations. For example, for the specific case of the Implementation of an energy management plan, just one of the four analyzed organizations with an EMS implemented and certified against ISO 14001 had this type of formal plan. Conversely, three of the four analyzed organizations with an EMS defined against EMAS had this type of plan. Similarly, in the case of the organizations certified against ISO 14001 none of them defined any energy performance indicator and conversely, in the case of the EMAS registered hotels, all of the analyzed cases defined a set of energy performance indicators in their respective EMSs.

The in depth analysis of the documentation related to the EMSs of the case organizations evidenced the mentioned heterogeneous adoption of a very diverse set of practices and tools related to energy and environmental management. One plausible explanation of this diverse approach could be related to the role played by the external consultants that assisted companies with the implementation and certification of the EMS. As it was ascertained by one of the interviewed environmental managers a EMAS registered Hotel "*in our case the role played by the external consultants is crucial as they have the expertise to propose us specific tools aimed at improving the energy management of our organizations*". In the case of the EMAS registered organizations, the more homogeneous perspective could be related to the specific effort established in the EMAS III version of the standard regarding the energy management issue.

Table 5. Main findings obtained from the case-studied companies.

	Firm 1	Firm 2	Firm 3	Firm 4	Firm 5	Firm 6	Firm 7	Firm 8
Firms' characteristics								
Number of employees	24	22	43	31	38	39	45	100
First year of ISO 14001/EMAS certification	2007 (ISO 14001)	2009 (ISO 14001)	2011 (ISO 14001)	2012 (ISO 14001)	2011 (EMAS III)	2003 (EMAS III)	2014 (EMAS III)	2015 (EMAS III)
Number of stars	3	4	3	4	3	4	3	4
Adoption of EMSs								
Main motivation (internal/external)	Environmental performance improvement (internal)	Fulfill regulations (internal)	Improvement of the image of the hotel (External)	Strategy of the hotel chain (internal)	Improvement of the image of the hotel (External)	Strategy of the hotel chain (internal)	Strategy of the hotel chain (internal)	Improvement of the image of the hotel (External)
Main difficulty	Lack of knowledge	Motivation of employees	Complex local regulations	Internalization of the EMS	Complex local regulations	Internalization of the EMS	Fulfill regulations	Internalization of the EMS
Time for adoption	14–16 months	12–14 months	18–20 months	15–17 months	18–20 months	14–16 months	18–20 months	16–18 months
Public subsidies	Yes	Yes	No	Yes	No	Yes	Yes	Yes
Training to employees	No	Yes	No	Yes	No	Yes	No	No
External consulting service	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Benefits of the EMSs regarding Energy Management								
Approximated saving in % (per year)	---	3–4%	Very low	1–2%	Very low	1–2%	3–4%	2–3%
Pay off (adoption cost of the standard for EMS)	---	---	Probably never	6 years	6–8 years	6 years	4 years	---
Initiatives for Energy Management								
Implementation of an energy management plan	No	Yes	No	No	Yes	Yes	Yes	No
Energy performance indicators	No	Yes	No	No	Yes	Yes	Yes	Yes
Installation of heat-recovery controlled ventilation	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Monitoring energy consumption	No	Not totally	No	No	Yes	No	Yes	Yes
Efficient automated low-energy lighting systems	No	No	No	No	Yes	No	Yes	Yes
Renewable energy installations	Yes	Yes	No	Yes	Yes	Yes	No	Yes
Green energy certifications	No	Yes	No	No	No	No	No	No
Automatic "turn-off" mechanisms	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Own elaborated by the authors.

Nevertheless, the specialized knowledge related to the specific requirements and guidelines of the EMAS reference standard was rather superficial among the respondents. For example, the relevance of the specific SRD titled "*Sectoral Reference Document on best Environmental Management Practice in the Tourism Sector*" which establishes a set of practical steps aimed to improve the environmental and energy performance of the organizations of the sector was underlined by all the interviewed managers. Surprisingly, just one of the interviewed managers of the EMAS registered organizations evidenced a substantive knowledge of the mentioned SRD.

As a result of the exploratory findings summarized in this article, it seems clear that there is still potential for improvement regarding the energy management and the energy performance through the implementation and certification of either an ISO 14001 or an EMAS based EMS. This finding is even more relevant if it is considered that the fieldwork is focused on a sector of activity whose impact of energy consumption is one of the most relevant environmental impacts.

5. Discussion and Conclusions

The recent launching of the ISO 50001 standard to adopt EnMSs has renewed practitioners' interest in the implications for energy management of EMSs based on ISO 14001 and EMAS. This issue has been under-researched in the scholarly literature. This lack of research is especially evident with the development of new versions of the standards for environmental management—ISO 14001:2015 and EMAS III. This article contributes to the literature shedding light on this issue. First, there are significant differences between ISO 14001:2015 and EMAS III as international references for energy management practices.

ISO 14001:2015, does not specifically emphasize energy management for environmental management purposes. ISO 14001 is an international certifiable standard for the adoption of EMSs as management tools that do not require specific performance levels for energy management. In other words, as underlined by Heras-Saizarbitoria and Boiral [21] and Boiral et al. [36], ISO 14001 is not a performance standard and it does not measure the environmental quality of companies' products, processes or services. Organizations that adopt an SME based on ISO 14001:2015 could integrate energy management aspects into their EMS, but there no specific focus on environmental management as energy management. Surprisingly, ISO 14001:2015, the main global environmental standard, has not established a clear focus on encouraging the use of energy, when this is one of the import topics in environmental management. As a result, as pointed out by Welch [26], ISO 14001 has not been able to engage energy managers.

EMAS III is rather different. Similar to ISO 14001:2015, the standard is procedural in nature. Nevertheless, in the latest revisions, an effort has been made to set specific best environmental management practices and performance measures as a reference (see, for example, ANEC [56]). Similarly, EMAS includes core aspects related to energy management that are different from ISO 14001. In summary, EMAS III requires organizations that adopt the standard to choose the level of energy management and energy performance they need, although they are encouraged to go beyond legal compliance with some specific sectoral best practices, as reported above. However, without mandatory requirements, the standard may be seen as a paper tiger.

In summary, the major weaknesses of the principal schemes for EMS, such as ISO 14001 and EMAS, include a lack of performance requirements and the absence of a mandatory set of comparable performance indicators which would allow for differentiation between good and bad performers in terms of energy management.

The present study also has some implications for managers, policy makers and other stakeholders. Managers interested in energy management should be aware of the shortcomings of ISO 14001 and EMAS so that they can integrate energy aspects into their EMSs. The distinctive contribution of the EMAS III standard should be taken into account by ISO 14001 certified companies to improve their energy management. Policy makers should be aware that some European consumer NGOs (e.g., ANEC and ECOS) have proposed an alternative approach to ISO 14001 and EMAS for the management of energy issues, which should include the establishment of general and sector specific mandatory indicators and benchmarks for energy management, together with minimum performance requirements for energy management (established based on the state-of-the-art for each sector), going beyond legal compliance. Other stakeholders, such as consumers and NGOs, should be aware of the lack of focus on energy management issues in the main reference standards for environmental management.

Finally, regarding potential avenues for further research, it could be interesting to carry out a comparative analysis of national reference standards for EMSs and EnMSs, even though most national standards use to be transpositions of the main international standards. Similarly, it could be interesting to broaden the objectives and the scope of the exploratory study to carry out a quantitative study of the real outcomes in terms of energy management and energy efficiency of the implementation and certification of ISO 14001 and EMAS in companies belonging to very diverse sectors of activity. Furthermore, it could be interesting to analyze the real added value of implementing and certificating an EnMS in companies with a certified EMS.

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