energies

MDPI

Article

Comparative Study of an Energy Information System and Energy Management System According to ISO 50001

Ebagninin Séraphin Kouaho [1,*], Yao N'Guessan [2] and Christophe Marvillet [1]

[1] LAFSET-Laboratoire du Froid et des Systèmes Energetiques et Thermiques, 75003 Paris, France; christophe.marvillet@lecnam.net
[2] Unité Mixte de Recherche et d'Innovation 18, Science et Technique de l'Ingénieur, Ecole Doctorale, INP-HB-Institut National Polytechnique Félix Houphouët-Boigny, Yamoussoukro BP 1093, Côte d'Ivoire; yao.nguessan@inphb.ci
* Correspondence: ebagninin.kouaho@lecnam.net

Abstract: Energy management, especially in communities, is attracting growing interest but is often marred by confusion between the terms "energy information system" (EIS) and "energy management system" (EMS). This ambiguity hinders understanding of their uses and roles in improving energy performance. Our objective is to clarify these terms and their contributions to energy management. We used a mixed qualitative and quantitative approach to evaluate and compare the criteria of definition, objective, functionality, and role, as well as correlated elements, such as organizational structure, responsibilities, planning, and policy, according to the requirements of ISO 50001, in addition to criteria specific to the two systems. The study revealed differences in the roles of the EIS and the EMS, with a complementarity of 40% between the two systems depending on the positioning of the EIS in relation to the elements of the EMS process. The EIS plays a crucial role in facilitating the implementation of the EMS according to ISO 50001. This clarification contributes to a better understanding of the respective roles of these systems in energy management, thus helping communities to improve their energy performance in an effective manner.

Keywords: energy information system; ISO 50001; energy management system; energy

check for updates

Citation: Kouaho, E.S.; N'Guessan, Y.; Marvillet, C. Comparative Study of an Energy Information System and Energy Management System According to ISO 50001. *Energies* **2024**, *17*, 5446. https://doi.org/10.3390/en17215446

Academic Editors: Fuzhan Nasiri, Ursula Eicker and Karthik Panchabikesan

Received: 1 July 2024
Revised: 12 August 2024
Accepted: 15 August 2024
Published: 31 October 2024

Copyright: © 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

1. Introduction

The global energy system is the largest source of CO_2 emissions. Global CO_2 emissions from fossil fuels in the energy system increased by 4.6% (1.1% yr^{-1}) between 2015 and 2019, reaching 38 GtCO2 yr^{-1} and accounting for about two-thirds of global annual anthropogenic greenhouse gas (GHG) emissions. In 2020, with the global COVID-19 pandemic, CO_2 emissions from the energy sector decreased by about 2 GtCO2 yr^{-1} (Figure 1). However, global energy-related CO_2 emissions are projected to rebound by almost 5% in 2021, approaching the 2018-19 peak. Reducing emissions from the energy sector is therefore essential to limit warming. The energy systems of the future will look very different from those of today if the world is to limit warming to well below 2 °C. Realizing and responding to these changes presents a daunting set of challenges and opportunities [1].

"The conclusions of the European Council of 10–11 December 2020 endorsed the Union's binding domestic reduction target for net greenhouse gas (GHG) emissions of at least 55% by 2030 compared to 1990. The European Council concluded that the climate ambition needed to be raised in a manner that would spur sustainable economic growth. In its Communication of 19 October 2020 entitled "Commission Work Programme 2021", the Commission announced a legislative package aimed at achieving a climate neutral European Union by 2050. The package covers a number of policy areas, including energy efficiency, renewable energy" [2]. And COP 23 was a key moment for France to commit to continuing and consolidating the implementation of the Paris Agreement. It is a stakeholder in the various international and European commitments that have an impact on climate,

energy, and air quality issues. International and national targets are essential to frame the actions of states in the fight against climate change [3].

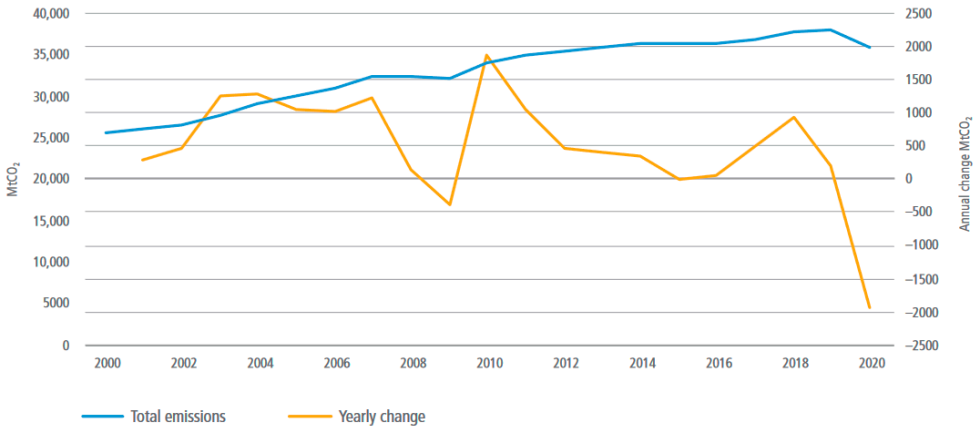


Figure 1. Global energy sector fossil fuel CO_2 emissions and annual change 2000–2019 (MtCO2 yr^{-1}). Source: adapted from Minx et al. (2021a); Crippa et al. (2021) [1].

As part of the energy and climate policy of the Évreux Porte de Normandie (EPN) community, which includes 74 municipalities, the General Management has decided to optimize energy management in order to reduce energy consumption. This initiative is reflected in the implementation of an Energy Management System (EMS) in accordance with the ISO 50001 standard [4] in a pilot commune of the EPN agglomeration. This international standard, related to the ISO 9001 and ISO 14001 standards, aims to promote best practices in energy management and a reduction in greenhouse gas (GHG) emissions. The adoption of the EMS has already led to an improvement in energy performance indicators, resulting in an immediate reduction in energy consumption, while the impact on GHG emissions will be felt in the long term. By 2030, this approach could prevent the emission of 6500 million tons of CO_2. To achieve this goal, it is essential to spread the standard to as many private and public structures as possible, in various industrial and administrative sectors worldwide [5]. However, a major challenge remains: the lack of awareness among communities of the complexity of energy management, in terms of understanding both the concepts and practical implementation due to the scale of their real estate assets.

Energy management is a complex and time-consuming subject for local authorities according to Aymard Caroline of "DeltaConso Expert". This is because their assets are disparate in terms of use and performance, with a multitude of sites to manage and many regular or occasional users [6]. All of these problems make it difficult to collect energy data from different sources in a heterogeneous environment.

However, in its approach to energy data collection as part of an energy audit, the ISO 50001 standard recommends, in paragraphs "6.6. Planning for energy data collection" and "9.1. Monitoring, measurement, analysis, and evaluation of energy performance and the EMS", the metering system method, which groups together a set of devices for measuring, recording, and analyzing energy performance.

However, when data are collected in an automated manner and used by energy management software, the term "energy management information system" (EMIS) is preferred to "metering system". The terms ISEM (information system and energy management) or EIS (energy information system) are sometimes preferred to EMIS in a fully equivalent manner according to the Technical Energy Environment Association (ATEE) [7]. In Natural Resources Canada's guide and planning tool, the term ISEM stands for "information system on energy management" [8]. For the GIMELEC, a group of companies in the French electronics sector [9], an energy information system (EIS) is similar to an energy management system (EMS) but has a more developed or elaborate data collection function.

In view of these elements of approach or understanding, we note the use of different terminologies to discuss energy management with the same objective of an approach to the continuous improvement of energy performance. In this case, how can these terminologies be reconciled with improving energy performance?

The main objective of this article is to clarify the distinction between an energy information system (EIS) and an energy management system (EMS), an area that has been little explored in research and the scientific literature. Therefore, we try to highlight the objective and functional differences, as well as the epistemological and processual differences, between an EIS and an EMS. This comparative approach will be reinforced by statistical analysis, allowing for a better understanding of the nuances between these two systems that are essential to energy management.

The ultimate goal is to understand the objectives and role of an energy information system (EIS) in relation to an energy management system (EMS). This understanding could facilitate the adoption of the ISO 50001 standard by organizations with significant assets—especially certain communities—by promoting environmental impacts such as reducing their carbon footprint and conserving energy resources, in addition to providing economic benefits such as reduced energy costs and positive human and social impacts through the involvement and effective management of internal teams around collective projects focused on concrete actions.

Clarification of these concepts would contribute to a better understanding of the respective roles of these systems in energy management, thus enabling communities to improve their energy performance in an efficient manner.

2. Methodology

Four main criteria guided our approach: the definition and objectives of the two systems under review and related elements such as organizational structures, roles, and responsibilities, planning, organization operation, and policy in the framework of an energy management system (EMS) according to the ISO 50001 standard. We also considered other aspects of both systems, as well as the positioning of the energy information system (EIS) in relation to the elements of the EMS process. Given that we are in a new research area where there are few or no scientific publications on this topic, our epistemological approach was based on some thirty references from various disciplines, including engineering articles, encyclopedia entries, and thesis work. This enabled us to consolidate the notions and definitions of key terms such as "energy", "system", "information", and "management", as well as specific expressions such as "information system" and "energy management system". This body of literature also enabled us to draw up a conceptual diagram of the flows of an energy information system (EIS) and to use that of the continuous improvement process of an energy management system (EMS) in accordance with ISO 50001.

Given the importance and the stakes of this study, we carefully carried out analyses based on an evaluation protocol defined by the characteristics of the definitions, objectives, functions, roles, and/or principles of the two systems. These analyses were supplemented by the study of four sets of comparative elements of an energy management system (EMS) and an energy information system (EIS) to carry out a qualitative analysis of the dualities of all elements compared. Each element of comparison was analyzed objectively based on an understanding of the meaning given by the standard, the scientific and engineering literature, and Cartesian logic to determine if it was an element of differentiation or complementarity between the two systems. The results of this analysis were converted from qualitative variables into numerical data for quantitative evaluation.

3. Results

3.1. The Energy Concept

According to Feynman [10], energy is a very difficult concept to define: "...It's a very abstract idea, because it's a mathematical principle". The same is true for Poincaré, but

if we project the principle of the concept of energy in all its generality and apply it to the universe, all that remains is this: "there is something that remains constant" [10].

It was Max Planck who first understood the essential significance of this law of conservation of energy; in a work published in 1887 entitled The Principle of Conservation of Energy [11], energy is defined by the fact that it is conserved, and it is identified by the entropy of a physical system according to physicist Etienne Klein in the IFG Parenthèse Culture 22 conference on energy.

According to the Larousse dictionary, energy is a force in action.

We do not claim to provide an academic definition of energy here, given its complexity, but to summarize our understanding of the concept of energy as follows, we could define energy as an invisible force in action characterized by conservation and identify it using a quantity that characterizes the capacity of a physical system to undergo spontaneous transformations.

In other words, energy is an invisible force in action characterized by its conservation and is identified by the entropy of a physical system.

So, to consume energy is to transform low-entropy energy using another form of energy with higher entropy.

3.2. The System Concept

The term "system" is commonly used in almost every field—mathematics, physics, astronomy, physiology, computer science, economics, and finance, to name but a few.

The notion of "system" is defined as follows: "a system is a set of identifiable, interdependent elements, i.e., linked together by relationships such that, if one of them is modified, the others are also modified, and consequently the whole system is modified, transformed. It is also a bounded set, the limits of which are defined according to the objectives (properties, goals, projects, finalities) we wish to emphasize" [12].

To understand systems theory, according to Edgar Morin, we can approach it from two different angles, each within one of the standard paradigms: the analytical approach and the systems approach.

In our study, we will rely on the systems approach, which relates to or affects a system as a whole, looks at the interactions between elements, considers the effects of interactions, relies on global perception, modifies groups of variables at once, and leads to multi-disciplinary teaching [13].

In other words, a system can be defined as an organized totality of endogenously and exogenously interacting elements with the characteristics of the three "sub-levels" of Edgar Morin's systems theory: cybernetics, "systemism", and systemics.

3.3. The Concept of Information

Information is a concept from the discipline of information and communication sciences (ICS). Etymologically speaking, "information" is that which gives form to the mind. It comes from the Latin verb "informare", meaning "to give form to" or "to form an idea of" [14].

The concept of information theory, according to E. Morin, is based above all on the conformity between a message that is transmitted and the message received. It is to be distinguished from communication theory, which is not simply the transmission but the creation and circulation of content [13].

In other words, the term "information" refers to the action of bringing news to the attention of the public and of communicating events and current events, according to the Académie française. From the point of view of computer science, information is an element of knowledge translated into a set of signals according to a given code, with a view to being stored, processed, or communicated [15].

To summarize, we can define the concept of information as the restitution of collected data that have been processed, thus providing a message, explanation, or knowledge of a situation, state, or system, with a view to being stored or communicated.

3.4. The Management Concept

The concept of management is a set of techniques for managing, organizing, and administering an entity to achieve its objectives [16].

Other management approaches consist of the following [17]:

- Setting objectives (strategic and operational);
- Choosing the means to achieve them;
- Implementing these means (searching for efficiency);
- Monitoring implementations and results;
- Ensuring regulation based on this control (governance).

We can thus understand that the concept of management can be defined as an approach based on the following functions: steering (setting strategic and operational objectives), monitoring/evaluating results, organizing, leading, delegating, and directing.

3.5. Energy Information System (EIS)

The first approach to energy information systems (EISs) for buildings defined them as performance monitoring software, data acquisition hardware, and communication systems used to store, analyze, and display building energy data [18].

Public Services and Procurement Canada refers to an information system on energy management (ISEM) as a system that provides relevant information and helps to make energy performance visible to employees and key departments in the organization, enabling them to take concrete actions intended to create financial value for that organization [8].

According to GIMELEC's presentation, an energy information system collects and analyzes consumption data and facilitates the day-to-day management of energy and fluids [9].

An energy information system is, therefore, an organization, an operation, and a set of resources (material, software, data, procedures, human, etc.) that are structured and unstructured and allow the automatic collection, storage, memorization, and processing of energy data into information in order to make it available (in the form of data, texts, sounds, images, etc.) for dissemination within and between organizations.

The objective of an energy information system (EIS) is to collect all of the energy performance—specific and global, internal and external to the organization—in order to provide the right information at the right time and on the right support (screen, smartphone, etc.) to the right people who can analyze, decide, act on, and evaluate the results. We immediately see one of the main roles of an EIS: that of automatically centralizing the data collected from several heterogeneous energy-consuming systems.

In other words, the basic objective of an energy information system (EIS) is to provide information, especially statistical information that allows for knowledge and regular monitoring of an organization's energy consumption situation.

The functionalities of an EIS are based on the following four conceptual dimensions:

- The functional dimension: Its main activities are to produce, promote, and disseminate energy data, but also, above all, to develop a map of an organization's heritage and energy consumed.
- The human dimension: The actors in the human dimension of an energy information system are characterized by the actors in the project phase, the actors in the operational phase, and the asset manager.
- The organizational dimension: This is characterized by the definition of the governance and the design of an urbanization of energy data for the construction of an architecture of the energy information system.
- The technological dimension: This presents an energy information system as support for the collection, processing, storage, and dissemination of energy data in a cycle of data processing and management processes.

An energy information system (EIS) enables daily operational needs to be met. It is linked through integration to an organization's information system and performance

indicators, as well as to users through communication tools. It automatically centralizes various available information related to energy, which can be taken into account at the level of an energy metering plan and the energy performance of all types of assets (buildings, transportation, public lighting, green spaces, etc.) of an organization or community [19].

An energy information system (EIS) is a support and communication channel between an energy management system (EMS), an energy operating system (EOS), and the outside of an organization or community. This communication channel is represented as follows (see Figure 2).

- The energy management system (EMS) transmits general information to the energy operating system (EOS) through the energy information system (EIS).
- The EIS collects, stores, and processes basic information from the EOS; inputs energy information flows; and transforms them into decision information for the EMS and/or disseminates the energy information to the partners of the organization or community.
- Finally, the EOS produces basic information and executes the orders of the EMS.

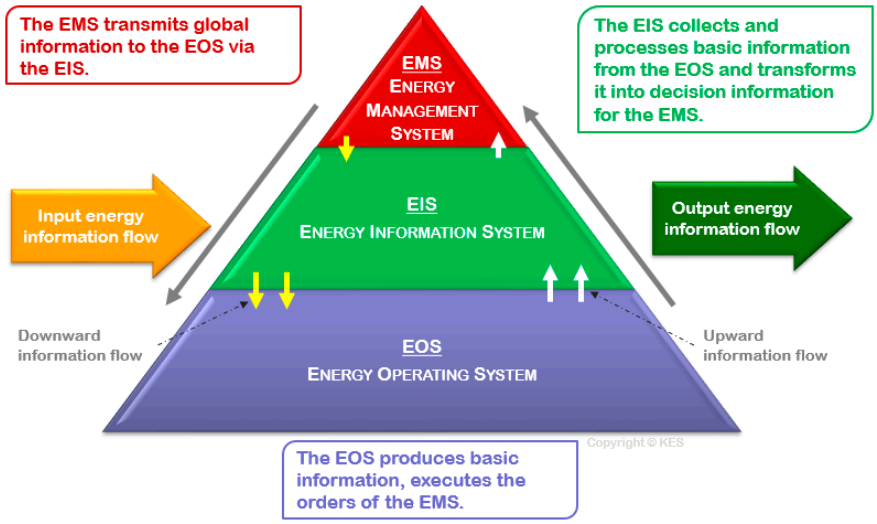


Figure 2. Flow of an energy information system. The colors indicate the areas of each system. The arrows show the direction of the information flow.

3.6. Energy Management System (EMS)

The term "energy management" has different meanings to different people and different contexts in different fields.

The Verein Deutscher Ingénieur (VDI) Guideline 4602 (2007) [20] provides a standard definition of energy management: "Energy management is the proactive, organized and systematic coordination of procurement, conversion, distribution and use of energy to meet the requirements, taking into account environmental and economic objectives". Turner (2004) [20] defined it as the judicious use of energy to accomplish prescribed goals. Energy management is also a real "taking charge" of the energy position within an organization. It is not a matter of a machine or of highly sophisticated equipment but, above all, of an entire organization, made up of decisions, objectives, methods, skills, behavior, and motivation—a matter of people and of a team [21].

This leads us to believe that the term energy management has different meanings depending on the author or actor. For example, some believe that energy management is "the effective and efficient use of energy to reduce energy consumption and minimize costs". For others, energy management is generally defined as a set of activities aimed at managing the efficient and judicious use of energy to achieve prescribed objectives.

According to the ISO 50001 standard, "An energy management system (EMS) is the set of correlated or interacting elements of an organization used to establish an energy policy, objectives, and processes to achieve those energy objectives".

In other words, we note that "The energy management system is a system aimed to establish an energy policy, objectives, energy targets, action plans and one or more processes to achieve these objectives and energy targets " according to ISO 50001 [4].

An EMS aims to continually improve energy performance to reduce consumption and, therefore, costs. It is also a management and control system that helps organizations measure their energy consumption in detail, identify levers for action, and plan improvements.

Based on the functions of management, we could say that an energy management system focuses on the following four functions: steering, i.e., setting goals for an organization and controlling them; organizing by distributing and coordinating the work of teams; animating by mobilizing individuals around common goals; and leading by making decisions to achieve goals.

However, in the context of the ISO 50001 standard, an energy management system is based on the functionalities of a set of correlated elements, which are presented in the following Table 1.

Table 1. Functionality of correlated EMS elements.

Energy policy to manage	• Commitment, objectives, and resource allocation (means and responsibilities)
Implementation and operation to be organized	• Process for identifying opportunities for improvement, benchmarks, and energy audits. • Prioritization and action planning
Review that needs to be animated	• Investment • Implementing new solutions
Planning to lead	• Measuring progress • Communicating the approach • Management review of the achievement of objectives • Correction of objectives and actions

According to the ISO 50001 standard, an EMS is based on the model defined in the diagram in Figure 3, which describes the flow of the process of continuous improvement of energy performance, including efficiency, uses, and energy consumption of the body.

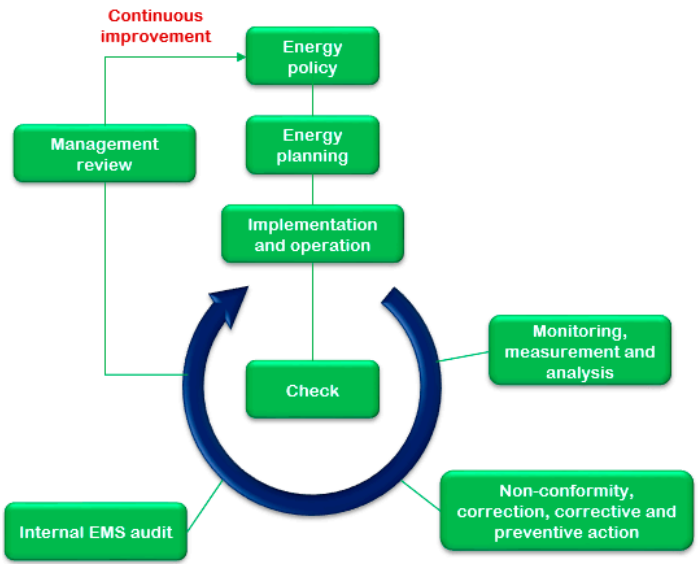


Figure 3. Flow of the process of continuous improvement of an EMS according to the PDCA.

3.7. Comparative Tables of the Different Concepts or Approaches of the Two Systems

Our comparative study of energy information systems (EISs) and energy management systems (EMSs) is carried out according to the criteria of the definitions, objectives, and roles of correlated elements from the ISO 50001 standard or other elements of comparison. Each element is analyzed according to the identified characteristics of the corresponding systems, as shown in Tables 2–4.

Table 2. Elements for comparing the definitions and objectives of the two systems.

Elements of Comparison	EMS	EIS	Analysis
Definition	System aimed to establish an energy policy, objectives, energy targets, action plans, and one or more processes to achieve these objectives and energy targets [4]	System aimed at organizing and operating a set of structured and unstructured resources (material, software, data, procedures, people, etc.) allowing the automatic collection, storage, memorization, and processing of energy data into information in order to make it available (in the form of data, texts, sounds, images, etc.) for dissemination within and between organizations [8,9,18]	DIFF
Objectives	Optimizing energy performance	Generation and dissemination of energy data	DIFF

DIFF: The elements of the comparison represent different concepts, approaches, or scopes of the two systems.

Table 3. Comparison of the correlated elements of the two systems.

Correlated Elements of Comparison	EMS	EIS	Analysis
Organizational Structure	This term refers to the hierarchical framework that defines an energy policy.	This term refers to the hierarchical framework that defines an internal department or work organization for its EIS.	DIFF
Roles and Responsibilities	An energy officer is appointed by management to set up an energy team to establish and maintain the management system. He/she is responsible for the proper monitoring of the EMS.	A project manager is appointed by management to set up and implement a technical and organizational platform for the production and dissemination of energy data.	DIFF
Planning	This term refers to: • Energy diagnosis; • Energy-saving potential; • The determination of significant energy uses (SEUs); • The definition of the energy performance indicators (EPIs) for each SEU; • The action plan.	This term refers to: • The inventory of the organization's heritage and the energy used; • The study and the technical and organizational platform dedicated to the production and dissemination of energy data.	DIFF
Organizational Functioning	The organization defines the energy performance targets to be achieved.	The organization defines the energy data and performance to be made available to decision makers.	DIFF
Energy Policy	Formal expression by the management of the intentions, general orientations, and commitments regarding the energy performance of an organization.	Formal expression by the information systems department to translate the commitments of the general management regarding energy performance.	DIFF

Table 4. Comparison of the other elements of analysis of the two systems.

Other Elements of Comparison	EMS	EIS	Analysis
Energy targets	Significant energy uses (SEUs)	All heritage and SEUs.	DIFF
Reference energy situations (RESs)	There are quantified benchmarks that serve as a basis for comparing performance.	There are quantified references that serve as a basis for comparing performance and energy consumption.	DIFF
Energy performance indicators (EPIs)	This is a measure defined by the organization on a more limited scope.	This is a measure defined by the organization over a wider area of application.	DIFF
Internal audits	This is an independent and objective activity to provide assurance on the level of control of activities within a defined scope.	This is an independent and objective activity to ensure the level of control of technical operations and energy data flows.	DIFF
Purchasing process	To improve energy performance	To monitor energy performance	DIFF

Another observation from this study is that the scope of an EIS is broader than that of an EMS (see Figure 4).

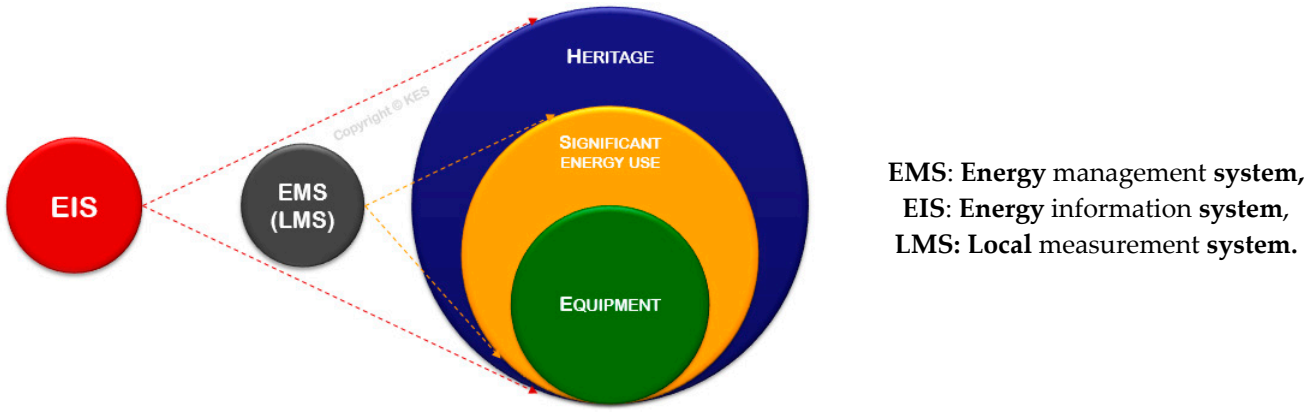


Figure 4. Scope of an EIS and EMS.

3.8. Positioning of the EIS in Relation to the EMS

The study of the positioning of an energy information system (EIS) in relation to an energy management system (EMS) is carried out on the basis of the role that the EIS plays in the elements of the EMS's process. Each element of the process is analyzed according to its need to request or use the functionalities of an EIS. See Table 5 for details on the positioning of the EIS process elements in relation to the EIS and the summary in Table 6.

The role of an EIS in relation to the continuous improvement process (Plan Do Check Act) of an EMS.

Summary of each system's roles.

Evaluation of the EIS and EMS: Benchmarking study (Table 7).

Table 5. Positioning of the elements of an EMS's process in relation to an EIS.

Elements of the Process	EMS Role	EIS Role	Analysis
Energy policy	General management defines commitments, objectives, and resource allocations	The EIS provides management with the right energy information at the right time to define energy policy.	EIS DR
Energy planning	The action plans are: • Energy diagnosis; • Definition of energy-saving potential; • Definition of SEUs; • Definition of energy performance indicators (EPIs) on each SEU; • An action plan is developed to achieve the energy objectives in accordance with the energy strategy defined by management.	The EIS provides energy consumption data during the initial energy diagnosis to create an inventory of the different stations. It also makes it easy to identify SEUs and energy-saving potential, as well as to automate, store, and communicate EPIs. The EIS serves as a function and support for collecting, storing, and processing energy data to develop an action plan and communicate.	EIS DR
Implementation and operation	These are the following actions: • Process of researching possible improvements, benchmarks, and energy audits; • Prioritizing and planning actions; • Implementing the monitoring of the effectiveness of action plans.	An EIS provides, through a database, structured data for the search for possible improvements, benchmarks, and energy audits.	EIS DR
Management review	An evaluation of the effectiveness of the action plans will be carried out with guidelines based on the energy performance to be achieved.	The EIS is not directly required.	EIS NR
Verification	The actions taken are measured, controlled, and monitored: checking and acting.	The EIS plays a supporting role in the collection, storage, processing, control, and communication of energy performance data.	EIS DR
Monitoring, measurement, and analysis	Monitoring of measurable results of energy efficiency or energy consumption related to energy use compared to the reference energy situation.	The EIS serves as a channel to provide the EMS with measurable results of energy efficiency related to energy use compared with the reference energy situation.	EIS DR
Non-compliance, correction, corrective and preventive actions	This involves: • Checking or verifying the fulfilment or non-fulfilment of a documented requirement; • Carrying out actions aimed at eliminating the causes of non-compliance and preventing them from recurring.	The EIS includes the provision of energy consumption data and EPIs for energy stakeholders to analyze compliance or non-compliance with normative requirements.	EIS DR
EMS internal audit	Internal controls of the EMS are planned at regular intervals to ensure compliance with normative requirements, energy objectives, and targets defined via the energy strategy. It is ensured that the EMS is properly implemented and maintained.	The EIS provides information for the internal audit of the EMS to ensure compliance with normative requirements, energy objectives, and targets defined in the energy strategy.	EIS DR

(EIS DR: EIS directly requested by the elements of the EMS process); EIS NR: EIS not directly requested by elements of the EMS's process.

Table 6. Overview of the roles of each system.

Role of the Energy Information System	Role of the Energy Management System
✓ Continuous Monitoring	✓ Reducing Energy Costs
✓ Precise Analysis	✓ Environmental Impact Reduction
✓ Adaptability	✓ Regulatory Compliance
✓ Informed Decision Making	✓ Brand Image Enhancement
✓ Internal and External Communication	✓ Stakeholder Engagement

Table 7. Evaluation of the EIS and EMS: benchmarking study.

	EMS/EIS		
	DIFF	**EIS DR**	**EIS NR**
Elements of the comparison of the definitions and objectives of the two systems	2	0	0
Elements of the comparison of the correlated elements of the two systems	5	0	0
Elements of the comparison of the other elements of the analysis of the two systems	5	0	0
Positioning of the elements of the EMS's process in relation to the EIS	0	7	1
Total observed results	12	7	1

DIFF: The elements of comparison represent different concepts, approaches, or scopes of the two systems. EIS DR: EIS directly required by the elements of the EMS's process. EIS NR: EIS not directly requested by elements of the EMS's process.

4. Discussion

The comparative study, which was based on the criteria of the concepts, definitions, objectives, function, and roles in the set of correlated elements of the ISO 50001 standard or other elements of analysis and complemented by the positioning of an EIS in relation to the elements of an EMS's process, seems to show us different partitions, which are characterized by notions, approaches, or the fields of application of the two systems, as well as their functioning. As shown in Tables 2–4, we found a dozen differences between the EIS and EMS according to the criteria used above, as summarized in Table 7.

Table 5 also shows that the two systems complement each other—an EIS is directly or indirectly involved in eight elements of the EMS's process as part of the operational implementation of the EMS.

On the other hand, it is interesting to note that the Canadian government's Public Services and Procurement defines an energy management information system (EMIS) as a device providing relevant information aimed at making energy performance visible. This definition has similarities with the characteristics of an energy information system (EIS), although an EMIS also incorporates management functionalities in the background.

Out of about twenty elements of comparison, we observed about a dozen differences in the functioning of the two systems, i.e., 60% (12/20) autonomy, where an EMS can operate without an EIS. Eight elements of an EIS are directly or indirectly solicited by the elements of the EMS's process, i.e., 40% (8/20), representing the EMS's dependence on the EIS. This shows that each system has a defined role in an organization, with different predominance.

According to the flow of an energy information system shown in Figure 1, we can see that an energy information system (EIS) is the support and communication channel between an energy management system (EMS), an energy operating system (EOS), and the outside of the body. This communication channel allows the energy management system

(EMS) to transmit general information to the energy operating system (EOS) through the energy information system (EIS). The EIS collects, stores, and processes basic information from the EOS, receives energy information streams, and transforms them into decision information for the EMS and/or disseminates the energy information to the organization's end users or partners. Finally, the EOS produces basic information and executes the orders of the EMS. Thus, the energy information system (EIS) makes it possible to meet the operational needs of energy consumption among stakeholders (energy manager, energy referent, shared energy advisor (SEA), decision makers, etc.). It is linked via integration to the organization's information system and performance indicators, allowing end users to monitor or diagnose energy consumption in real time using communication tools.

The EIS also makes it possible to automatically exploit all energy data and find what is important to improve efficiency, facilitate daily management, enhance investments, reduce operating costs, monitor and optimize contracts, unite and raise awareness, evolve easily, prepare for certification, etc. It can provide an overview of energy consumption on sites and its distribution during an energy audit because its scope extends to the organization's heritage. This could justify the selection of significant energy uses (SEUs) of the organization's assets.

As part of an energy review, the EIS can also identify the areas of potential energy savings and prioritize the potential for overall and specific improvement to complete the analysis of the significant energy uses and constitute a certification area for the EMS.

The energy management system (EMS), according to the ISO 50001 standard, shows us a flow process of continuous improvement of energy consumption based on a set of correlated elements of the requirements of the said standard. This flow process is defined in several phases, namely, carrying out an energy management review; defining the energy policy and planning; organizing the implementation and operation of the EMS; managing the monitoring, verification, measurement, and analysis of energy solutions; checking non-compliance, corrections, and corrective and preventive actions; and providing an internal audit of the EMS.

This energy management and control helps organizations to measure their energy consumption in detail, identify levers for action through process implementation, and plan improvements. This provides a structuring framework for the organization because energy management involves making decisions, implementing methods, modifying uses in the direction of the same energy policy, etc.

With a focus on equipment and significant energy uses (SEU), the EMS can improve energy efficiency, reduce overall energy consumption, and protect against rising energy prices. This increase is due to the peak electrical loads that can be observed in an energy information system. It also makes it possible to comply with legal requirements, strengthen the competitiveness of the organization, and obtain certification according to the ISO 50001 standard.

The comparative study also showed us that the main similarities between an energy information system (EIS) and energy management system (EMS) lie in the fact that both systems remain structured and structuring in an important heritage environment where energy management is a complex and time-consuming subject.

On the other hand, the significant differences between the two systems are found in the concepts, notions, definitions, or approaches of the elements of comparison described in Tables 1–5. These are the elements of the comparison of the definitions and objectives, the correlated elements of an EMS, and other elements of analysis of the two systems.

In summary, the energy information system (EIS) is of particular interest to the energy management system (EMS). This is because it is positioned as a system linked or complementary to the EMS that is capable of performing the following functions:

- Playing a facilitating role in the implementation of the EMS and, above all, identifying the certification scope of the ISO 50001 standard;
- Serving as a support, communication, and information channel for the EMS and stakeholders;

- Covering asset and energy inventory management functions;
- Providing global and specific energy data for the EMS;
- Facilitating energy performance diagnostics for the EMS;
- Identifying significant energy use;
- Facilitating daily management;
- Reducing operating costs.

In other words, the energy information system is a "facility management" tool or facilitator for the installation or operational implementation of the energy management system.

5. Conclusions

This comparative study between an energy information system and an energy management system according to ISO 50001 was the subject of a scientific study of the concepts, approaches, designs, and functions of the two systems (see Table 8). This study, which was based on the criteria of definition, objective, functionality, role, or set of correlated elements of the ISO 50001 standard supplemented by other criteria specific to the two systems (EIS and EMS), showed that they are related or complementary by up to 40%, depending on the position of the EIS in relation to the elements of the EMS's process. See Figure 5.

An energy information system (EIS) makes it possible to satisfy operational needs, i.e., to automatically generate and use all global and specific energy data in order to facilitate the diagnosis of energy performance, to identify significant energy consumption, to facilitate daily management, and to reduce operating costs. An EIS can also be used as a support tool. It can also serve as a support, communication, and information channel for the EMS and stakeholders. In other words, it plays a facilitating role in the implementation of the EMS and especially in the identification of the certification scope of the ISO 50001 standard.

On the other hand, an energy management system (EMS) is a management and control system that helps organizations measure their energy consumption in detail, identify action levers through the implementation of processes, and plan for continuous improvement. It is a real "taking charge" of the energy position within the body.

This comparative study clearly showed that, compared to the energy management system (EMS), the energy information system (EIS) is positioned as a support tool or facilitator in the implementation of the EMS according to the ISO 50001 standard in an organization with significant assets, where energy management is a complex and time-consuming issue. This is because the two systems are 40% linked or complementary, according to the comparative study. See Figure 5.

Table 8. Summary of the functionalities of each system.

EIS Functionalities	EMS Functionalities
✓ Continuous Monitoring	✓ Reducing Energy Costs
✓ Precise Analysis	✓ Environmental Impact Reduction
✓ Adaptability	✓ Regulatory Compliance
✓ Informed Decision Making	✓ Brand Image Enhancement
✓ Internal and External Communication	✓ Stakeholder Engagement

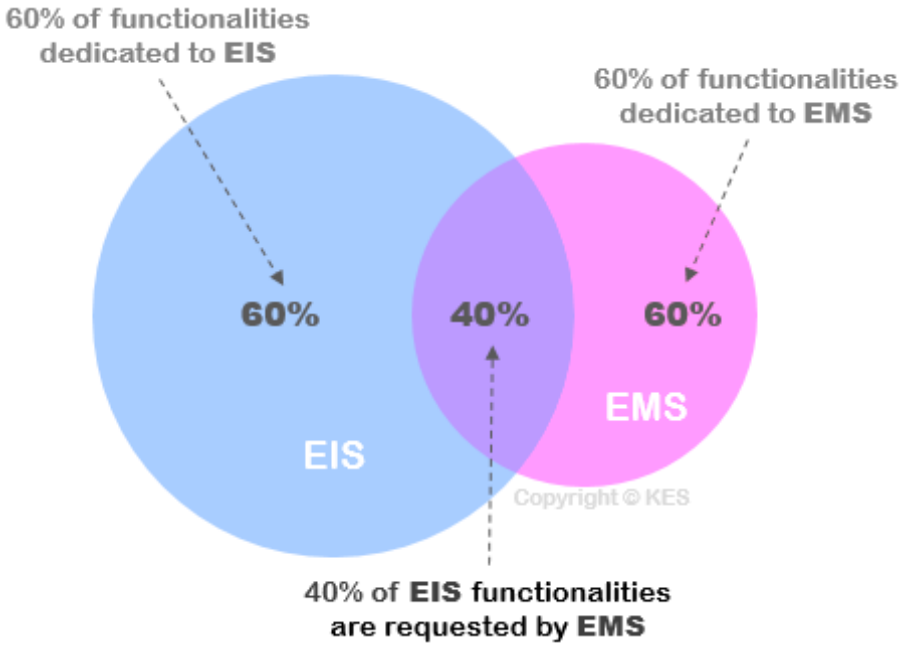


Figure 5. Distribution of functionalities of the 2 systems.

This clarification of these two concepts should contribute to a better understanding of the respective roles of these systems in energy management, thus enabling communities to effectively improve their energy performance.

However, our study has some shortcomings, particularly with regard to the review of the scientific literature. Due to the novelty of this area of research, there are few, if any, relevant scientific publications, which limits our ability to summarize the progress of existing studies.

In the context of technological advances, innovative equipment and processes play a driving role in improving energy management, energy efficiency, and energy cost control. However, these advances do not fully address the challenge of integrated energy consumption management for organizations with significant real estate assets. Integrating an energy information system (EIS) within these organizations could be a first step toward automated energy management. For example, quickly identifying energy-saving opportunities and defining the certification scope for implementing an energy management system (EMS) compliant with ISO 50001 would be a significant step forward for this standard.

Author Contributions: Conceptualization, E.S.K.; Methodology, C.M. and Y.N.; Validation, C.M. and Y.N.; Investigation, E.S.K.; Resources, C.M. and Y.N.; Writing—original draft, E.S.K.; Writing—review & editing, C.M. and Y.N.; Supervision, C.M. and Y.N. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding. And The APC was funded by UNITEC-SA Universal Technologie Côte d'Ivoire.

Data Availability Statement: The original contributions presented in the study are included in the article, further inquiries can be directed to the corresponding author.

Conflicts of Interest: The authors declare no conflict of interest.

Abbreviations

EIS	Energy Information System
EMS	Energy Management System
EMIS	Energy Management Information System
ISEM	Information System and Energy Management
EPN	Evreux Porte de Normandie
LMS	Local Measuring System
SEU	Significant Energy Uses
EOS	Energy Operating System
SEA	Shared Energy Advisor
PDCA	Plan Do Check Act
GHG	GreenHouse Gas
GIMELEC	Group of companies in the French electronics sector

References

1. Intergovernmental Panel On Climate Change (IPCC) (Ed.) Energy Systems. In *Climate Change 2022—Mitigation of Climate Change*, 1st ed.; Cambridge University Press: Cambridge, UK, 2023; pp. 613–746. [CrossRef]
2. The European Parliament and the Council of the European Union. *Directive (Eu) 2023/1791 of the European Parliament and Of the Council of 13 September 2023 on Energy Efficiency and Amending Regulation (EU) 2023/955 (Recast)*; Official Journal of the European Union: Brussels, Belgium, 2023; p. 111.
3. COP23—La France Engagée Pour la Mise en Œuvre de l'accord de Paris, RPUE—Repré-Sentation Permanente de la France Auprès de l'Union Européenne. [En Ligne]. Available online: https://ue.delegfrance.org/cop23-la-france-engagee-pour-la (accessed on 18 July 2024).
4. ISO; AFNOR. ISO 50001:2018(en), Energy Management Systems—Requirements with Guidance for Use. AFNOR Energies, 17 Janvier 2023. [En Ligne]. Available online: https://www.iso.org/obp/ui/#iso:std:iso:50001:ed-2:v1:en (accessed on 28 November 2023).
5. JLira, M.S.; Salgado, E.G.; Beijo, L.A. Which factors does the diffusion of ISO 50001 in different regions of the world is influenced? *J. Clean. Prod.* **2019**, *226*, 759–767. [CrossRef]
6. Aymard, C. Logiciel de Suivi Énergétique Pour Votre Collectivité, DeltaConso Expert. [En Ligne]. Available online: https://www.deltaconso-expert.fr/secteurs/gestion-energetique-collectivite/ (accessed on 9 July 2022).
7. ATEE. Guide des Logiciels de Gestion Énergétique. mars 2016. [En Ligne]. Available online: https://atee.fr/efficacite-energetique/maitrise-de-lenergie/mesurer-la-consommation-denergie-audits (accessed on 21 August 2022).
8. D. Générale des Services Intégrés Services Publics et Approvisionnement Canada, Systèmes D'information sur la Gestion de L'énergie: Guide et Outil de Planification. Canada: Ressources Na-Turelles Canada. Office de L'efficacité Énergétique, 2010. [En Ligne]. Available online: https://publications.gc.ca/site/fra/9.637837/publication.html (accessed on 22 January 2023).
9. Gimélec. Systèmes D'information Énergétique: Recommandations pour les Décideurs. . ., 6 Novembre 2015. [En Ligne]. Available online: https://fr.slideshare.net/Gimelec/systmes-dinformation-nergtique (accessed on 14 August 2022).
10. Hervé, N.; Venturini, P.; Albe, V. La construction du concept d'énergie en cours de phy-sique: Analyse d'une pratique ordinaire d'enseignement. *RDST Rech. En Didact. Des Sci. Et Des Technol.* **2014**, *10*, 123–151. [CrossRef]
11. Klein, É. 1. L'énergie, une grandeur « qui se conserve ». In *L'énergie à Découvert*; Jeandel, C., Mosseri, R., Eds.; In À Découvert; CNRS Éditions: Paris, France, 2017; p. 39. Available online: http://books.openedition.org/editionscnrs/10913 (accessed on 25 January 2023).
12. Lugan, J.-C. «La Définition des Systèmes», Vol. 5e éd., 2738 Vol., in Que Sais-Je?, Vol. 5e éd., Paris Cedex 14: Presses Universitaires de France, 2009, pp. 32–50. Available online: https://www.cairn.info/la-systemique-sociale--9782130575528-p-32.htm (accessed on 28 January 2023).
13. Morin, E. La Théorie des Systèmes et la Théorie de L'information. Ed. Du Seuil., Vol. Introduction à la Pensée Complexe. 1990; p. 3. Available online: https://psychaanalyse.com/pdf/EDGAR_MORIN_INTRODUCTION_A_LA_PENSEE_COMPLEXE_1990.pdf (accessed on 28 January 2023).
14. Encyclopédie. Information, Wikipédia. 19 Janvier 2023. [En Ligne]. Available online: https://fr.wikipedia.org/w/index.php?title=Information&oldid=200585973 (accessed on 29 January 2023).
15. Académie Française. Dictionnaire de l'Académie Française. [En Ligne]. Available online: https://www.dictionnaire-academie.fr/article/A9I1218 (accessed on 28 January 2023).
16. Le Dictionnaire. Définition Management, LE DICTIONNAIRE. [En Ligne]. Available online: https://www.le-dictionnaire.com/definition/management (accessed on 31 January 2023).
17. Encyclopédie. Management, Wikipédia. 24 Janvier 2023. [En Ligne]. Available online: https://fr.wikipedia.org/w/index.php?title=Management&oldid=200749121 (accessed on 30 January 2023).
18. Piette, M.A.; Granderson, J.; Wetter, M.; Kiliccote, S. 2012—Intelligent Building Energy Information and Contro.pdf. [En Ligne]. Available online: https://eta-publications.lbl.gov/sites/default/files/LBNL-5894E.pdf (accessed on 9 October 2023).

19. Kouaho, E.S. Mise en Œuvre du Système de Management de l'Energie Selon la Norme ISO 50001 Dans une Collectivité: Cas Evreux Porte de Normandie. Thèse Professionnelle, CESI, Rouen, France, 2020.
20. Rouhani, O.M.; Beheshtian, A. *Energy Management: Energy Science and Technology*; Studium Press LLC: Houston, TX, USA, 2015; Volume 12, p. 26.
21. C. CHABANEL et C. RAFFRAY—ADEME Service Communication, Système de management de l'énergie ce sont les entreprises qui en parlent le mieux, Agence L'Effet papillon. 2015. Available online: https://librairie.ademe.fr/changement-climatique-et-energie/2892-systeme-de-management-de-l-energie-ce-sont-les-entreprises-qui-en-parlent-le-mieux.html (accessed on 28 November 2023).

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.