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Modelling the System of Integrated Energy-Environmental Business Management Using International Standards

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ABSTRACT

Today, the business practice in a globalized environment is characterized mainly by the energy crisis and environmental-safety aspects, impacts as well as risks of the sustainability of its production in the context of further socio-economic development. Organizations in this context are looking for more efficient and sustainable ways to manage the green growth of their activities, processes and production as such. The research conducted by the authors so far points to a strong connection in the optimization of energy and environmental aspects of corporate production, both from the point of view of their intervention links and the necessity of a standard management system. As part of this research, standardized globally recognized concepts, guidelines and models for production energy management, especially ISO50001, ISO50006, ISO50015, and for environmental management ISO14001, respectively were identified and analysed more deeply. EMASIII, ISO14045, ISO14051, from the point of view of the possibility of their merger and subsequent IMS certification, were built in the organization according to an innovative model. The HLS structure of the key elements of the IMS was designed, supplemented by standards to support the process of the system by using indicators of energy and environmental management and their connection to indicators of sustainable production and its green growth.

Keywords: corporate energy, environmental aspects, management system, system integration, ISO standardization, modelling, green growth and green economy.

INTRODUCTION

From both an economic and an environmental point of view, corporate energies play a key role in solving the issue of sustainable socio-economic development and in overcoming crisis situations in society as well as solving global problems of the Earth. Environmental-energy development sustainability necessarily requires global thinking, local action and standard methods of process management integrated into the functional management system of every organization, regardless of its size, nature of its activity and localization (Center et al., 2002).

The organization's standard energy management system according to ISO 50001 is an integral part of the organization's management, ensuring continuous improvement in the area of energy consumption (STN EN ISO 50001. 2020). A functional, certified and maintained energy management system brings to organizations an improvement in their energy efficiency, a reduction in the energy intensity of processes, an increase in competitiveness as well as an improvement in the environmental profile in a systematic and sustainable manner (Mirakyan et al., 2013).

The most widespread standard environmental management systems in corporate practice are systems built and certified according to ISO 14001, or according to the EMASIII scheme with subsequent registration in the European Register (without certification) (STN EN ISO 14001.2016). In both cases, the system is a component of a complex management system,

ensuring the preparation, implementation, review and maintenance of the organization's environmental policy (Majerník et al., 2020). It is a voluntary management tool of the organization for a systematic approach to the creation and protection of the environment in all aspects of business.

MATERIAL AND METHODS

Standardization of the energy management system according to ISO standards

In connection with the ever-increasing importance of energy in social life, in the economy, in trade and in environmental studies, uniform rules and measures are necessary in the territory of individual countries, international communities and in all organizations, which should ensure diversification and efficient use of resources, but also guarantee protection energy infrastructure and the environment, in addition to demonstrating the readiness of the parties and organizations to effectively respond to crisis situations and development challenges (Majerník et al., 2020). The goal of standardized, globally recognized and used energy management systems, implemented according to ISO 50001, is to enable organizations to introduce, certify as well as maintain systems and processes necessary for the continuous improvement of energy management, including improving the energy efficiency of energy use and consumption. The standard determines the requirements for an energy management system (EnMS) for organizations, regardless of their size, nature of activity and location. It also applies to the design and procurement of equipment, system equipment as well as processes using energy

EnMS of continuous improvement according to ISO50001

Key elements of the HLS P-D-C-A structure and supporting standards

1.	Context of organisation	ISO50006
2.	Internal and external affairs	
3.	Stakeholder needs and expectations	
4.	Subject of the EnM system	
5.	Planning	
6.	Improvement	
7.	Leadership	
8.	Support and operation	
9.	Assessment of the level of the economy	ISO50015
10.	Intended results of the EnM system	

ISO50006 - Energy management systems - Measuring the energy efficiency of energy use using baselines (EnB) and energy performance indicators (EnPI) - General principles and guidelines

ISO50015 - Energy management systems – Measurement and verification of the energy performance of organizations – General principles and instructions

Figure 1. Standardized energy management systems

Table 1. Key elements of the EnM system in the PDCA cycle

Specification of EnMS phases in the Deming cycle			
P – plan	D – do	C – control	A – act
• Understanding of the organization and its context • Creation of energy policy and EnM team • Consideration of measures to manage risks and opportunities • Review of energy use • Identification of significant energy use • Determining energy management indicators and creating a reference level of use • Intentions and energy goals, action plans	• Implementation of action plans • Control of operation and maintenance • Ensuring communication and competence of the staff • Consideration of management in the design and procurement of production inputs	• Monitoring of energy processes • Measurement of energy performances • Analysing and evaluating efficiency • Compliance auditing, internal, external, certification • Review of the system by company management • Preparation of continuous improvement audit reports	• Taking corrective measures to resolve disagreements • Taking preventive measures to avoid disagreements • Sustainable improvement of energy management • Improving the environmental profile of corporate energy

within the scope and boundaries of EnMS (Majerník et al., 2009; Cai, 2010).

EnMS, Figure 1, is based on the framework methodology of continuous improvement in the Deming cycle P-D-C-A. The ten-element HLS structure of the system according to ISO 50001 is complemented by standard guidelines for process intensification in energy management and energy management. A more detailed specification and content of individual phases of the cycle is given in Table 1.

The development and implementation of the EnM system includes energy policy, energy intentions, goals and action plans related to its energy efficiency, energy use as well as energy consumption while meeting the requirements of legislation and other requirements of regulatory documents (Majerník et al., 2022). Implementation of the system can also lead organizations to meet the overall climate change mitigation goals by reducing their energy-related greenhouse gas emissions.

Standardization of the environmental management system according to ISO standards

Sustainable socio-economic development in a globalized market environment can only be ensured by balancing social, economic and environmental aspects in the needs of society (Hussain, et al., 2021). Social expectations of sustainable development, transparency and personal responsibility and are developing with increasingly strict legislation, growing pressures against environmental pollution, inefficient use of resources, improper waste management, climate change, degradation of ecosystems and loss of biodiversity. This leads organizations to adopt a systematic approach to environmental management by implementing standard environmental management systems (Naščáková, et al., 2020). The intention of the organizations is thus to contribute to the environmental pillar of sustainable development and to take advantage of opportunities to prevent or mitigate adverse environmental aspects, impacts as well as risks, especially those that have strategic and competitive consequences. Environmental management systems built according to the ISO14001 model are created on the basis of Deming's PDCA continuous improvement cycle. This model, shown in Figure. 2, provides an interactive process used by organizations to achieve continuous improvement and can be applied to the system as a whole as well as to each of its individual elements, also using supporting ISOs.

RESULTS

Integration of environmental and energy management systems

The international standard ISO 14001 meets the requirements of the ISO organization for management system standards. These requirements include a higher level structure (HLS), identical core text and generic terms with basic definitions designed to benefit users implementing multiple ISO management system standards. The standard does not contain requirements specific to other management systems (quality, safety, energy or

Continuous improvement EMS according to ISO14001

Key elements of the HLS structure in the P-D-C-A cycle and supporting standards

1.	SUBJECT OF THE STANDARDS – improvement of environmental behaviour, fulfilment of binding requirements, achievement of environmental goals	
2.	NORMATIVE LINKS - no links to others	
3.	TERMS AND DEFINITIONS – related to organization and leadership, to planning, supporting and operating, to evaluation and improvement	
4.	CONTEXT OF THE ORGANIZATION – understanding the context and needs of stakeholders, the subject matter and the EMS system	
5.	LEADERSHIP – commitment, environmental policy, responsibility roles, awareness, authority in the organization	ISO14004 ISO14006
6.	PLANNING – solutions to risks and opportunities (aspects), environmental goals and planning to achieve them	ISO31000
7.	SUPPORT – resources, competence, awareness, communication, documented information	ISO14063 ISO50001
8.	OPERATIONS – planning and management of operational activities, emergency preparedness and response	ISO14031 ISO19011
9.	BEHAVIORAL ASSESSMENT - monitoring, measurement, analysis and evaluation, internal audit, management review	ISO14051 ISO14045
10.	IMPROVEMENT - general, non-conformance and corrective action, continuous improvement, green growth	

Figure 2. Standardized environmental management systems – PDCA model and management framework

finance), but it allows the organization to use a common approach based on risk management (ISO 31000) and the integration of its functional EMS with the requirements of other management systems. Figure 3 shows a set notation for building a system model of EMS in an organization based on the current newly revised ISO standards based on authors' research.

The international standard ISO 50001 as a model for building and implementing an energy management system is in accordance with the requirements of the ISO organization for standards of management systems, including the superior HLS structure, which ensures a high level of compatibility with other standards of management systems (STN EN ISO 14051. 2012). Organizations can therefore use it when building their system independently or in combination with other management systems (such as quality, health and safety, etc.) or integrate the energy management system built according to it into achieving other business as well as social goals and in connection with sustainable development, sustainable consumption, and the production of mainly environmental intentions. The model for building and implementing energy management systems in organizations based on ISO 50001 and key supporting standards is formulated by the set intersection in Figure 4.

By integrating the management system into business practice, organizations can create a procedure for continuous improvement of energy

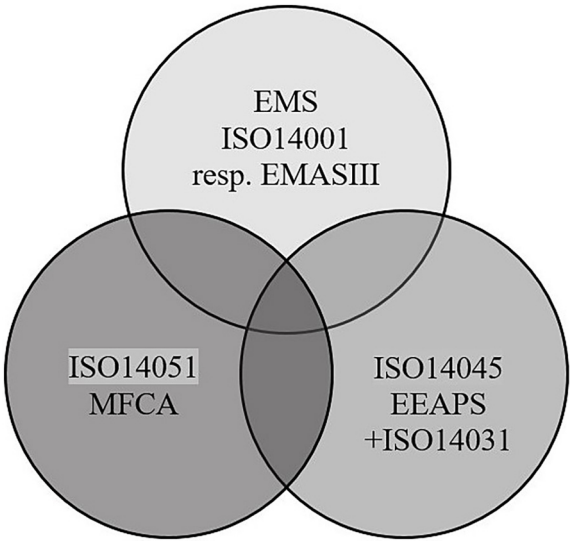

Figure 3. Model of environmental management in the organization based on ISO international standards; ISO14001 – environmental management systems. Requirements with guidance for use; ISO14045 – environmental management. Eco-efficiency assessment of product systems. Principles, requirements and guidelines; ISO14051 – environmental management. Material flow cost accounting; EMAS – environmental management and audit according to the scheme of the European Community; ISO14031 – assessment of environmental behaviour – indicators

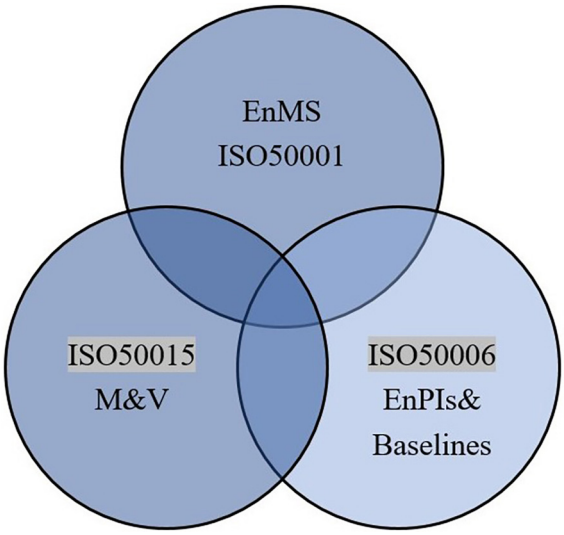

Figure 4. Model of energy management in the organization based on ISO international standards; ISO50001 – energy management systems. Requirements with guidance for use; ISO50006 – standard for energy baselines and performance indicators; ISO50015 – measurement and verification of energy performance of organization – general principles and guidance

management and for increasing their competitiveness. Integrated implementation can lead organizations to simultaneously meet overall the climate change mitigation goals by reducing energy-related greenhouse gas emissions. Integrated management systems arise from the needs of organizations to harmonize, merge or combine separately implemented management systems.

Despite the creation of various IMS concepts, no ISO standard has yet been adopted to implement, maintain, audit and certify these systems. IMS were and are still being created by connecting and combining key elements of various specifically focused standardized models of management systems.

Figure 5 presents a possible model for building a system of integrated energy-environmental business management based on the newly revised ISO standards for the field of energy and the environment.

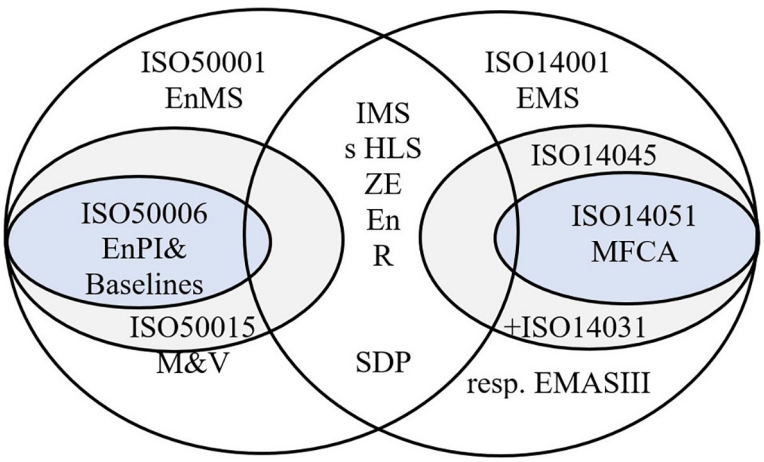

Figure 5. Model of the integrated energy-environmental business management system based on ISO standards; ZEEnR – green environmental and energy growth; IMS – integrated management system of corporate energy and environment; SDP – sustainability development production; HLS – replaced structure (High Level Structure); EMASIII – environmental management registered in the EU scheme

The model is suitable for independent implementation of the system, but also for integration with other management systems in the organization, especially production quality and safety, built according to the newly revised ISO standards. An integrated management system built according to the model can be an effective tool for the organization of sustainable production and consumption, competitiveness and development sustainability in globalized markets. Monitoring and measuring progress in the field of green growth (according to OECD) and green economy (according to UNEP) within global development strategies is currently provided in the form of standard indicators. From this point of view, when implementing integrated management for the continuous improvement of their energy and environmental behaviour, organizations can choose supplementary and aggregated indicators in terms of relevant standards.

The basis for improving the environmental behaviour of the company is the balance of material and energy flows (e.g. in kg/year) using the analysis of inputs and outputs of quantitative nodes, according to ISO14051. Environmentally significant incoming and outgoing flows of mass and energy for balancing are shown in Table 2.

ISO14031 and recommended indicators of management behaviour and operational behaviour can be used for the evaluation of the environmental behaviour of the organization. From a formal point of view, these can be absolute (e.g. in kg/period), relative (related to production), indexed or aggregated.

ISO standard 14045, the Slovak version of which (STN) the authors participated in research on, describes how it is possible to evaluate environmental performance in an organization (STN EN ISO 14045. 2013). When building energy management systems according to the ISO 50001 model, organizations are recommended to use the add-on standards: ISO 50006 (for creating performance indicators) and ISO 50015 (for measuring and verifying energy performance).

The ISO 19011 standard: Auditing of management systems can be used for auditing the integrated system (internal, external – certification). Framework for indicators of green growth and green economy according to OECD, or UNEP covers three main areas:

- green transformation of key sectors of the economy;
- goods and efficiency, separation of economic activities from the use of resources and related environmental impacts;
- overall indicators of progress and well-being.

In Table 3, as an example, the indicators for the assessment of environmental and resource productivity, economic instruments and political responses to development, which are used in Slovakia, are given with a recommendation for their use in organizational practice.

Table 2. Environmentally significant I/O flows of mass and energy in the company

Inputs in kg, GJ/period	Outputs in kg/period
Raw materials	Product
Auxiliary substances	Main product
Operational substances	By products
Packaging	Waste
Energy	Ordinary garbage
Gas	Usable waste - recyclable Dangerous waste
Coal	
Fuels	Waste water
District heating	Amount of waste water
Renewable resources (biomass, wood)	Heavy metals
Solar energy, wind, water	CHCO (chemical consumption of oxygen), BCO_5 (biochemical consumption of oxygen per 5 days)
Electricity produced outside the company	AIR EMISSIONS
Electric energy produced in the enterprise	CO_2, CO
Water	NO_x
Municipal water	SO_2
Underground water	Dust particles
Spring water	NH4, volatile organic substances
Rain / surface water	Substances damaging the ozone layer

Table 3. ZR monitoring – selected areas and indicators

Environmental and resource productivity	
CO_2 productivity and energy productivity	CO_2 productivity
	Energy productivity
	Energy intensity in sectors of the economy
	Share of energy from RES in gross domestic energy consumption
	Contribution of electricity produced from RES
Resource productivity	Material productivity
	Generation of waste (without municipal waste) and the rate of its recovery
	The amount of produced municipal waste and the rate of their recovery
	Balance of nitrogen and phosphorus
	Water productivity
Economic instruments and political reactions to ZR	
Prices and taxes	The share of environmental taxes in total tax revenues
	Share of environmental taxes on GDP
	Electricity and natural gas prices for households and organizations
	Average price for the production, distribution and supply of drinking water
Innovations	Spending on research and development in selected sectors
Implementation of voluntary instruments of environmental policy	Environmental management systems – ISO14001
	Share of green public procurement contracts
	Registration of organizations in EMASIII – share of registrations
	The share of products with the mark environmentally suitable
	Integrated management systems according to ISO

CONCLUSIONS

The competitive environment in globalized markets, new customer demands, innovations and constant changes in legislation today force the management of organizations to constantly and comprehensively improve their performance and ensure sustainability.

An integrated energy-environmental management system, built, functionally maintained and certified according to the latest internationally recognized ISO standards, currently represents a priority in the unregulated and regulated sphere, on globalized markets, from the point of view of the sustainable development of any organization. Previous research points to the fact that such system integration and its subsequent transfer into the complex integrated management of any organization is a key tool for the sustainability of production, consumption, green growth and the green economy (Feng et al., 2020).

The complex quality of production and consumption and its sustainability will first of all be verified by customer loyalty, but obtaining a certificate for a functional management system, built according to the integrated ISO model, represents quality with a safe choice even in green public procurement.

By introducing and certifying an integrated management system, the organization will improve its internal activities, streamline its processes, clarify the organizational structure, levels of responsibility and authority as well as develop innovative work procedures and other specific documentation prescribed by ISO standards (Bhatt et al., 2010). The system will bring positive effects to organizations in the form of limiting duplications and thereby reducing costs, greater focus on the interrelationships of individual systems and resulting synergistic effects, in the form of focusing on business goals and especially in the form of simplifying as well as streamlining auditing by using joint and combined continuous improvement audits: internal, external, certification, supervisory.

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REFERENCES

1. STN EN ISO 50001. 2020. Energy management systems. Requirements with guidance for use.

2. STN EN ISO 14001. 2016. Systém environmentálneho manažérstva podľa normy.
3. Majerník, M., Chovancová J., Hodolič J. 2009. Environmentálne manažérske systémy. SEVŠ v Skalici, 160.
4. Majerník, M., Daneshjo N. 2020. Projektovanie integrovaných systémov manažérstva. Petit s. r. o., Košice, 172.
5. Naščáková, J., Majerník, M., Daneshjo, N., Tarča, A. 2020. Udržateľné systémy energetického manažérstva. Vydavateľ: Petit s. r. O.
6. STN EN ISO 14051. 2012. Environmental management.. Material flow cost accounting. General framework.
7. STN EN ISO 14045. 2013. Environmental management. Eco-efficiency assessment of product systems. Principles, requirements and guidelines.
8. Majerník, M., Drábik P. 2020. Udržatelny rozvoj a environment. Petit s.r.o, 146s.
9. Majernik M., Malindžáková M. 2022. Inteligent logistics in business practic. Ram –Verlag, Germany, 118.
10. Hussain, C.M., Velasco-Munoz, J.F. 2021. Sustainable Resource Management: Modern Approaches and Contexts. Elsevier.
11. Mirakyan, A., De Guio, R. 2013. Integrated energy planning in cities and territories: A review of methods and tools. Renewable and sustainable energy reviews, 22, 289-297.
12. Cai, Y. 2010. Integrated energy-environmental modeling and climate change adaptation planning under uncertainty. Faculty of Graduate Studies and Research, University of Regina.
13. Feng, G., Kai, X., Hao, J., Hengxun, S. 2020. Introduction and prospect of integrated energy service platform in industrial parks. In IOP Conference Series: Earth and Environmental Science, IOP Publishing, 431(1), 012056.
14. Bhatt, V., Friley, P., Lee, J. 2010. Integrated energy and environmental systems analysis methodology for achieving low carbon cities. Journal of Renewable and Sustainable Energy, 2(3), 031012.
15. Center, F.S.E., Martin, E. 2002. Energy And Environmental Integration Through A Green Municipality Designation.