



*Aneta Wysokińska-Senkus*³¹

THE ROLE OF THE ENERGY MANAGEMENT SYSTEM IN THE IMPLEMENTATION OF THE PRINCIPLES OF THE CIRCULAR ECONOMY

Abstract: The purpose of this study is an attempt to find an answer for the research question: "Does the implementation of the energy management system determine the increase in the organizational effectiveness and enable the implementation of the principles of the circular economy?" The article describes the role of the energy management systems in improving management processes in an organization. References are made to principles of the circular economy. Moreover, the development prospects of standardized management systems are presented with particular emphasis on the energy management system according to the ISO 50001 standard requirements. The results of the primary and secondary data analysis have proved that a well-planned and implemented energy management system contributes to achieving many significant benefits, including: improving energy efficiency, reducing energy costs by reducing its consumption, reducing greenhouse gas emissions, introducing proper supervision of the organization's energy management system, ensuring compliance with energy efficiency legislation requirements, enabling integration with other management systems as well as improving the organization's image among stakeholder groups. The energy management system is an important tool supporting the process of efficient energy use in any organization and the implementation of principles of the circular economy.

Key words: Efficiency, organization development, energy management, energy management system (EMS), circular economy.

INTRODUCTION

The problem of the energy organizational effectiveness is a very interesting issue and is still in a focus of research. Its importance is especially essential for the economic practice due to the fact that the increase in energy efficiency is a key objective of every organization.

An increasing number of organizations notices problems associated with the energy use. The improvement of the organization energy efficiency obtained by skillful energy management is a priority of the state energy policy.

It is to ensure their survival and development that organizations should focus on the implementation of new organizational solutions relating to specific aspects of their operations, including the energy management. There is a growing interest in solutions proposed in the ISO 50001 standard on the Polish market. The energy management system contributes primarily to improving energy efficiency and reducing energy costs as well as enables organizations to implement principles of the circular economy. The requirements of the ISO 50001 standard enable organizations to implement principles allowing integrating energy efficiency into management practices.

THE ESSENCE OF THE ENERGY MANAGEMENT SYSTEM

Nowadays, an energy management system is implemented and certified on the basis of requirements of the PN-EN ISO 50001:2012 standard: energy management systems. Requirements

³¹ *War Studies University, Management and Command Faculty, 00-910 Warszawa, al. Gen. A. Chruściela 10, e*
– mail: *a.wysokinska-senkus@akademia.mil.pl*



with guidance for use (ISO 50001: 2011 Energy management systems. Requirements with guidance for use).

The standard can be implemented in all organizations whose aim is to meet the requirements of the energy policy and convince stakeholders of their implementation.

The ISO 50001 standard covers the requirements for implementing and continuously developing energy management systems in terms of energy efficiency and consumption in an organization.

The ISO 50001 standard has been developed to simplify the integration of the energy management system (SME) with other management systems. It is obtaining a certificate confirming implementation of an energy management system according to the ISO 50001 standard by an organization that provides contractors with the guarantee that the organization applies the best practices in energy management. Moreover, the purpose of the standard is to support the organization in evaluating and prioritizing while implementing new energy efficient technologies.

According to the requirements of the PN-EN ISO 50001: 2012 standard, energy management systems. Requirements with guidance for use, an organization should:

- Implement and continuously improve EMS-es to achieve better energy outcomes,
- Carry out and document an energy planning process,
- Identify, implement and have access to all applicable legal and other requirements which the organization is obliged to fulfill and which are related to the organization's energy consumption and use as well as its energy efficiency,
- Analyze the use and consumption of energy on the basis of measurements and other data as well as identify areas of significant energy use as well as prioritize energy efficiency improvements to improve the energy outcome,
- Define energy outcome indicators and the methodology for their determination and updating,
- Define, implement and maintain energy goals and targets,
- Identify and plan activities related to the significant energy use,
- Take measures to improve energy outcome and operational control while designing new, modified or renewed facilities, equipment, systems and processes which may have a significant impact on its energy consumption,
- In the case of purchases of energy services, products and equipment which have or may have a significant impact on energy use, the organization should: inform suppliers that the purchase is partially assessed on the basis of the energy outcome; the organization should also define and implement evaluation criteria for use, consumption and energy efficiency in relation to the planned or expected time of their operation,
- Ensure that key performance characteristics which determine the energy outcome are measured, monitored and analyzed at scheduled intervals,
- Assess the compliance with legal and other requirements, which the organization has undertaken to comply with, at scheduled intervals,
- Carry out audits at scheduled intervals to ensure that the EMS is consistent with the planned energy management arrangements, energy objectives and targets,
- Conduct a review of inconsistencies or potential inconsistencies, identify their causes, assess the need for action to ensure that inconsistencies do not occur or repeat and take appropriate measures in this regard.
- Keep records of corrective and preventive actions and review the effectiveness of corrective and preventive actions taken,
- The senior management should review the EMS at scheduled intervals to ensure that it remains adequate and effective [ISO 50001, 2011].



In order to determine the effectiveness and consistence of the energy management system as well as corrective and preventive measures, audits of the EMS should be carried out.

The PN-ISO 50003: 2017 standard: Energy management systems. The requirements for the units carrying out audits and certification of energy management systems determine requirements for competences, consistency and impartiality in relation to audits and certification of energy management systems (EMS-es) of the entities providing these services. It is in the ISO 50003 standard that the audit process and competence requirements of the personnel involved in the certification process of the energy management system have been determined.

THE STATE AND PROSPECTS FOR THE DEVELOPMENT OF ENERGY MANAGEMENT SYSTEMS IN THE WORLD

It was by the end of 2015 that 11,985 energy management system certificates had been granted according to the requirements of the ISO 50001 standard in the world. According to the data contained in the ISO Survey report, it was in 2015 that the increase in the number of certificates confirming compliance with the requirements of the ISO 50001 standard by 77% compared to 2014 (6765 certificates) could be noted [ISO 2015 Survey]. The table 1 presents the number of certificates per ISO standard worldwide in 2004-2005.

Table 1. The number of certificates according to the ISO standards, in the world in the years 2014-2015

| Standard | The number of certificates in 2015 | The number of certificates in 2014 | Annual increase / decrease |
|---------------|------------------------------------|------------------------------------|----------------------------|
| ISO 50001 | 11985 | 6765 | 5220 |
| ISO 9001 ** | 1033936 | 1036321 | -2385 |
| ISO 14001 *** | 319324 | 296736 | 22588 |
| ISO 27001 | 27536 | 23005 | 4531 |
| ISO 22000 | 32061 | 27690 | 4371 |
| ISO/TS 16949 | 62944 | 57950 | 4994 |
| ISO 13485 | 26255 | 26280 | -25 |
| ISO 22301 | 3133 | 1757 | 1376 |
| ISO 20000-1 | 2778 | - | 2778 |

Source: own study, 2017 based on The International Organization for Standardization – ISO Survey Of Certifications 2015, 2016.

The largest increase in the number of certificates confirming compliance with the ISO 50001 standard in 2015 compared to the previous year was recorded in Europe: by 84.7%.

The highest number of certificates confirming compliance with the ISO 50001 standard in 2015 was granted in Germany - 5931, United Kingdom - 1464, France - 500, Italy - 470, India - 405, Spain - 390, China - 262, Taipei, Chinese - 262, Austria - 220, Thailand - 138.

Among the five industrial sectors for the ISO 50001 certificates 2015, there can be distinguished: Basic metal & fabricated metal products, Food products, beverages and tobacco, Rubber and plastic products, Chemicals, chemical products & fibers, Electrical and optical equipment.

By the end of 2015, 74 certificates confirming the correct functioning of the energy management system in organizations were granted in Poland.

Błąd! Nieprawidłowy odsyłacz do zakładki: wskazuje na nią samą. presents the number of the environmental management system certificates in the world issued according to the ISO 14001

standard in 2011-2015. The figure shows that the number of energy management system certificates increased more than 26 times between 2011 and 2015. Since 2011 until 2015, a continuous increase in the number of certificates could be observed. This is due to the fact that the improvement of organization energy efficiency obtained by skillful energy management is a priority of the state energy policy. Implementation of an energy management system promotes energy management policy, strengthens thinking in terms of energy efficiency and, above all, reduces energy expenditure.

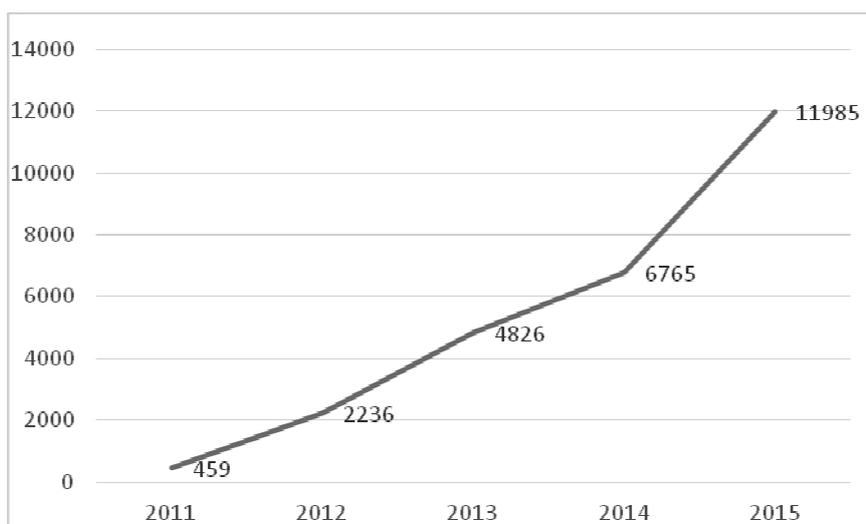


Figure 2. The number of certificates according to the ISO 50001 standard in the world in the years 2011-2015

Source: own study, 2017 based on *The International Organization for Standardization – ISO Survey Of Certifications 2015, 2016.*

PRINCIPLES OF THE CIRCULAR ECONOMY MODEL

The world economy is currently largely based on the linear "take, use and throw away" principle, which involves three stages:

- Acquisition of raw materials;
- Processing raw materials into finished product;
- Utilization of used products.

Acquisition of raw materials often involves the excessive use of rare natural resources, which may result in many negative consequences for the environment. The dominant model of production is the mass production using a large amount of raw materials and energy. The disposal of used products, especially electronic equipment, often becomes an insurmountable problem.

According to experts, such over-exploitation of resources coupled with energy-intensive production contributes to the increase in raw materials' and consequently consumption goods' prices [Grilli, Yang, 2013].

Therefore, as far as possible, organizations should apply principles of the circular economy, which leads to rational use of resources through a systematic approach to management. The implementation of the principles of the circular economy is based on a comprehensive look at processes carried out in an organization, starting from design stage through creation and delivery of



consumer products or services which are user-friendly, health-friendly, easy to use and organization of the convenient collection and disposal of waste products.

The circular economy is a complete opposite of the linear economy. The principles of the circular economy are focused on the design of a waste-free, closed circuit which assumes the reuse of used products which may become new products in the same or another form. The implementation of circular economy principles leads to reduced demand for raw materials and, consequently, to the complete elimination of the problems associated with waste management. It does not mean only new requirements within the scope of the comprehensive management approach but is also an opportunity to enhance the innovativeness of the solutions applied.

"The industrial revolution has created a production system which:

- Emits millions of tons of toxic materials to air, water and soil every year;
- Requires thousands of complicated rules to protect people and natural systems against excessive intoxication;
- Produces materials so dangerous that they will require constant vigilance from future generations;
- Generates gigantic quantities of waste;
- Destroys diversity.

According to Michael Braungart, one of the authors of the concept "cradle to cradle": "... it is not enough to do "less bad", it should be done something that brings real effects ...".

The development of the circular economy was influenced by many concepts, including the following:

- Regenerative design: the concept developed by an American landscape architect John T. Lyle. He began to develop the concept of the "regenerative design", which was supposed to be applied to all systems, in 70s of the 20th century. It gave the basis for the development of the other concepts [Cole, 2012].
- Performance Economy: initiated by Walter Stahel, an architect and economist. It was in the report for the European Commission titled: "The Potential for Substituting Manpower for Energy" (1976) co-authored with Genevieve Reday that he presented a vision of a closed-circuit economy and its impact on job creation, economic competitiveness, resource saving and waste prevention [Stahel, 2012].
- Bionic: Jane Beynous presented a revolutionary look at bionics as a technical and ecological science in her book titled: "Biomimicry Innovation inspired by nature" (1997), depicting the most well-known bionic solutions in the literature and implemented for commercial applications. Bionics was initiated already in the 1930s. The pioneers of bionics can be considered: George Cayley, Michael Kelly, Otto Lilienthal, Gaston Biot or Igo Etrich. However, it was Jane Beynous who introduced bionics as a technical-ecological science presenting commercially-available bionic solutions. An example is a Bionic Mercedes, whose shape and skeleton is modeled on a fish of the Ostraciidae family, which, despite its unusual appearance, is characterized by a low air resistance indicator, which is extremely desired in aerodynamics; Shinkansen - Japanese train, traveling at speeds of over 200km/h. At such high speeds, the biggest problem was aerodynamic noise from the train and other components such as pantograph, lines, poles, etc. The problem of the noise arising while leaving a tunnel was solved by modeling the front of the train in the shape of a kingfisher body, which does not cause a splash while diving - does it silently [Benyus, 1997].
- Industrial ecology: "Industrial ecology is the science concerning materials and energy flows in industrial systems." This approach aims at creating a closed loop of the process, in which waste serves as raw material for others by focusing on interconnections between operators

within the "industrial ecosystem", thus eliminating undesirable by-products. The trend initiated by Robert Frosch and Nicholas E. Gallopoulos in "Managing Planet Earth," published in "Scientific American" (1992) [Frosch, Gallopoulos, 1989].

- Blue Economics: initiated by a former CEO of eCover and Belgian businessman prof. Gunter Pauli. The concept assumes that "it is with the means available in cascade systems that waste from a single product becomes a raw material for a new flow", which gives not only healthy, ecological but also cheaper products than the ones coming from the existing production systems [Pauli, 2010].
- Cradle to Cradle is a concept and certification protocol developed by prof. Michael Braungart and William McDonough. It is a design philosophy that perceives all materials used in industrial and commercial processes as raw materials divided into two main categories: technical and biological [McDonough, Braungart, 2010].

The report, developed by the Ellen McArthur Foundation and the Mc Kinsey&Company titled "Towards Circular Economy", 2012, became a key document for the circular economy. ... The circular economy is based on systematic thinking (understood as scientific understanding of the way how the world works) in relation to people and their relationships with their surrounding ecosystems, material resources, energy, money and finances. The circular economy also deals with how these aspects affect humans, how the "living system" works ... [MacArthur, 2012].

Towards the Circular Economy: reports prepared by the Ellen McArthur Foundation and developed by the Mc Kinsey & Company, published from January 2012, are a kind of economically-business guidelines for transforming organizations' activities into the circular economy model.

Studies on practical solutions related to the implementation of the circular economy have also become a priority of the Horizon 2020 research program [<http://www.2020-horizon>].

IMPLEMENTATION OF THE CIRCULAR ECONOMY PRINCIPLES AND IMPROVEMENT OF ENERGY EFFICIENCY OF ORGANIZATIONS (CASE STUDIES)

Implementation of principles of the circular economy becomes a necessity for organizations which want to compete on European markets.

The circular economy is not limited to protection of the environment. The aim of the implementation of the circular economy principles is to design, create and provide consumers with products or services, which are safe for their users in terms of health, ease of use as well as organization of the convenient collection and disposal of waste products.

The implementation of an energy management system (EMS) according to the requirements of the PN-EN ISO 50001: 2012 standard and its continuous improvement contributes to achieving better energy performance by the organization. The requirements contained in the standard show the principles of integrating energy efficiency into management practices, which in turn enables organizations to implement the principles of the circular economy, which has now become one of the key policies of the European Union. The implementation of the EMS makes managers aware that the energy management is an important part of management in an organization. The energy management system is an important tool supporting the process of efficient energy use in any organization and the implementation of principles of the circular economy.

The energy policy set by the organization's top management is an obligation for improving the energy outcome and is intended to be the basis for defining and reviewing energy targets. It is widely available for individual employees and therefore it contributes to increasing their awareness within the scope of the energy efficiency as well as it gives them the opportunity to comment and improve ideas for energy management in their organization.



The practical experience of organizations and theoretical studies show that it is possible to implement environmentally friendly production while achieving tangible economic benefits, not only for organizations themselves, but also for individual stakeholder groups.

The implementation of the "Cradle 2 Cradle" concept in the Desso company brought the following benefits:

- EBIT increase in the carpet section by 9% in 2010;
- 32% reduction in energy consumption between 1998 and 2010 in the Desso factory in Waalwijk;
- Reduction of CO₂ emissions by 50% in 2010/2011;
- Total energy self-sufficiency by 2020.

The implementation of the "Cradle 2 Cradle" concept in the AGC company brought the following benefits:

- AGC has reduced water consumption by over 70% over the past 15 years. In the same period, the degree of water pollution decreased by 60%;
- Composition of products which is safe for people. For example, if a given substance is included in the REACH Regulation, AGC strives after optimizing the composition of the product by seeking safer and healthier alternatives;
- Glass is 100% recyclable. Up to 30% of the glass produced by AGC is made from recycled raw materials.

The implementation of the "Cradle 2 Cradle" concept in the Ford Motor Company in Rouge River brings savings of about \$ 35,000,000 per year; among the benefits, the following ones can be distinguished:

- Extension of lifetime of roofs by two times, reduction of maintenance costs - the green "coating" protects against UV rays;
- Reduction of costs associated with interior heating/cooling, as the green "coating" is a perfect insulation;
- Reduction of waste disposal costs: it was in the normal process that all the rainwater from the plant surface had to be subjected to an expensive purification process. Now the green "coating" purifies the water naturally and it may go straight to the river; moreover, production principles minimizing production waste have been implemented [<http://www.c2ccertified.org/innovation-stories>].

CONCLUSION

Experience of organizations shows that the involvement in environmental issues has become an important variable to be taken as part of modern competition strategies. The improvement of the organization energy efficiency obtained by skillful energy management is a priority of the state energy policy.

In the face of the increasing dependence of organizations on energy supplies, it is important to examine and determine directions for the development and modernization of energy infrastructure, which will enable to achieve a high level of supply of heat energy, cold, electricity and "mobile" energy in the long run. Improvement of the energy infrastructure is a key process in improving Poland's energy security.

It is also important to recognize the need for new energy solutions that are part of the EU regulations, including those contained in the winter package and in line with the principles of the circular economy, which has become one of the key EU policies.

The integrated climate and energy plans of individual member states are an important pillar in energy policy. Therefore, while addressing energy security challenges, we must focus on ensuring security of supply, energy efficiency, decarbonisation: reduction of CO₂ and the share of renewable energy sources (RES) and R&D, innovation and competitiveness.

**REFERENCES**

1. Benyus, J. M. (1997), *Biomimicry*. New York: William Morrow.
2. Cole, R. J. (2012), Transitioning from green to regenerative design. *Building Research & Information*, 40(1), 39-53.
3. Frosch R.A. , Gallopoulos N.E. (1989), *Strategies for manufacturing in managing Planet Earth*, Readings from Scientific American, New York.
4. Grilli and Yang; Pfaffenzeller; World Bank; International Monetary Fund; Organisation for Economic Cooperation and Development (OECD) statistics; Food and Agriculture Organization of the United Nations (FAO); UN Comtrade; Ellen MacArthur Foundation; McKinsey Global Institute analysis.
5. MacArthur, E. (2012), *Towards the circular economy. Economic and business rationale for an accelerated transitio-executive summary*.
6. McDonough, W., Braungart, M. (2010), *Cradle to cradle: Remaking the way we make things*. MacMillan.
7. Pauli, G. A. (2010), *The blue economy: 10 years, 100 innovations, 100 million jobs*. Paradigm publications.
8. PN-EN ISO 50001:2012 Systemy zarządzania energią. Wymagania i zalecenia użytkowania.
9. Stahel, W. R. (2010), *The performance economy (Vol. 572)*. Hampshire, UK: Palgrave Macmillan.
10. The International Organization for Standardization – ISO Survey Of Certifications 2015, 2016.
11. Wysokińska – Senkus A., Senkus P. (2013), *Systemy Zarządzania w Świetle Nowych Wyzwań. Ewolucja systemów, jakość, środowisko*, Wydawnictwo ROI, Warszawa 2013.
12. <http://www.2020-horizon.com/Moving-towards-a-circular-economy-through-industrial-symbiosis-i2018.html>, dostęp 2017.
13. <http://www.c2ccertified.org/innovation-stories>, dostęp 2017.