DOI: 10.32347/2412-9933.2025.64.23-28
UDC [004:005.8]:658.26

Semko Inga
PhD, Associate Professor, Associate Professor of the Department of Electrical Engineering Systems,
https://orcid.org/0000-0002-6251-5830
Cherkasy State Technological University, Cherkasy
Bedrii Dmytro
Doctor of Technical Sciences, Associate Professor, Senior Researcher, Acting Director; Professor of the Department of Management and Marketing; Professor of the Department of Artificial Intelligence and Data Analysis,
https://orcid.org/0000-0002-5462-1588
State Enterprise "Ukrainian Scientific Research Institute Of Radio And Television", Odesa State Academy of Civil Engineering and Architecture, Odesa Polytechnic National University, Odesa
Semko Oleksandr
PhD, Associate of the Department of Electrical Engineering Systems,
https://orcid.org/0000-0002-4309-3556
Cherkasy State Technological University, Cherkasy

APPLICATION OF PROJECT MANAGEMENT STANDARDS IN CONDUCTING ENERGY AUDITS OF INDUSTRIAL FACILITIES

Abstract. *The article discusses the feasibility of applying international project management standards in the process of conducting energy audits of industrial facilities as an effective tool for systematizing, controlling, and improving the effectiveness of energy efficiency measures. It emphasizes that the application of project management standards will facilitate the transition from the traditional approach to energy auditing as a one-time check to a comprehensive management process with defined goals, deadlines, resources, stakeholders, and success criteria. The correspondence of the stages of energy auditing to key areas of project management in accordance with the PMBOK standard, in particular content, risk, quality, communications, resource, and stakeholder management, was analyzed. The structure of the energy audit life cycle is also examined in accordance with the PRINCE2 principles, which focus on flexibility, accountability, and control of results. It has been determined that the integration of project-oriented approaches into energy audit practice will allow the creation of a unified energy management system capable of responding quickly to changes in technological, economic, and organizational conditions. It was concluded that the introduction of project management standards into energy audit practice creates the basis for the formation of new energy efficiency management models that combine technical accuracy, organizational discipline, planning flexibility, and a strategic focus on the sustainable development of the industrial sector.*

Keywords: energy; energy audit; project management; standards; energy efficiency; industrial facilities

Introduction

Modern energy, as one of the leading sectors of national economies and a driver of technological progress, is simultaneously under increasing pressure due to increased energy consumption, declining fossil fuel reserves, threats to energy security, and the need to respond to climate change. As a source of CO_2 emissions, the industry has found itself at the center of structural changes aimed at reducing its carbon footprint and mitigating its negative impact on the environment [1].

In the context of improving energy efficiency, the industrial sector, which remains the leader in energy consumption and, at the same time, has significant potential for its rational use, attracts particular attention.

Accordingly, energy audits are becoming an important tool that allows for the systematic assessment of an enterprise's energy consumption «mechanism», the identification of losses, the proposal of optimization measures, and the justification of investments in energy conservation projects. However, the effectiveness of an energy audit is determined not only by the accuracy of the analysis and the soundness of technical decisions, but also by the ability to implement the proposed measures in practice. Studies show that in the absence of a clear management approach covering the stages of planning, coordination, monitoring, and control of the implementation of energy-saving measures, a significant part of the identified potential remains unrealized [2; 3].

The successful implementation of energy efficiency projects also requires the creation of a favorable

institutional environment, including government support, access to financial resources, stimulation of innovation, and development of staff competencies. An important role in this is played by raising awareness among enterprise management of the long-term benefits of energy conservation, such as reduced operating costs, increased competitiveness, and reduced environmental impact.

In addition, a necessary condition for sustainable change is the formation of a corporate culture focused on resource efficiency. This involves actively involving employees at all levels in energy consumption management processes, motivating them to initiate change, and using modern digital technologies to monitor and analyze energy performance in real time.

That is why the integration of international project management standards, in particular PMBOK and PRINCE2, opens up real opportunities for the successful implementation of energy-efficient solutions in the industrial sector. Combining the analytical accuracy of energy audits with the clear logic of project management will help reduce organizational risks, ensure control over the implementation process, and increase the economic value of energy-saving measures.

Purpose of the article

Justification of the feasibility of applying project management standards in the process of conducting energy audits of industrial facilities, with the aim of improving the effectiveness of energy efficiency measures, reducing risks, and ensuring sustainable energy results.

Analysis of latest research

The author of the study [4] notes that an energy audit «is a type of scientific energy management method» that provides a quantitative assessment of all energy flows at a facility in order to achieve a balance between energy consumption and expenditure in accordance with its functional purpose, using statistical analysis methods, inspection tests, and diagnostic assessment.

The main task of an energy audit is to identify problem areas in the energy consumption system at an enterprise, assess the rational use of energy resources, and develop competent recommendations for optimizing processes, which are:

- diagnosis of the state of energy management;
- analysis of energy consumption indicators;
- analysis of financial costs;
- analysis of the efficiency of energy use;
- development of a strategy for energy-saving measure.

In [5], the authors analyzed the possibilities of applying project management methodology in the energy sector in the context of the transition to a circular economy model. The main focus was on improving the effectiveness of energy-saving initiatives and strengthening a systematic approach to energy efficiency. The analysis showed that Ukraine has an extremely high energy intensity of its economy, which significantly exceeds the European average, and that improving energy efficiency is not only a tool for saving resources, but also a critical factor in strengthening the country's energy independence and reducing the energy intensity of national production.

Article [6] substantiates the feasibility of introducing project management principles into the system of implementing energy-saving measures at enterprises. The concept proposed by the authors provides not only for a clear definition of the role of project management in the organizational structure of an enterprise, but also for the creation of responsible teams focused on achieving specific results in the field of energy efficiency.

The use of project-oriented approaches in the field of energy efficiency contributes to the optimization of resources, reduction of the duration of implementation of measures, and reduction of technological and managerial risks, which ultimately allows for an increase in the overall effectiveness of project implementation and strengthens the competitive position of the enterprise in the market.

The paper [7] presents the results of a study aimed at identifying key factors in building capacity in energy efficiency project management.

Study [8] examines approaches to project management focused on improving the energy efficiency of heating, ventilation, and air conditioning (HVAC) systems in the context of climate change. The increase in energy consumption in these systems requires the implementation of systemic management solutions that reduce energy losses. One of the key factors for success is careful planning, which includes conducting energy audits and energy assessments to identify inefficient areas and form priority areas for optimization, while the use of flexible management methodologies, such as Agile or Lean, allows projects to be adapted to changes in the environment, ensures continuous improvement, and enables effective response to feedback during the implementation of energy-efficient solutions.

The authors of publication [9] discuss the challenges of identifying and implementing profitable energy efficiency projects, which are essential for the sustainable operation of enterprises. Almost every industrial enterprise has many such projects, but a frequently cited obstacle to implementation is the lack of an internal management system within which these projects could be identified, evaluated, and implemented. The authors emphasize that using a conceptual approach based on Kaizen management principles allows for the integration of energy efficiency project management with operational activities, engineering, and strategy.

Article [10] examines approaches and stages of conducting an energy audit as the first phase of developing an energy-efficient project capable of reducing heating costs by 20–60%. It identifies types of energy audits, a system of indicators for assessing the energy efficiency of buildings, mandatory certification requirements, and key energy-saving measures.

Despite the rapid growth of interest in energy efficiency and the widespread implementation of project management methods in various fields, the number of scientific works that comprehensively address these two topics together remains insufficient.

However, such interdisciplinary issues are extremely relevant and respond to contemporary challenges related to resource optimization, energy security, and sustainable energy development.

In this regard, further research in this area is not only advisable but necessary to improve the effectiveness of energy-saving measures.

Discussion of the main content

Energy audits are a fundamental tool for implementing effective energy management in industrial enterprises.

It allows identifying actual energy consumption flows, optimizing costs, and making informed decisions on energy efficiency measures [11], while integrating the project management principles laid down in the PMBOK (Project Management Body of Knowledge) standard [12] makes it possible to improve the efficiency, predictability, and manageability of energy audits, especially for complex industrial facilities.

Table 1 shows the correspondence between the stages of conducting an energy audit and the components of PMBOK [12; 13].

Table – Correspondence between the stages of conducting an energy audit and the components of PMBOK

Project performance domains	**PMBOK**	**Energy audit**	**Energy audit stage for UAMAP / ISO 50002**
Stakeholders	Stakeholder management: expectations, communication, and engagement in the project	Identification of the client, energy manager, technical staff, management	Preparation for conducting an energy audit.
Team	Team formation, development, and dynamics management	Formation of a group of auditors (energy specialist, heating engineer, instrumentation and automation engineer)	
Development Approach and Life Cycle	Choosing the approach (waterfall, iterative, hybrid) and defining the project life cycle	Adapting the audit to the type of facility (production intensity, access to data, seasonality)	
Planning	Definition of objectives, scope, schedule, resources, risks, and quality	Developing an energy audit plan: stages, deadlines, measurements, technical specifications, access schedule	Energy audit planning.
			Preliminary meeting.
Project Work	Execution management, performance monitoring, and goal alignment	Measurements, inspections, data collection, analysis, calculations, reporting	Collection and processing of basic data. Planning and conducting measurements. Conducting an energy audit of the facility. Processing and analyzing energy data.
Delivery	Procurement and contract management with external contractors and logistics	Renting or purchasing measuring equipment, engaging subcontractors	
Measurement	Defining KPIs, data collection and analysis, and decision-making	Measurement of energy consumption, efficiency, temperatures, lighting, losses, effectiveness	
Uncertainty	Managing risks, unforeseen changes, and complexity	Lack of data, limited access, changes in operating modes, unscheduled equipment shutdowns	
Closure	Project completion	Completion of the energy audit	Preparation and presentation of the energy audit report. Final meeting.

Project management processes [12] related to energy audits [13] are as follows:

- stakeholder management involves:

– identifying project stakeholders (client, project manager, project team, partners, suppliers, investors, end users, authorities, contractors), developing a communication plan, and engaging all project participants;

– identifying stakeholders for conducting an energy audit (client, energy manager, technical staff, and management), agreeing on access to the audit site, and the format of expectations for the audit results;

- team management includes:

– forming a project team, development (training, coaching), motivation and adaptability of the project team, feedback;

– forming a team to conduct an energy audit is carried out by selecting certified specialists of various profiles (energy specialist, electrical engineer, heating engineer, instrumentation and automation engineer);

- choice of approach:

– determination of the approach to project implementation (classical, flexible, hybrid, Lean, etc.) and division of the project into phases;

– the project approach to energy auditing ensures its flexible adaptation to the specifics of the enterprise, transforming the audit into a systematic, managed, and effective process;

- planning involves:

– setting project goals, determining project scope, scheduling, planning project resources, assessing risks, and defining project quality requirements;

– planning the stages of the energy audit involves determining the sequence of work, setting deadlines for its completion, coordinating schedules for the necessary measurements, and ensuring access to energy consumption facilities in order to obtain reliable data and form well-founded conclusions;

- project work (implementation) includes:

– organizing project work, controlling and monitoring project performance, and ensuring consistency with objectives;

organizing energy audit measurements, inspections, data collection, analysis, and reporting;

- supply:

– management of procurement, contracts, and project logistics;

– rental or purchase of equipment, engagement of subcontractors to conduct measurements and surveys of the energy audit site;

- measurement:

– determination of key indicators, collection and analysis of project data, management decision-making;

– determination of key indicators, collection and analysis of data, identification of potential for energy savings;

- risk and uncertainty management:

– project risk identification and analysis involves identifying potential threats, assessing the likelihood of their occurrence and impact on project results, and planning measures to minimize the consequences or eliminate the impact of unforeseen changes;

– lack of information and data, changes in operating modes, or unscheduled equipment shutdowns create risks for the performance of the audit;

- closure:

– official completion of project work and transfer of results to the client, closure of the project;

– preparation and presentation of the report, final meeting, transfer of information to the customer, and completion of the energy audit.

The project approach allows structuring the energy audit as a comprehensive management process based on PMBOK standards, which ensures the involvement of all stakeholders, effective planning of resources and deadlines, as well as maintaining technical accuracy and quality of audit performance.

If we consider the British PRINCE2 standard [14] as a conceptual basis for project management, its integration into the energy audit process makes it possible to transform the audit from a purely technical survey into a structured management project with a clearly defined life cycle, control points, distribution of responsibilities, and documented results, which increases the efficiency and transparency of all stages of work.

The correspondence between the stages of conducting an energy audit and the components of PRINCE2 [13; 15] can be represented as follows:

– the business justification for the project is carried out through the formation of ideas and feasibility assessments, and for energy audits, this component, as part of the preparatory stage, determines the purpose of the energy audit, the expected benefits, the scope, and the objectives of the audit;

– project organization involves creating a management structure by forming a team, identifying responsible persons and communication channels; for energy audits, this means creating a working group and assigning responsibilities;

– the quality of project implementation results includes establishing criteria that meet stakeholder requirements, which for energy audits means data quality, calibration of measuring instruments, and verification of results;

– project and energy audit planning includes the development of a detailed work plan;

– risks, as an element of both project and audit activities, must be accompanied by risk monitoring and the development of measures to minimize them;

– making changes and adjustments during the implementation of the project and energy audit involves clarifying the objectives or methods if new factors are identified;

– progress, as the final stage, is implemented in the form of an analysis of the results achieved and a comparison with the initial objectives.

The introduction of PMBOK and PRINCE2 standards into the field of energy auditing allows for a transition from fragmented implementation of auditing procedures to the creation of a comprehensive management system focused on achieving measurable results.

Within the framework of such approaches, energy auditing is viewed as a full-fledged project with a defined life cycle, objectives, expected results, stakeholders, and success criteria. This not only ensures transparency of processes but also promotes greater accountability for the final result.

Conclusions

The application of PMBOK in energy auditing allows structuring the process based on nine key management areas, making energy auditing a manageable process in which each stage is supported by analytical indicators and control mechanisms.

This allows the company not only to identify energy losses, but also to form a portfolio of energy-efficient projects with projected payback periods, risk assessments, and investment attractiveness.

The British PRINCE2 methodology, in turn, emphasizes flexible management, which for energy audits means creating a clear structure where each participant (auditor, energy manager, management, customer) has a defined role and area of responsibility, and the results of each stage are verified against predefined criteria. This ensures that processes are focused, which is critically important for companies undergoing certification to ISO 50001 or ISO 9001 standards.

The use of project-based approaches in combination with energy audits allows for synergy between technical analysis, economic planning, and management decisions. Such integration will ensure:

– reducing the time required to implement energy efficiency measures;

– improving the reliability of results through standardization of procedures;

– effective management of risks associated with data uncertainty or external factors (seasonality, changes in operating modes, technological shutdowns);

– improving internal communications between stakeholders;

– creating conditions for the digital transformation of energy audits through the use of IT tools, artificial intelligence, virtual models, and digital twins of energy systems.

In practice, this means that energy audits are no longer a one-time check but become a dynamic energy efficiency management system in which the results of each project influence the strategic decisions of the enterprise.

Thus, the synthesis of project methodologies in energy audit management forms a new energy efficiency management model based on consistency, standardization, transparency, and continuous process improvement.

References

1. Lizhi Wang, Chung-Li Tseng. (2012). Special Issue on Challenges and Opportunities in the 21st Century Energy Infrastructure. *Journal of energy engineering*, 138 (2): 31–32. DOI:10.1061/(ASCE)EY.1943-7897.0000072.

2. Jayaraman Chillayil; Suresh M.; Viswanathan P. K.; Sushanta Kumar Mahapatra; Sasi K. Kottayil. (2021). Industrial energy behaviour model: an analysis using the TISM approach. *Journal of Science and Technology Policy Management*, 2023, 14 (1): 74–97. URL: https://doi.org/10.1108/JSTPM-02-2021-0018.

3. Lisauskas, A., Kveselis, V., Dzenajavičienė, E.F., Masaitis S. & Perednis E. (2022). Analysis of energy audits results and impacts: case of small and medium enterprises in Lithuania. *Energy Efficiency* 15, 48. URL: https://doi.org/10.1007/s12053-022-10052-x.

4. Ankit Tandon, Jitendra Kasera, Mr.Manish Pokharna (2012). Energy Audit and Management. *International Journal of Latest Technology in Engineering Management & Applied Science* (IJLTEMAS), Vol. 1, Is. 3, pp. 47–50. ISSN 2278-2540. URL: https://www.researchgate.net/publication/309463130_Energy_Audit_Management.

5. Bedrii, D. I., Semko I. B., Tkachenko, V. F. (2021). Peculiarities of managing energy saving projects in the context of the transition to a circular economy. *Management of complex systems development*. Kyiv, 47, 6 – 13, dx.doi.org\10.32347/2412-9933.2021.47.6-13.

6. Semko I. B., Bedrii D. I., Babych M. I. (2016). Project approach to energy management. Bulletin of National Technical *University "KhPI" : coll. of sci. papers. Ser. : Strategic management, portfolio, program and project management*. Kharkiv: NTU "KhPI", 1 (1173), 97–100. DOI: https://doi.org/10.20998/2413-3000.2016.1173.19.

7. Miodrag M. Vuković. (2014). Upravljanje projektima energetske efikasnosti. *Tehnika – menadžment* 69 (5): 855–860. DOI:10.5937/tehnika1405855V. URL: https://www.researchgate.net/publication/279274811_Management_of_projects_for_energy_efficiency.

8. Wisdom Ebirim, Nwakamma Ninduwezuor-Ehiobu, Favour Oluwadamilare Usman, Kehinde Andrew Olu-lawal, Emmanuel Chigozie Ani, & Danny Jose Portillo Montero. (2024). Project management strategies for accelerating energy efficiency in hvac systems amidst climate change. *International Journal of Management & Entrepreneurship Research* Vol. 6, Is. 3, P. 512–525. DOI: 10.51594/ijmer.v6i3.841. P-ISSN: 2664-3588, E-ISSN: 2664-3596.

9. Sam Aflaki, Paul R. Kleindorfer, and Victor Sáenz deMiera Polvorinos. (2013). Finding and Implementing Energy Efficiency Projects in Industrial Facilities. *Production and Operations Management*, Vol. 22, Is. 3. Pp. 503–517. URL: https://doi.org/10.1111/j.1937-5956.2012.01377.x.

10. Bieliaiev, S. V., & Bieliaieva, N. S. (2020). Approaches to the energy audit of buildings as a component of an energy-efficient project. Economic Space, 154, 68–74. URL: https://doi.org/10.32782/2224-6282/154-12.

11. Guidebook on Energy Audit. (2020). Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)GmbH. Kyiv. 148 p. URL: https://uamap.org.ua/storage/Посібник%20з%20енергоаудиту.pdf?utm_source=chatgpt.com.

12. A Guide to the Project Management Body of Knowledge (PMBOK® Guide)– Seventh Edition. (2021). Project Management Institute, Inc. Newtown Square, PA. 370 p.

13. Practical Guidebook on Energy Audit. (2021). State Agency on Energy Efficiency and Energy Saving of Ukraine, GIZ. Kyiv. 141 p. URL: https://old.saee.gov.ua/sites/default/files/2021_04_02_Practical_Energy_Audit_Guidebook.pdf

14. PRINCE2. (n.d.). The British Prince of Project Management. Worksection Blog. URL: https://worksection.com/ua/blog/prince2.html?utm_source=chatgpt.com.

15. Managing Successful Projects With PRINCE2 7 – Watermarked. 2023. p 363. URL: https://www.scribd.com/document/799374849/Managing-Successful-Projects-With-PRINCE2-7-Watermarked.

The article has been sent to the editorial board 30.07.2025

Семко Інга Борисівна
Кандидатка технічних наук, доцентка, доцентка кафедри електротехнічних систем,
https://orcid.org/0000-0002-6251-5830
Черкаський державний технологічний університет, Черкаси
Бедрій Дмитро Іванович
Доктор технічних наук, доцент, старший дослідник, в.о. директора, професор кафедри менеджменту і маркетингу, професор кафедри штучного інтелекту та аналізу даних, *https://orcid.org/0000-0002-5462-1588*
Державне підприємство «Український науково-дослідний інститут радіо і телебачення»,
Одеська державна академія будівництва та архітектури, Національний університет «Одеська політехніка», Одеса
Семко Олександр Вікторович
PhD, асистент кафедри електротехнічних систем,
https://orcid.org/0000-0002-4309-3556
Черкаський державний технологічний університет, Черкаси

СТАНДАРТИ УПРАВЛІННЯ ПРОЄКТАМИ В ПРОВЕДЕННІ ЕНЕРГОАУДИТУ ПРОМИСЛОВИХ ОБ'ЄКТІВ

Анотація. *Розглянуто доцільність застосування міжнародних стандартів управління проєктами у процесі проведення енергетичного аудиту промислових об'єктів як ефективного інструменту систематизації, контролю та підвищення результативності енергоефективних заходів. Акцентовано, що застосування стандартів управління проєктами сприятиме переходу від традиційного підходу до енергоаудиту як разової перевірки до комплексного управлінського процесу з визначеними цілями, термінами, ресурсами, стейкхолдерами та критеріями успішності. Проаналізовано відповідність етапів енергоаудиту ключовим сферам управління проєктами згідно зі стандартом PMBOK, зокрема управлінню змістом, ризиками, якістю, комунікаціями, ресурсами та зацікавленими сторонами. Досліджено структуру життєвого циклу енергоаудиту відповідно до принципів PRINCE2, які орієнтовані на гнучкість, відповідальність та контроль результатів. Визначено, що інтеграція проєктно-орієнтованих підходів у практику енергоаудиту дозволить створювати єдину систему управління енергоменеджментом, здатну оперативно реагувати на зміни технологічних, економічних і організаційних умов. Зроблено висновок, що впровадження стандартів управління проєктами у практику енергоаудиту створює підґрунтя для формування нових моделей управління енергоефективністю, яка поєднує технічну точність, організаційну дисципліну, гнучкість планування та стратегічну орієнтацію на сталий розвиток промислового сектору.*

Ключові слова: енергетика; енергетичний аудит; управління проєктами; стандарти; енергоефективність; промислові об'єкти

Link to publication

APA Semko, I., Bedrii, D., & Semko, O. (2025). Application of project management standards in conducting energy audits of industrial facilities. *Management of Development of Complex Systems*, 64, 23–28, dx.doi.org\10.32347/2412-9933.2025.64.23-28.

ДСТУ Семко І. Б., Бедрій Д. І., Семко О. В. Стандарти управління проєктами в проведенні енергоаудиту промислових об'єктів. *Управління розвитком складних систем.* Київ, 2025. № 64. С. 23 – 28, dx.doi.org\10.32347/2412-9933.2025.64.23-28.