INTEGRATION OF ENERGY AUDIT INTO THE MANAGEMENT SYSTEM OF AUTOMOBILE TRANSPORT ENTERPRISES

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INTRODUCTION

Introduction. In the face of climate change and the push for a smaller carbon footprint, managing energy resources is key for companies, especially in the automobile transport sector which is integral to global logistics. These companies face the challenge of high fuel use and emissions, needing to find ways to use resources more efficiently and reduce environmental harm. Energy audits are crucial for these enterprises, helping improve efficiency and support corporate social responsibility [1]. These audits, which assess and suggest optimizations for energy use - including fuel consumption, vehicle and logistics efficiency, and energy management in buildings - are vital for integrating into strategic planning. They are increasingly important due to rising energy costs and the demand for environmental sustainability, highlighting the importance of effective energy management for the success of automobile transport enterprises. This research examines how energy audits can be effectively incorporated into their management systems, using a systemic approach.

The aim of the research is to develop a detailed description of the energy audit system in automotive enterprises to ensure its efficiency, enhance energy efficiency, reduce negative environmental impact, and shape the enterprise's image as a socially responsible business in the face of modern sustainable development challenges..

Objectives:

1. Define the essence and explore the main components of the environmental audit system, their structure, functions, and connections within automotive enterprises, ensuring its effective operation and integration into the overall management system of the enterprise.
2. Identify the objectives of the energy audit system in automotive transport enterprises and the key elements necessary for its effective functioning.
3. Outline the subjects and objects of the energy audit in these enterprises, their essence, roles, and interactions.
4. Thoroughly investigate the current processes occurring within the energy audit system and their interactions.
5. Develop methods of interaction between the system elements, as well as management and control mechanisms.
6. Establish the main ways to enhance energy efficiency and reduce the environmental impact of the enterprise.
7. Examine the energy audit system in the context of external factors, including market conditions, legislative requirements, environmental standards, and societal expectations.
8. Consider opportunities to improve energy efficiency in the company's vehicle fleet, specifying concrete measures that can be implemented to reduce fuel consumption and enhance the environmental impact of vehicles.

The methods of the research. Integrating energy audits into the management systems of automobile transport companies requires a holistic approach, viewing energy use as part of the wider organizational system. This method is crucial for several reasons: it allows for a full understanding of energy needs and opportunities for improvement by encompassing all levels of the organization, from strategic planning to operations and logistics. It also helps identify and implement energy-saving measures, reducing costs and boosting efficiency. Moreover, a systemic approach provides the flexibility to quickly adapt to changes in the energy and transport markets. It demonstrates a commitment to environmental responsibility and sustainable practices, improving the company's image. Finally, this approach keeps management informed about energy use, aiding in the decision-making process for investments in energy efficiency and environmental initiatives.

Theoretical background. Numerous scholars, including Y.V. Belinska, V.M. Boyarchuk, R.B. Hevko, T.V. Hilorme, L.Yu. Hordeieva-Herasymova, A.Yu. Deyna, Y.V. Dzyadykevich, L.I. Kytskay, V.A. Malyarenko, V. Mamalyga, M.O. Myhalochkina, V.I. Perebyinis, V.P. Rozen, O.I. Solovey, S.V. Tyshchenko, A.M. Tryhuba, O.V. Fedirets, A.V. Chaplygin, and others, have devoted significant attention to resolving the theoretical and methodological aspects of energy audits. However, despite the thoroughness of their research, which encompassed the organizational and practical aspects of conducting energy audits, Ukraine still lacks sufficiently developed projects on energy efficiency implementation in automobile transport enterprises, especially considering the requirements of European standards. This gap in research underscores the need for a detailed study and justification of the process of integrating a comprehensive energy audit system into the organizational management structure of enterprises.

Main findings

An energy audit systematically evaluates an enterprise's energy usage, aiming to enhance efficiency and reduce costs by examining all aspects of operations, including vehicles, buildings, and equipment. Its primary objective is to optimize energy consumption and implement energy-saving measures, thus lowering operational expenses and improving financial performance. By promoting the rational use of energy resources and minimizing fuel consumption, energy audits contribute to environmental protection through reduced emissions, aligning with legislative and regulatory standards to prevent fines. Furthermore, energy audits bolster an enterprise's reputation by demonstrating a commitment to sustainability and responsible resource use, fostering trust and market position. Additionally, they drive innovation by highlighting areas for technological and procedural improvements. Overall, energy audits are vital for sustainable development in automobile transport enterprises, offering economic advantages while underscoring societal and environmental responsibility. The EA system has a hierarchical structure with clearly defined roles for each component. The interaction between components is facilitated through coordination mechanisms and information exchange procedures.

Key Elements, Interactions and Roles in the Energy Audit Process in ATEs:

Element	Description	Role & Interaction in the Energy Audit Process
Energy auditors	Experts with specialized knowledge in energy management, overseeing the audit from data gathering to proposing energy-saving actions. They evaluate current energy use, pinpoint wasteful practices, and suggest improvements.	Collect and analyze data on fuel efficiency, energy consumption in buildings, and logistical operations. Develop tailored recommendations for optimizing energy consumption.
Vehicles	Core of ATE operations. Assessing vehicles' fuel efficiency is crucial for finding ways to cut fuel use and costs. Strategies might involve fleet upgrades, better vehicle utilization, and adopting fuel-saving technologies.	Analyzed for fuel efficiency to identify ways to reduce fuel consumption. Data impacts energy efficiency strategies for buildings and logistical processes.
Service and Administrative Buildings	Energy use in these buildings is scrutinized, focusing on electricity, heating, and water use, among others. Recommendations might cover enhancing insulation, installing energy-efficient lighting, and other energy reduction strategies.	Energy consumption and optimization measures analyzed to affect overall energy efficiency. Leads to optimization of logistical processes and implementation of energy-efficient technologies.
Logistics and Operational Processes	Involves analyzing routing, scheduling, and other logistical activities that impact energy use. Streamlining these areas can lead to significant energy efficiency gains.	Interact with information systems for energy consumption analysis and optimization strategy development. Identifies inefficient routes and processes to reduce fuel and energy consumption.
Information systems	Manage data on energy consumption, enabling the automation of monitoring, identifying anomalies, and evaluating the success of energy-saving initiatives.	Facilitate the gathering, analysis, and storage of data on energy usage from all components, enabling the development of optimization strategies.

The subjects of the energy audit in ATEs include energy auditors and the management of ATEs, who are responsible for deciding on conducting an energy audit, selecting auditors, and adopting and implementing recommended measures; technical staff, such as engineers and technicians, who maintain vehicles and other energy-consuming systems in ATEs, providing necessary information and support to auditors during the audit; and ATE employees, whose actions and work processes affect energy consumption and who may be involved in implementing recommended energy-saving measures.

The objects of the energy audit in ATEs are, firstly, vehicles such as buses, trucks, service cars, etc., belonging to the enterprise's fleet. These are the main consumers of fuel and are analyzed for fuel efficiency improvement; secondly, service and administrative buildings like offices, garages, service stations, and other buildings that use electricity, heat, and water are analyzed for insulation, lighting, ventilation, and other factors affecting energy consumption; thirdly, logistical and operational processes including routing, schedules, transportation logistics, and other operational processes that can be optimized to reduce fuel consumption and increase efficiency; and fourthly, energy systems and equipment like heating, ventilation, air conditioning, lighting systems, and other equipment in ATE buildings that are significant energy consumers. For theoretical and practical use, the objects of the energy audit in ATEs should be characterized (analyzed) by the following parameters: object name describes the specific audit object (e.g., truck, administrative building, lighting system, etc.); type of energy consumption indicates the type of energy used by the object (electricity, gasoline, diesel fuel, etc.); current consumption records the current level of energy consumption by the object (e.g., liters/100 km, kWh, etc.); savings potential assesses the potential reduction in consumption through optimization (in percentage change); recommended measures define specific actions for improving energy efficiency (e.g., route optimization, fleet modernization, eco-driving, insulation, lighting and ventilation system upgrades, GPS system implementation for route optimization, energy-efficient equipment introduction, automation of management, etc.); expected payback calculates the period within which investments in measures will pay off; environmental impact assesses the impact of recommended measures on reducing emissions and environmental impact (e.g., reducing CO_2 emissions and other substances, reducing fuel and energy consumption, etc.).

The EA system within ATEs is influenced by several external factors that impact its operation and efficiency. These factors include legislative and regulatory frameworks that mandate adherence to energy efficiency, emissions, and sustainability standards; market conditions, which affect energy costs due to fluctuations in fuel, electricity, and water prices influenced by economic, political, and social variables; environmental standards aimed at reducing pollution and ensuring environmental safety; technological advancements that offer new ways to enhance energy efficiency and decrease environmental harm; and societal expectations on environmental and energy performance, pressuring companies to adopt sustainable practices. Together, these elements shape how ATEs manage their energy use and environmental impact.

MAIN RESULTS AND CONCLUSIONS

MAIN RESULTS: It has been determined that a systematic energy audit provides a comprehensive assessment of a company's energy consumption, contributing to increased efficiency and optimization of energy expenditures. An hierarchical structure of the energy audit has been established with clearly defined roles for each component, facilitating effective interaction and information exchange. It has been ascertained that the subjects of the energy audit include management, technical staff, and employees who have a direct impact on energy consumption processes. The pivotal role of energy auditors in identifying and implementing energy-saving measures at all levels of company operations has been proven. Strategies have been developed to increase the fuel efficiency of vehicles, including fleet modernization, optimization of vehicle use, and the application of fuel-saving technologies. Significant potential has been identified for reducing energy consumption through the optimization of logistical and operational processes, which includes routing, planning, and the use of information systems for monitoring.

Conclusion. Therefore, the conducted research has developed a detailed description of the energy audit system in ATEs, which aids in ensuring its effective functioning. This system is aimed at achieving goals related to enhancing energy efficiency and reducing environmental impact. Additionally, it improves the enterprise's image as a socially responsible business, a crucial factor in today's world. In conclusion, it can be asserted that the environmental audit within the management system of ATEs serves as a key tool for achieving not only environmental benefits but also long-term economic advantages. It facilitates the establishment of an effective environmental management system, enabling enterprises to respond to contemporary challenges and meet the high standards of sustainable development.