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Energy Audit in Construction Production

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Abstract: In this research work, the need to improve and use information technologies for the development of the construction industry, to provide information to the market of construction products, works and services, to provide information acquisition and transmission in various areas of the industry is shown. All this determines the need to evaluate the effectiveness of automated control systems (ACS), which reflects the level of compliance of the system with the specified tasks.

Keywords: Analysis, ASK, transport-operational indices, pavement strength, longitudinal and transverse evenness, road pavement condition, intensity, geometric parameters, bite coefficient, pavement strength, road network.

INTRODUCTION

The solution to the problem of saving energy resources - an increase in the efficiency of energy saving - in the construction industry can be ensured through the development and implementation of relevant provisions, which include the issues of accounting, analysis and regulation of fuel and energy resources (FER) consumption, the formation of a complex of energy-saving organizational and technological measures, and the assessment of the effectiveness of their use. Decisions made should be based on reliable information on the current level of energy consumption in the construction industry. Such information is necessary for a qualitative analysis of energy consumption and for establishing economically justified objective norms for the consumption of fuel and energy resources in the construction industry.

Studies of the problem of energy saving have shown that the available information on the consumption of energy resources during construction work is insufficient for their analysis and purposeful solution to the problem of saving energy resources [1]. As a rule, construction organizations keep separate records of consumed types of fuel and energy resources: electricity and heat, diesel, gaseous fuels, gasoline, and others, which could not be reduced to a single measure unit (for example, to fuel equivalent); this does not allow determining the total energy intensity of construction products.

ENERGY AUDIT METHODS

To study the identified issues, the author proposes to use energy audit methods for the consumption of fuel and energy resources in the construction industry, based on the results of his dissertation research.

An energy audit in the construction industry is understood as an analysis conducted by independent specialists (experts) of the system for organizing, monitoring, and managing the consumption of energy resources, applying energy-saving technical-organizational and technological solutions, checking the technical conditions of energy consumption units (machines, mechanisms, equipment, utilities, systems and networks), as well as the examination of design-technical documentation for the construction of facilities.

The purpose of the energy audit is to improve the energy efficiency of construction and installation works, the development and implementation of innovative energy saving measures, and the modernization of construction production.

An energy audit in the construction industry is an energy audit of construction and installation processes in order to establish the actual level of energy consumption and its compliance with established standards, analysis of the current energy consumption system, formation a plan for energy-saving measures, development of progressive fuel consumption rates, etc. An energy audit allows specialists to reveal the reasons and perform a quantitative assessment of the irrational consumption of fuel and energy resources, choose a rational solution for saving energy resources, taking into account the individual characteristics of the construction of the facility, establish norms for the consumption of fuel and energy resources for construction and installation works [2, 3].

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Thus, an energy audit in the construction industry includes the following main stages:

- Monitoring of fuel and energy consumption:
- Forming a plan for energy-saving solutions:
- Regulation of fuel and energy consumption.

Monitoring fuel and energy consumption in the construction industry is a process of systematic or continuous acquisition, processing, and analysis of information on the consumption of energy resources in the course of construction and installation works. Such information is necessary to assess the efficiency of fuel and energy consumption, and develop appropriate energy-saving solutions and consumption rates. Monitoring can be conducted on the basis of appropriate organizational observations of the construction and installation processes.

The main task of monitoring is to obtain actual data on the structure and amount of energy consumption for various production and auxiliary needs, and on the presence of factors affecting the consumption of fuel and energy resources [4]. Costs for production needs include the consumption of energy resources for transport and technological arrangements necessary for the operation of group I energy consumers who are directly involved in the creation of construction products: vehicles, excavators, bulldozers, assembly cranes, welding machines, painting and plastering stations, etc. Costs for auxiliary needs include the consumption of energy resources to create the required microclimate parameters and comfortable conditions for people to stay on the premises; compliance with safety, labor, and environmental protection measures; automation of management processes; household and other needs necessary for the operation of energy consumers of groups II and III, which are indirectly involved in the creation of construction products, providing normal conditions for the construction and installation processes: devices for heating, electric heating, lighting equipment, automated control systems, etc.

The results of observations can be reflected on the forms of graphic or mixed photo accounting. In the process of observation, the operating time of energy consumers, the amount of fuel and energy resources actually used, the volume (quantity) of manufactured products, as well as all the identified information necessary for analyzing the efficiency of energy consumption are registered [5-8], including:

- brand and technical characteristics of fuel and energy consumers, their compliance with standards and other regulatory documents, energy resource consumption rates in different operating modes, and technical conditions;
- description of the organizational and technical conditions that characterize the process under study;
- information about the factors affecting the increase or decrease in energy consumption;
- data on the use of energy resources for other purposes, for example, lighting of premises in the absence of people, excessive heat consumption for heating domestic premises at night, complete loading of mechanisms, etc.;
- reasons for the loss of energy resources, and technological breaks during which the devices are idling:
- factors for performing unnecessary work, etc.

For observations, it is appropriate to use special technical means for recording time, electric and heat energy, mass, and volume, for example, a stopwatch, a voltmeter, heat meters, thermal imaging units, air flow meters, scales, measuring containers, a measuring tape, etc.

The duration of observation should not be less than a full work shift. In some cases, observation is conducted during the day, sometimes - on weekends, for example, when determining the cost of lighting, heating, heat treatment of monolithic concrete, etc.

For the analysis of energy consumption, it is proposed to divide the entire consumption of fuel and energy resources into two groups: production costs and losses. The first group includes the costs of performing work on the assignment and the costs of unforeseen work. The subgroups of energy resource costs of performing work on the assignment include the costs allocated for the operation of energy-consuming devices under full load, part load, and no-load modes.

The second group includes energy consumption for various kinds of losses associated with:

- the technology and organization of construction;
- the performance of random and unnecessary work;
- the violation of labor discipline.

Observation results processing is registered on special forms (MPS forms), which

reflect the main indices necessary to analyze the consumption of fuel and energy resources (Fig. 1). When filling out the form, along with indicating the operating time of energy-consuming devices, it is also necessary to calculate the amount of energy consumed during this time, bringing the appropriate explanations and calculations.

For the convenience of analyzing energy consumption in the construction industry, it is proposed to determine the specific consumption of fuel and energy resources, expressed in the amount of fuel equivalent (kg of fuel equivalent, ton of fuel equivalent), referred as the product measure. The amount of manufactured products (work) can be taken as a measure of production expressed in specific units, for example, m², m, running meter, piece, kg, l, etc. It is appropriate to use a conventional unit - the cost of construction and installation works as a measure, for example, 1 thousand rubles in basic prices (CU CMP). (Y_E CMP). Then the unit of measurement of the specific consumption of fuel and energy resources is written as t (kg) y. t./(CU CMP).

As a result, based on the monitoring data on the consumption of fuel and energy resources, the total consumption of energy resources spent on the production of a certain volume (quantity) of construction products is determined, the weight of the group of production costs and losses is estimated, and the specific index of energy consumption is calculated. The results of the monitoring are the primary information for the formation of a plan of energy-saving solutions aimed at eliminating the identified losses and reducing the share of production costs associated with the operation of energy consumers under idle and partial load modes. Based on the analysis of the results of observations, technical and organizational and technological proposals were identified aimed at reducing the cost of energy resources, including the replacement and repair of building machines, equipment and technical devices, R&D, training and instruction of personnel, changes to the project documentation, etc. [2, 9]. Monitoring the consumption of fuel and energy resources during construction and installation works makes it possible to obtain the necessary reliable primary information on the actual consumption of energy resources, which is necessary for further development of solutions of energy saving plans.

The considered methods of an energy audit are universal. They allow the specialists to solve a number of issues related to the organization of energy saving in construction production. Monitoring fuel and energy consumption is necessary to improve the efficiency of energy saving in construction and installation organizations, the formation of energy-saving organizational and technological solutions, and the determination of current and future energy consumption rates in the construction industry. An energy audit allows for assessing the energy characteristics of construction and installation processes, the level of energy consumption, and analyzing the effectiveness of energy-saving decisions made. To determine the progressive consumption rates of fuel and energy resources in the construction industry, it is proposed to use the developed methods for the formation of complex organizational and technological solutions aimed at reducing the cost of energy resources in the production of construction and installation works [2, 3].

Table 1. Indices to determine STL ACS (PC SMR-W)

Factor name	**Notation**	**Quality characteristic**	**Estimation**
Process type		Continuous process with discontinuous material flow	
Payback period of ACS	T		1 year
Degree of coverage of the tasks	y_{3A}		0.7
Level of ACS software design methodology: a) system-wide documentation: information computing functions	y_{N1}	Automated Prototypes	1.0 0.7

information support and programming tool b) a complex of technical means	Y_{N3} Y_{N4}	Automated	0.8 1.0
Information acquisition and processing	Y_{11}	Acquisition, primary processing and storage of technical and technological information	3.0
Calculation of indices and preparation of information	Y_{12}	Preparing information for higher and related systems and management levels	10
Control and registration of parameters	Y_{13}	Control and registration of deviations of process parameters and equipment condition from the set parameters	10
Analysis, diagnostics and forecasting of states.	Y_{14}	Diagnosis and forecasting of the states of the complexes of technical means of automated control systems	10
Displaying information and executing procedures	Y_{15}	Implementation of procedures for automatic exchange of information with higher and related control systems	10
Type of regulation	Y_{21}	Multi - coupled regulation	10
Logic and software control	Y_{22}	Execution of software and logic operations of discrete control of the process and equipment	10
Optimal control	Y_{23}	Optimal control of the facility as a whole with adaptation of the control system	10
Information support	Y_{31}	A single information base	10
Software	Y_{32}	Operating Systems	10
Number of points of control and management	Y_{41}	Up to 900	5
Structure of TMC	Y_{42}	Direct digital control	10
Violation resistance	Y_{43}	No disruption due to automation redundancy	10
Type of PC	Y_{44}	PC	10

CONCLUSION

- Energy survey of the current level of energy consumption in the construction industry is aimed at solving the problem of economical and rational use of fuel and energy resources.
- Energy audit of construction and installation processes is necessary for the analysis of energy consumption, the formation of a plan for rational energy-saving measures, and it can be used in the development of norms for the consumption of fuel and energy resources in the construction industry.
- Monitoring the consumption of fuel and energy resources makes it possible to obtain reliable primary information about the actual level of energy consumption, identify the loss of energy resources and the reasons for the irrational consumption of fuel and energy resources during construction and installation works.

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