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© **V.S. Gorbunova, E.U. Puzina**
Irkutsk National Research Technical University

Irkutsk, Russia

EFFICIENCY OF INTRODUCTION OF THE ENERGY MANAGEMENT SYSTEM IN RUSSIAN INDUSTRIAL COMPANIES

Aim: The purpose of the study is to present an overview of national and international energy management systems and suggest activities to enhance the quality of the realisation of the energy management systems in Russian industrial companies.

Methods: The authors have used the description of the energy saving and energy management systems directions under research, the analysis of the qualitative properties of the energy management systems in use, structural and functional method for the development of the general structure and stages of functioning of the energy management systems.

Results: During the research, the authors have revealed the necessity to unify separate directions of the energy saving policies of Russia's industrial companies into the energy management system that is a subsystem of the overall enterprise management, combining the company's strategic goals, energy auditing, training personnel in energy saving and energy efficiency enhancement, energy resources recording system, the formation, realisation and monitoring of the energy saving programme, and automation of the energy saving and energy efficiency enhancement activities.

Conclusion: The realisation of the suggested measures will enable forming the conditions for the transition to a large-scale implementation of the energy management system, that fosters the realisation of the state policy in energy saving and energy efficiency enhancement.

Keywords: energy management system, increasing energy efficiency, development of the energy policy.

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Иркутский национальный исследовательский технический университет

Иркутск, Россия

ЭФФЕКТИВНОСТЬ ВНЕДРЕНИЯ СИСТЕМЫ ЭНЕРГЕТИЧЕСКОГО МЕНЕДЖМЕНТА В ПРОМЫШЛЕННЫХ КОМПАНИЯХ РОССИИ

Цель: Представить обзор зарубежных и российских систем энергетического менеджмента и предложить мероприятия, направленные на повышение качества реализации систем энергетического менеджмента в российских промышленных компаниях.

Методы: Использовались описание исследуемых направлений энергосбережения и систем энергетического менеджмента, анализ качественных характеристик применяемых систем энергетического менеджмента, структурно-функциональный метод для разработки общей структуры и этапов функционирования систем энергетического менеджмента.

Результаты: В ходе исследования выявлена необходимость объединить частные направления энергосбережения российских промышленных компаний в систему энергетического менеджмента, которая является одной из подсистем общей системы управления предприятием, соединяющей стратегические цели компании, энергетический аудит, подготовку персонала по вопросам энергосбережения и повышения энергетической эффективности, систему учета энергоресурсов, формирование, реализацию и мониторинг программы энергосбережения, а также автоматизацию деятельности по энергосбережению и повышению энергетической эффективности.

Выводы: Реализация предложенных мер позволит сформировать условия для перехода к широкому внедрению системы энергетического менеджмента, способствующего реализации государственной политики в сфере энергосбережения и повышения энергетической эффективности.

Ключевые слова: система энергетического менеджмента, повышение энергоэффективности, разработка энергетической политики.

Introduction

Currently, in today's enterprise management practices, the problem of increasing energy efficiency is becoming more acute. In other countries, there are active actions being taken to develop and realise projects of energy efficiency bolstering [1]. Embedding these projects is also one of the directions of Russia's industrial enterprises' development.

The increase of relevance of energy saving caused by the world's global and regional economic downturns, led to necessity of improving the international standardisation system of energy management, the basic objectives of which are regulation and disclosure of principles of development of energy efficient

processes of industrial enterprises' operation, and elaboration of rational energy management policies of enterprises.

The energy management in enterprises comprises a range of functions, the fulfillment of which gives a detailed information on major fuel and power consumers, main industrial processes' efficiency, reduction of power consumption. All this actually makes up the energy management system (EMS).

The active pace of development of the energy management technologies is frequently connected with the emergence of economic crises, during which the issues of production competitiveness, distribution or consumption of fuel and power resources (FPR) become particularly acute [2]. One of the most significant stages to determine transition to today's stage of development of systemised approaches to energy conservation, was the 1970s energy crisis, that triggered elevation of oil prices and, naturally, inflation rates [3]. One of the crucial consequences of the crisis was a widespread dissemination of energy saving technologies, which are one of the main instruments of enhancement of competitiveness of industrial enterprises' products.

In this respect, by the end of 1970s, the governments of several states (Germany, the USA, Japan) began implementing legal mechanisms to incentivise energy conservation on a national scale. This led to the emergence of separate directions in the sphere of FPR consumption. In the same period, the first concepts of energy efficiency management in connection to ecological problems of the regions with industries were formulated [4].

Thus, the big industrial enterprises' coming to the idea of the energy management was connected with the acute need in saving resources, cutting down indirect expenditures on production, and reducing environmental pollution.

Gradually, the realisation of separate directions in the sphere of energy conservation was becoming more systemised in the majority of industrial states, which lead to development of the International Energy Management Standard [5]. The systemised idea of energy management sees a close interrelation with other types of management: operation of production processes, production logistics, ecology management and HR management [6]. Thus, the today's energy management is a continuation of an early energy saving concept.

The problems of the implementation of EMS in Russia's industrial enterprises are connected with the peculiarities of the modern stage of social and economic development, which is characterised by development of private ownership in the industrial sector and transition to decentralised planning. Some authors maintain that the energy crisis negatively influenced the processes of formation of internal approaches to energy saving, opening export channels for local energy resources [3]. A number of researchers point out that a growing importance of energy saving in Russia relates to transition to market economy in the early 1990s: the energy resources' prices in the decentralised system of industrial production naturally grew by 15–20 % on average, with the general level of energy intensity of the industrial products saved [3].

The peculiarities of development of the Russian energy infrastructure also determined the investment policy. Thus, in 1990s the volume of financing of the energy sphere dropped substantially, despite significant moral and physical obsolescence of equipment in the enterprises of this branch. This also had a bearing on informational and technical, and monitoring facilities, which provide analysis of the current and future state of the energy infrastructure elements. Because of this, some producers perform with low efficiency, and their prices and tariffs on an international scale are not competitive.

One of the most significant factors to encourage development and implementation of EMS in today's Russia was its joining the World Trade Organisation. Joining WTO, again, emphasised low competitiveness of national products in the international markets due to low energy efficiency of industries. Russia's joining WTO was preceded by a number of federal legislative acts, which reflected the state position on improvement of energy and ecology related aspects of Russia's economy [7]. At present, the Federal Energy Saving Programme up to 2020 is in action. It is aimed at decreasing the energy intensity of GDP of Russia by 13,5 %.

Generally, implementing EMS realises the systemised approach to management of FPR. However, for the majority of Russia's industrial companies the implementation of EMS is more driven by the legislation of the Russian Federation, and to a lesser extent by the actual intention to increase energy efficiency at the expense of such implementation. This can be explained not only by a low experience in realisation of this system, but also by lack of methods of assessment of the results of EMS implementation efficiency.

Setting the Task

Among the most serious problems of realisation of the energy management systems in Russia there are industrial companies' administrations' lack of understanding of the relevance of the energy policy, the boundaries of responsibility in its realisation and unclear documentation support connected with the realisation and implementation. These contradictions result in low efficiency of organisation of EMS in industrial enterprises.

Thus, during application of EMS in Russian enterprises, there will be a topical task to solve – the development of an efficient energy policy.

Now, a number of big Russian companies are realising projects of implementation of EMS on the basis of ISO 50001:2011 requirements (Russian National Standard (GOST) R ISO 50001-2012). Among these companies there are Rosneft, Transneft, Sibur Holding, Surgutneftegas, Lukoil, Rossiiskiy Seti (Rosseti), INTER RAO, Rosatom, RZhd, Gazpromneft, etc.

The Standard [8] sets requirements for EMS on development and realisation of the energy policy, tasks, objectives and plans, in which legal requirements and information concerning utilisation of energy are considered.

The purpose of the developed ISO 50001 consists in an enterprise's providing a well-structured and all-encompassing guideline on optimisation of energy resources consumption and systematic management of this process, to ensure continual improvement of energy efficiency.

The fig. 1 shows a model of EMS in accordance with ISO 50001, which is based upon the cycle: plan (planning) – do (implementation and operation) – check (checking) – act (internal audit, management review, continual improvement). As it can be seen from the fig. 1, the energy policy is a starting point and consequently the basis of any EMS. The ISO 50001 defines the energy policy as “the overall intentions and direction of an organisation related to its energy performance, as formally expressed by top management. The energy policy provides a framework for action and for the setting of energy objectives and energy targets” [9].

The implementation of EMS is aimed at following:

- energy provision;
- measuring, providing documents and reports on energy utilisation;
- procurement;
- developing methods of assessment of efficient utilisation of energy by equipment, systems and processes.

In order to survey best practices and efficiency of implementation of EMS in accordance with ISO 50001 provisions, in 2015, the Ministry of Energy of the Russian Federation with the participation of Russian Energy Agency of the Ministry of Energy, conducted monitoring of management of energy efficiency and implementation of EMS in Russian companies [10].

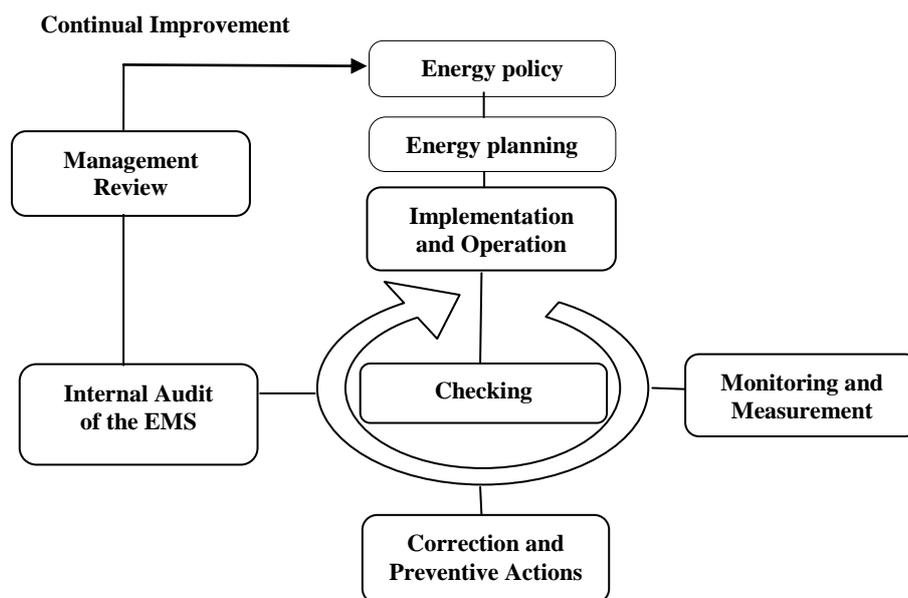


Fig. 1. Energy Management System Model

This survey covered more than 80 large industrial enterprises of Russia, engaged in energy sector, oil, gas, coal, metallurgical, extractive, chemical and petrochemical industries, as well as in transport and communication spheres.

The information about the share of companies under survey which implemented EMS, is given in the fig. 2.

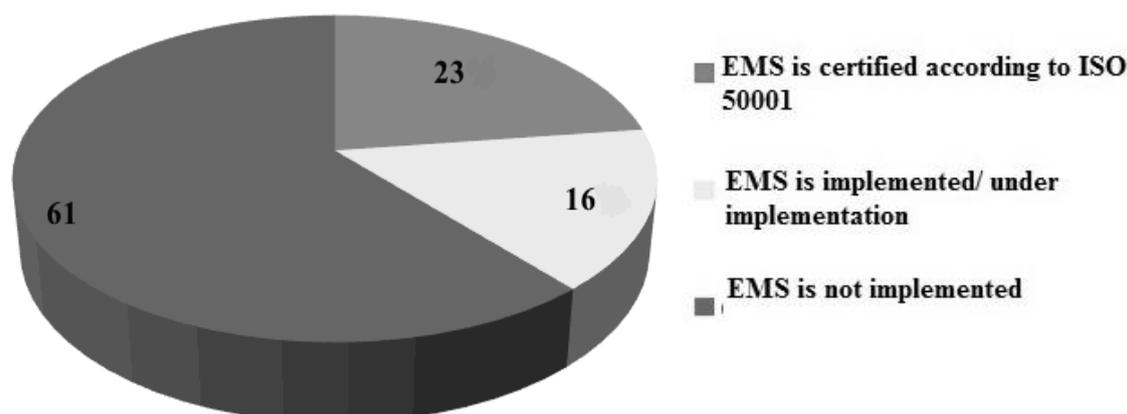


Fig. 2. The share of companies under survey which implemented EMS, %

As we can see, only 23 % of the companies surveyed implemented EMS. The most part of industrial companies, which are implementing EMS, is made up of big companies of energy, oil, gas, and coal industries. This can partly be explained by an increased attention to this issue of the Ministry of Energy as the federal supervising body.

All companies that had implemented EMS, developed energy policy, energy saving programme, and energy saving and EMS standards. In 70 % of companies, there are methods of assessment of activities to enhance energy efficiency.

In companies, which only observe legislation requirements, the energy policy was developed only in 7 % of cases, and the methods to assess efficiency of activities to enhance energy efficiency are developed in 10 % of companies. Enterprise energy saving standards are developed in one third of the companies, and every fifth organisation does not have any energy saving programme.

The results of the research allow concluding that the results of the mandatory energy survey are applied mostly in industrial companies, that implemented EMS, which is indicated by 100 % availability of energy saving programmes there.

In fuel and energy industry, 36 % of companies have already implemented EMS, and 19 % are either implementing or planning to implement by the end of 2017. This indicates that there is a high interest of the fuel and energy industry companies in a systematic approach to the problem of enhancing their energy efficiency.

In other branches of industry, EMS is implemented in 3 % of the companies, with 12 % planning to implement it in the near years.

The assessment of efficiency of implementation of EMS was carried out by experts by giving points for every criterion. At the same time, the significance of the influence of the indicator on the overall efficiency of energy saving activities and enhancing energy efficiency was determined. After the assessment, the efficiency rating was made, which indicates efficiency or inefficiency of implementation of EMS in a company.

Then, the companies were arranged by their points in %, which can be seen in the fig. 3.

The results of the study showed that in the process of energy efficiency management many companies underwent the energy survey, determined their further goals and objectives in energy saving and energy efficiency activities, conducted monitoring of indicators and highlighted those with the help of which the company may achieve increase in energy efficiency with minimal efforts and lowest investments (the performance ratio lies within 40–67 %).

Some companies went even further and appointed energy efficiency and saving supervisors, introduced key factors of energy efficiency, began energy efficiency training and raising awareness of energy saving among the personnel, realising mid-term activities, consisting in energy efficiency enhancement (the performance ratio lies within 67–90 %).

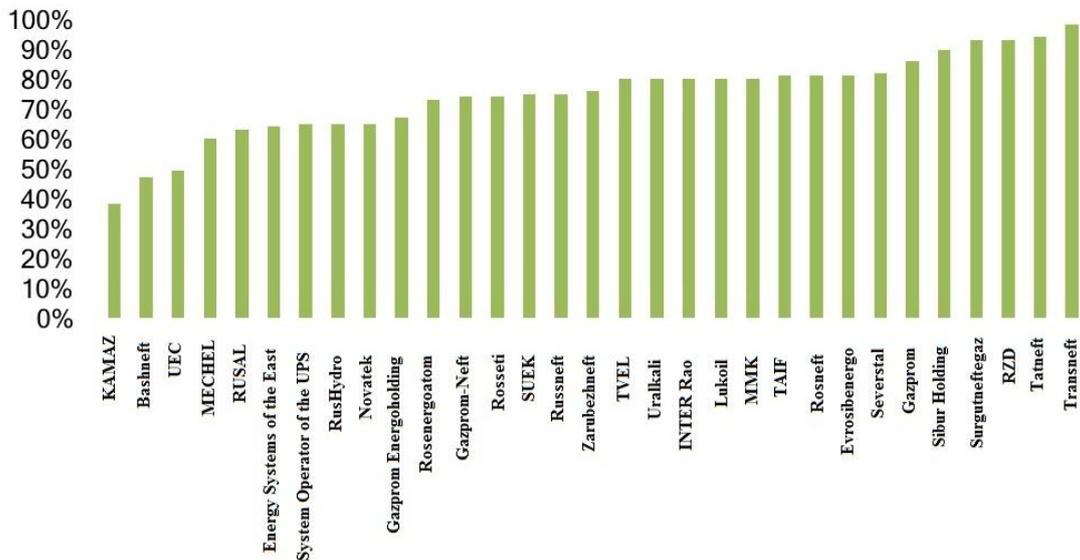


Fig. 3. Performance ratio of the companies under survey, %

During the survey, the evaluation summary of efficiency of functioning of EMS (fig. 4) was carried out, with the help of complex information analysis by chosen criteria of the energy management: fuel and power resources economy (%), the share of costs for energy saving measures from total costs of fuel and energy resources (%), the share of costs for fuel and energy resources in the cost of production compared with the base year.

Besides, the complex performance ratio analysis of implementation and functioning of EMS in the companies (fig. 5) was made.

The high results of the evaluation summary of performance ratio and efficiency of EMS of the companies were shown by Transneft, Sibur Holding and Rosseti, which implemented EMS.

The analysis of the changes in a company followed by implementation of EMS demonstrates significant effects, that were achieved with the implementation of EMS and its elements. For instance, in Transneft the improvement of personnel discipline as well as planning procedures were detected.

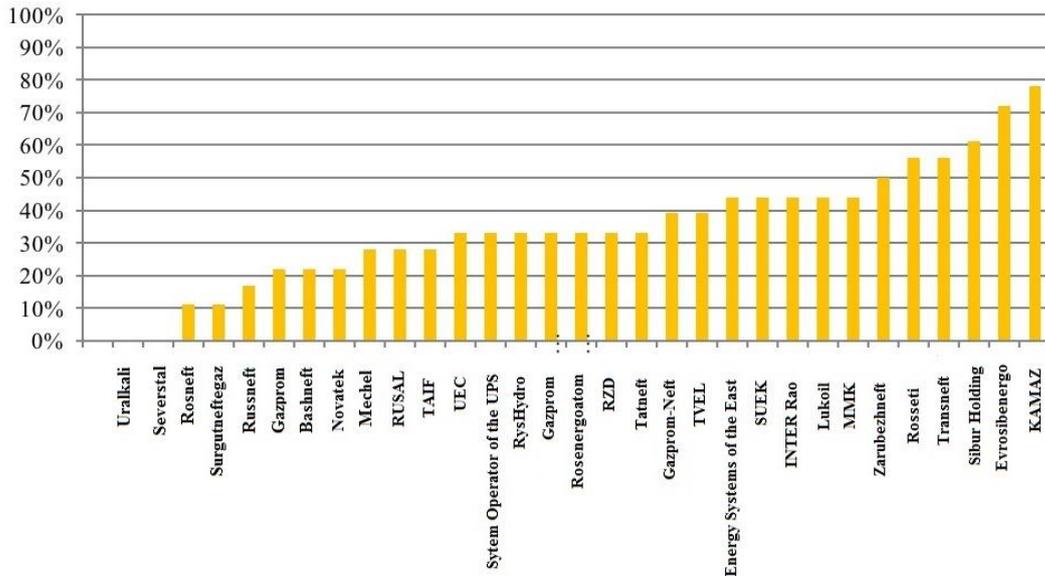
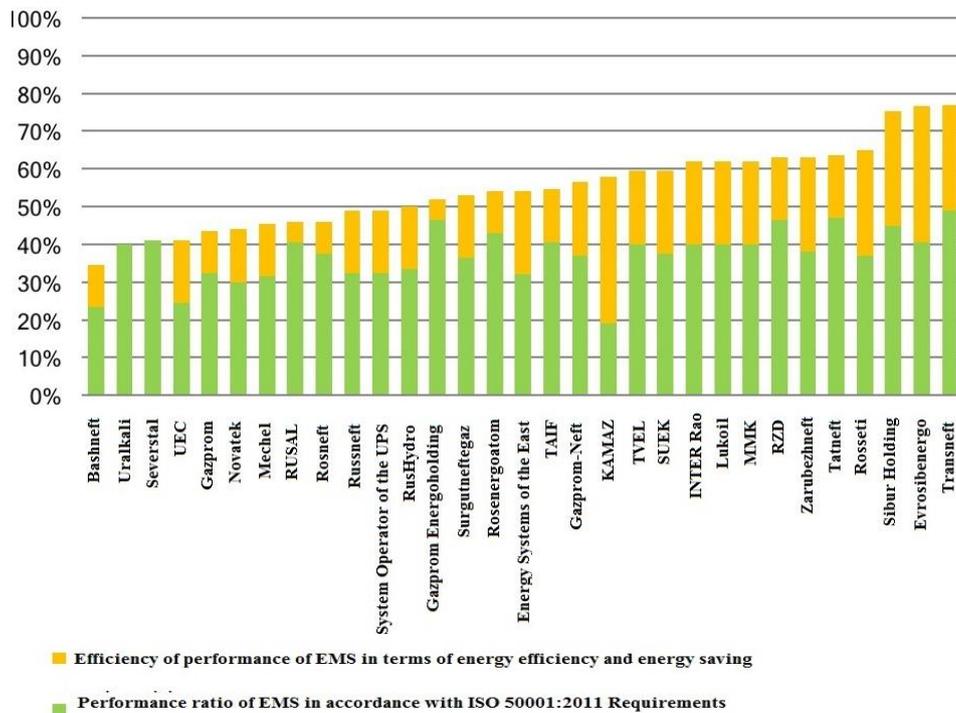


Fig. 4. Evaluation summary of EMS efficiency in companies, %



■ Efficiency of performance of EMS in terms of energy efficiency and energy saving
■ Performance ratio of EMS in accordance with ISO 50001:2011 Requirements

Fig. 5. Evaluation summary of performance ratio and efficiency of EMS in the companies, %

In Sibur Holding the generation of energy saving ideas and reduction of project realisation terms were detected. The implementation of a new energy efficient equipment enabled increasing safety, reliability of nuclear power plant systems, and the convenience of their maintenance and repair, which were noted in Rosenergoatom. In TVEL, the consumption of fuel and power resources were successfully reduced by virtue of more energy efficient materials and equipment.

In some enterprises, an increase of transparency of formation of expenditures for fuel and power resources were noted, which enabled, for instance in Rosseti, planning realisation of high energy efficient activities aimed at energy saving.

In RZhD there was a significant rise of performance ratio of energy saving activities. Also, the increase in the personnel involvement, implementation of best practices on railways, reduction of terms, and rational choice of places of implementation of energy saving technologies were noted.

Lukoil implemented Real Time Database (RTD), which now enables conducting real time objective assessment of fuel and power resources consumption by the personnel and taking prompt measures to reduce the consumption.

The qualitative result of the implementation of EMS in Surgutneftegaz is an increase in promptness of decision making, arrangement of management procedures in energy saving and enhancement of transparency of these procedures, organisation of the system of continuous energy audit of basic technological processes of oil extraction.

Despite a significant level of popularity of EMS in Russia's industrial companies, a range of companies face challenging factors which make it difficult for them to realise activities of development and implementation of EMS [11]. Among these factors there are:

- poor elaboration of the methodological base for justification of feasibility of energy saving and energy efficiency increasing activities;
- poor financial support of activities aimed at energy saving and energy efficiency increasing;
- lack of awareness of the efficiency and performance of EMS among the administration and personnel of the companies;
- lack of motivation of the administration and personnel of the companies to develop and implement EMS;
- lack of information about the companies providing services (energy analysis, recommendation on energy efficient activities, audit and automation) in development and implementation of EMS.

From the given theoretical analysis, it is obvious that EMS is one of the functional systems of industrial enterprise management. The implementation of EMS is an activity aimed at planning, organisation, and control of FPR utilisation.

tion in enterprises and motivation of energy saving on the basis of establishment of interrelating elements of the energy infrastructure and the personnel.

Methods

For sustainable management of energy efficiency, it is necessary to implement EMS, which is one of the subsystems of the overall system of enterprise management, thus connecting in one complex unit the strategic goals of the company and development of the energy policy, the energy audit and the energy resources accounting system, training personnel in energy saving, formation, realisation and monitoring of the energy saving programme and automation of energy saving and energy efficiency increasing activities.

Strategic Goals of the Company and Development of Energy Policy

The most crucial stage in organisation of EMS is the formation of the energy policy of the enterprise [12]. The energy policy is a system of monitoring and prognosis of the energy situation, formation and continuous improvement of the organisational, economic and legal mechanisms, which ensure reliable power supply and FPR rational utilisation.

The management practice shows that one of the main directions in the development of the energy policy is the formation of the fuel and energy balance as a tool for planning, controlling and forecasting changes in the conditions of the management of an industrial enterprise. In order to achieve the planned indicators, enterprises also need to use dynamic methods of energy consumption analysis, which allow tracing negative tendencies and eliminating them in the process of implementation of the energy consumption strategy.

While developing the energy policy and defining the strategic goals of an industrial company, special attention should be given to the following:

It is obligatory to find out the energy saving sources reserves, which belong to technological sphere, management of human resources, the sphere of ecological decisions in production process and others. It is also obligatory to develop methods to find reserves of energy saving.

The problems of implementation of EMS should be raised to the level of strategic analysis of the internal and external environment, in order to find fundamental problems of energy saving in enterprises, which belong to infrastructure, principles of work, general technological processes in enterprises. The fundamental problems are crucial for development of long-term investment plans in the enterprise.

In order to improve EMS it is obligatory to develop internal scientific and technical, and organisational and management structures, responsible for planning of innovative decisions in energy saving.

Training Personnel in Energy Saving and Energy Efficiency Increasing

An exceptional role in EMS is played by the personnel of the enterprise, who take the energy efficient initiatives and are the basis for formation of the internal expertise base of the energy management, and fulfill the innovative function. To improve efficiency of the work in energy saving, the enterprises conduct a multistage training of their personnel and use external intellectual resources.

The implementation of EMS requires introduction of all-round changes at all levels of the management of enterprise, beginning from the top management, at the level of strategy and structure of management, and ending with operational one, at the level of final administrators [13].

In the first place, the implementation of EMS should be initiated by the top management of an industrial enterprise. From the top management of the industrial company, it is required to appoint the person responsible for the introduction and implementation of EMS, with the authority and the required resources. Then, the changes of the organisational structure should be made, and a special body should be established (for instance, Energy Management Department, EMD).

The EMD encompasses the following major functions [14]:

- energy audit of industrial and auxiliary sections of the enterprise;
- development, introduction and supervision of projects of energy saving and energy efficiency;
- management of energy service contracts;
- support of the processes of purchasing energy resources;
- fulfillment of EMS programmes control;
- training the enterprise personnel;
- continuous search for key solutions.

The importance of realisation of EMS within the explained management structure is justified by its uniqueness in terms of involvement of all bodies and departments of the company in the realisation of the project, and integration of the processes of management, which are focused on increasing efficiency of energy consumption at all management levels. This enables quick deep organisational changes into the structure at all levels of the management of the company.

Energy Audit and Energy Resources Accounting System

The control of performance of EMS being implemented is carried out at the expense implementation of efficient energy resources accounting systems, management of energy consumption, and regular energy audit. The last one is a

software collection and analysis of information on sources, energy consumers, its ways of conversion, and its irrevocable losses.

When conducting the energy audit, it is obligatory to determine the general structure of energy consumption, directions and efficiency of utilisation of energy for further finding out the problems and the reasons for their emergence. The determination of the general structure of the energy consumption should begin with determination of basic elements of fuel and energy balance, sources of loss of various kinds of FPR. The losses are determined as inefficiency of technological processes, and the lack of rational approaches to organisation of works in the energy intense industry.

The basis of the audit becomes the establishment of qualitative and quantitative criterion values, reflected in the system of standards of the energy management. The audit enables efficient reducing energy expenditures in a short-term period and determining basic directions of energy savings in the future.

Formation, Realisation and Monitoring of the Energy Saving Programme, Automation of Activities of Energy Saving and Energy Efficiency Increasing

When forming the energy saving programme in the enterprise with high energy intensity production, the reserves for optimisation can be found in increasing energy efficiency of production processes and, in cases when different energy carriers are used, in the alteration of the structure of their consumption [15]. Increasing energy efficiency is feasible in the first place at the expense of implementation of more economical technologies in the major technological processes, and, in the second place, at the expense of application of general measures of energy saving. This kind of optimisation fosters reduction of costs in the long-term period and, subsequently, enhancement of competitiveness of the enterprise.

On the other side, on a national scale, the task to encourage enterprises' energy saving is justified by the fact that, firstly, the reduction of costs for production leads to increase of competitiveness of this production in the world market, which can contribute to the national economy growth. Secondly, the reserves of conventional energy resources are gradually exhausted. Thirdly, there is a negative impact of burning carbon-containing fuel on the environment

One of the crucial tasks of the state in this sphere is to establish a well-structured normative base of energy saving.

Currently, many enterprises are tailoring their internal energy saving business processes to international standards, in order to keep a high level of competitiveness and ensure their positions in the markets. The management of business processes are the management of energy saving, investment projects, financial management in the energy sector and management of the personnel's motivation to improve energy efficiency indicators. All these processes directly

relate to basic production processes and determine their energy efficiency in the long-term future. Among the supporting business processes there are different kinds of repairs of equipment of energy sector, resource supply, operational production control and control of financial results of energy saving programmes realised in the enterprise.

In the future, it is necessary to automate not only the process of collecting, accounting and analysing the energy consumption data, but also adjusting energy saving programmes in accordance with the changes in fuel and energy balance of the enterprise, identifying energy saving reserves, developing innovative approaches to energy saving.

When realising these methods of management, the best results can be achieved in increasing energy efficiency of enterprises. Thus, the performance ratio of the enterprises, that implemented EMS in accordance with ISO 50001:2011, can reach 98 %.

Final Remarks

By the present time, due to rising relevance of energy saving related problems caused by significant rise of energy resources' prices, the enterprises have developed traditional approaches to the energy management. The major ones reflect separate directions of energy saving which are further connected in one system with the help of strategic energy management.

The basic traditional approach is the formation of operational management of processes, modes of energy saving by virtue of technical control of production parameters, establishment of standards within the energy basis and formulation of the principles of motivation of the enterprise personnel. Traditional approaches are significant contributors, since they ensure the initial setting of the task of energy saving, demand attention of the administration of the company to the establishment of the unified system.

The development of traditional approaches leads to formation of the systematic idea of EMS as a combination of elements making up the basis of regular business processes with a developed system of training and motivation of the personnel.

The tendency that justifies transition to the systematic energy management, is a transition of the enterprise from one-time projects of investment in the energy infrastructure to construction of cyclic processes of development and implementation of organisational and technical measures in this sphere [14].

The model of EMS should function in the enterprise on the basis of the continuous cycle, the stages of which are given in the fig. 6. The cyclic fulfillment of these stages will enable implementing EMS on a longer-term basis, which will increase its efficiency.

Considering the suggested recommendations will enable any industrial enterprise to implement the management changes, allowing it to reduce energy ex-

penditures on the systematic and long-term basis, which will significantly increase its energy efficiency.

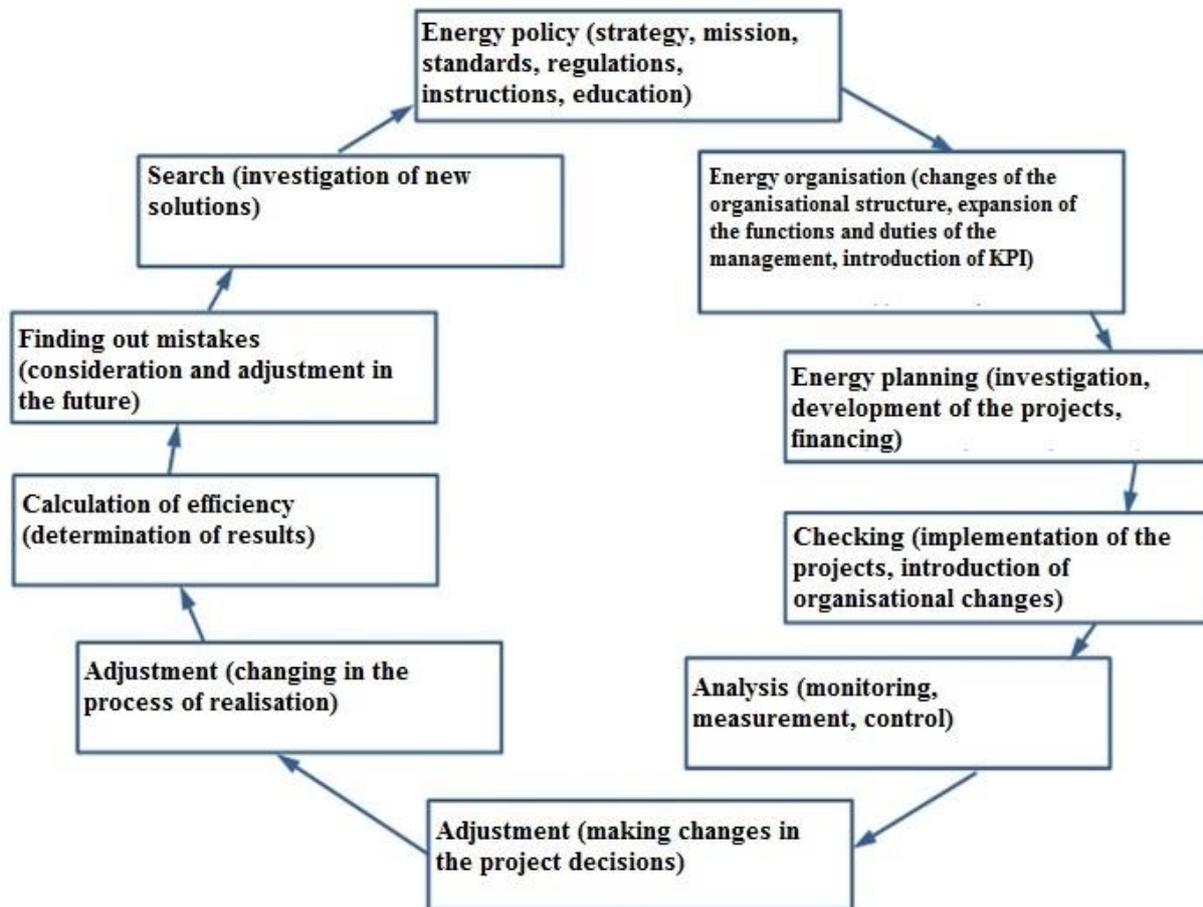


Fig. 6. EMS-model

EMS of the organisation is, without any doubt, an innovative decision, which is connected with the modernisation of the existing methods of management and psychology of management of energy consumption and energy expenditures.

In order to increase the quality of realisation of EMS in Russian industrial companies, it is necessary to implement the following measures:

- monitoring, analysis, popularisation and dissemination of best practices of the implementation of EMS on the basis of ISO 50001:2011;
- improvement of the methodological base of EMS and normative and technical base;
- expansion of practices of application of benchmarking for formation of goals and indicators of increasing energy efficiency and energy saving;
- development of professional and educational standards in the sphere the energy management;

- provision of energy management related education and qualification upgrade of specialists of industrial companies;
- preparation and acceptance of mid-term plans and programmes of implementation of EMS by companies;
- expansion of supporting measures and stimulation of companies to implement EMS;
- development of the system of voluntary certification in the sphere of the energy management;
- formation and implementation of the unified register of the authorised individuals and legal entities, providing services in the energy management;
- formation and maintenance of the unified register of the companies that confirmed their implementing EMS.

Conclusion

Thus, upon realising the above-mentioned measures, the conditions for transition to the large-scale implementation of EMS will be provided. This, in its turn, will foster realisation of the national policy in the sphere of energy saving and energy efficiency.

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Information about authors:

Veronika S. Gorbunova, Master's degree,
ORCID 0000-0003-4845-0070;

Elena Yu. Puzina, Candidate of Engineering Sciences, assistant professor,
ORCID 0000-0002-8746-2739;
E-mail: lena-rus05@mail.ru

Сведения об авторах:

Горбунова Вероника Сергеевна, магистрант,
ORCID 0000-0003-4845-0070;

Пузина Елена Юрьевна, кандидат технических наук, доцент,
ORCID 0000-0002-8746-2739;
E-mail: lena-rus05@mail.ru

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