

# On the need to improve the methodology for calculating energy saving and energy efficiency of enterprises

**R A Burganov, L V Maimakova, L R Urazbakhina and L A Golitsyna**

Department of Economics and Organization of Production, Kazan State Power Engineering University, 420066, Kazan, Russia. 51 Krasnoselskaya Str.,

E-mail: burraabr@gmail.com

**Abstract.** Currently, the development of nanotechnology and the digital economy requires a deeper study of the basic foundations of the functioning of society and the economy, among which the production, distribution and consumption of energy of various types and forms are of particular importance. The emphasis of theoreticians and practitioners on a comprehensive review of the role of energy should be reflected in the methodology for calculating energy conservation in the production process and the provision of services. This article draws attention to the need to revise the methodology for calculating the energy saving and energy efficiency indicators of a company based on the consideration of all types of energy (energy, heat, mechanical, light, human, etc.) in the company's activities. According to the author, a complete accounting of the energy used will optimize the costs of the company, maximize profits, and accordingly determine the development strategy of the company in the new business environment. In addition, the financial and economic performance of the company should also be updated and improved, taking into account the consumption of various forms and types of energy.

## 1. Introduction

Currently, energy as the main resource of any activity is becoming the focus of attention of both practitioners and representatives of the scientific community. And in world science, large financial and material resources are spent on finding ways to obtain and store energy in various forms [1-3]. An announcement at the RFBR of a competition for the best scientific projects of interdisciplinary basic research on the topic “Fundamentals of nature-like technologies for energy generation and consumption” indicates the relevance of a comprehensive study of the principles of energy generation and consumption even by living systems [4].

However, in the real economy, the methodology for calculating energy conservation and energy efficiency is based on the use of electricity and heat, which does not allow making the right strategic decision in the field of strategic development of economic entities, firms. In particular, in the field of energy conservation. So, in JSC “Network Company” the energy saving program of the company was implemented only in two areas: reduction of technological losses of electricity during transmission through the company's networks; optimization of electricity consumption for the company's business needs [5]. That is, the management of the enterprise does not pay due attention to the optimal use of other forms and types of energy. In such conditions, it is necessary to determine the methodology for revising the indicators of energy conservation and energy efficiency.

## 2. Methods

To achieve the goal of the study, both traditional and modern methods of analysis of technical, technological, financial and economic processes of the enterprise have been used. These methods included the analytical presentation and generalization of the functioning of the technical base of the enterprise through the use of various types of energy; classification of the types of energy used, including energy costs of personnel, analysis and synthesis of the calculation of



financial and economic indicators of the enterprise, etc. The interdisciplinary nature of the study made it possible to obtain more reasonable, scientifically-practical and competitive significant results in the world scientific space. Attention is paid to the use of the basic principles of implementing the energy theory of the company.

### 3. Results end Discussion

The aim of this work is to focus the attention of theoreticians and practitioners on a comprehensive review of the role of different types and forms of energy in the methodology for calculating energy conservation in the production process and the provision of services.

In modern times, the subject of priority tasks in economic development is the introduction of technologies based on the use of alternative energy sources in the production of goods and services. In addition, the struggle for energy is becoming a kind of driver for the development of human civilization.

The need for creating new approaches to energy efficiency has been brought to the attention of some scientists, for example D. Bueno M. Roitman, who present a general model for energy efficiency calculation, developed with the main purpose of being capable to deal with the fast changes our society faces nowadays [6] It should be consistent with the opinion of Ali Hasanbeigi, Lynn Price, who write that industrial plants are not always aware of energy-efficiency improvement potentials [7]. One can also highlight the work of Trianni, A. et al [8].

Certain aspects of the energy saving process are highlighted in the conference materials [9-11].

The very concept of "energy" is multidimensional and abstract. From the ancient Greek language "energeia" is defined as activity or active power. Energy as a fundamental category of science is actively studied in philosophy, physics, economics, etc. Without energy, as well as without labor, capital, no actions are taken to manufacture products and provide services. However, there is still no generally accepted and fundamental scientific definition of the term “energy”. So, Kogan I.Sh. notes that the concept of “energy” has acquired so many definitions and additions that it is sometimes difficult to understand what it is all about. There is also lack of clarity in metrological definitions of energy”[12]. Energy is coordinated with such concepts of the economic sphere as “the price of energy”, “useful energy”, “energy loss”. In particular, the energy efficiency coefficient is defined as the ratio of all energy used in the household (in an established area, electrical installation, etc.) to the total amount of energy consumed in terms of its primary energy. There are also uncertainties in the definition of the terms “forms of energy” and “types of energy”.

In the production process, various types of energy are used, since thermal, electric, electromagnetic, light (radiant), as well as the energy of biological resources, etc.

Mechanical energy is manifested in the movement of bodies, which has a certain direction in space (gas movement through a pipe, projectile flight, shaft rotation, etc.).

Electric energy is manifested in the latent movement of electrons along a conductor (electric current).

Thermal energy is expressed in molecular and intramolecular chaotic motion, representing the energy of the chaotic motion of atoms and molecules of matter. So, abroad, they came up with a floor covering that can generate energy when walking on it. The smart floor is made from cellulose fibers treated with a special chemical substance that allows them to generate an electric charge. According to researchers, the use of solar and wind energy has increased over the past 10 years, with an average annual increase in capacities of 51% and 21%. Although in the total production, the combined share of these types of energy accounts for only 4% [5].

All these forms of energy can be outside the field of view of management and economists, and, accordingly, are not taken into account when determining the effectiveness of the company.

The study of the use of energy of intellectual (mental) forces, energy, nerves and energy of the physical forces of employees of the enterprise is in high demand. Labor intensity is defined as the amount of energy a worker spends per unit of working time. In the anthology of economic theory, the provisions of Marxism on the need to take into account the energy expenditure of a worker to determine the level of wages are known. Malnutrition of employees does not restore the energy costs of the employee. The salary of the employee should provide opportunities for the restoration of the forces (energy) of the employee, as well as for the reproduction of labor by maintaining the viability of his family.

The process of energy consumption is based on certain principles. Under the principles understand the basic theoretical principles and rules that guide the company in its activities. The company should do only that which meets these principles, and nothing that contradicts them.

Any managerial actions of the firm's management should be taken in recognition of the leading role of various forms of energy in all production, financial, and technological operations. It is possible to have machines, machines, equipment in the balance sheet of the company, but they will not have value without connecting to an energy source. The energy balance of the company becomes the most important factor in planning the activities of the company.

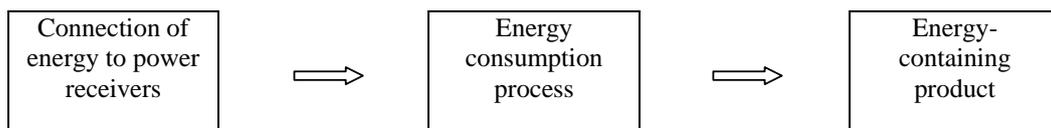
Among the negative aspects of this theory is a possible manifestation of energy. The most famous and consistent theoretician of energy was the German scientist W. Ostwald. According to him, "all natural phenomena can be subordinated to the concept of energy."

The state has created special conditions for entrepreneurs. For example, when consuming renewable energy sources, tax preferences are created for real estate tax, land tax, and profit tax can be partially or completely removed.

The need for a more focused study of the role and significance of various types and forms of energy has led to the creation of the energy-consuming theory of the company. The main provisions of this theory are considered by the author in a number of scientific papers [13-14].

Existing versions of the theory of firms did not take into account the complex processes of energy consumption and energy saving, did not provide recommendations for the management of the company to achieve certain success in the field of energy efficiency, and thus did not contribute to the achievement of the energy strategy of the company and the national economy. The theory of energy consumption of the company was created based on the analysis of extensive experience in using different forms and types of energy. Solving problems in the field of optimizing energy consumption in the course of a company's activity has always been the focus of its management. This is mainly due to the desire of the company to maximize profits, an increase in the state's demand for energy conservation, and toughening competition in the production and consumption of energy resources. In modern times, this is supplemented by a decrease in renewable energy sources, a change in the operation technologies of machines, equipment, machine tools, a decrease in external energy dependence, etc. The subject of these priority tasks is the introduction of technologies using alternative energy sources.

The general scheme of the process of movement of total energy during the production of goods and the provision of services is given in figure 1.



**Figure 1.** General scheme of the process of energy movement in a separate company

As can be seen from the figure, any product of production contains energy costs, including the energy of living organisms, that is, employees of the company.

The process of consumption of total energy is based on certain principles. Under the principles understand the basic theoretical principles and rules that guide the company in its activities. The company should do only that which meets these principles, and nothing that contradicts them.

The basic principles of the energy theory of the company include (table 1).

Each of the identified principles provides for the introduction of mandatory and (or) recommended requirements in the projects and programs of the company. Any managerial actions of the firm's management should be taken in recognition of the leading role of various forms of energy in all production, financial, and technological operations. It is possible to have machines, machines, equipment in the balance sheet of the company, but they will not have value without connecting to an energy source. The energy balance of the company becomes the most important factor in planning the activities of the company.

**Table 1.** The principles of energy theory of the company.

№	Name of principles	Principles
1	Principle of system	The result of the functioning of the company depends on the efficient use of all forms and types of energy, conditionally total energy
2	The principle of equal access to energy sources	All structural units of the company must be provided with energy
3	Optimality principle	Any decision in the field of energy consumption should be based on the task of optimal energy use.
4	The principle of achieving effect and energy efficiency	The use of energy should have an effect and efficiency, where there is an excess of results over costs

Compared with other versions of the theory of the company, the energy-consuming theory of the company has several advantages, at the same time, disadvantages.

The positive aspects of the energy theory of the company include universality of provisions, priority in the use of any energy (in particular, it is imperative to use the labor of a worker in production according to the factor theory of the company, and there is no way to use energy theory in energy theory), the prospect of relevance to scientific provisions.

The energy-consuming theory of the company is an integrated science, a significant place in it is occupied by physical, technical and economic concepts. This means that the researcher must possess an appropriate level of knowledge.

To determine the viability of a theory, it is necessary to consider the mechanism of its implementation in practice. The mechanism for the implementation of the theory in practice is various institutions, methods, tools that ensure the implementation of theoretical principles in the practical activities of the company. As a rule, such a mechanism includes activities of a managerial and financial and economic nature. Among the many institutions that contribute to the process of implementing the energy theory of the company into practice, we can distinguish internal company institutions involved in management decisions, mainly the management of the company and the owners who adopt regulatory documents.

Preparation of practical recommendations on energy management to increase energy and economic efficiency of energy resources based on the energy theory of the company includes the systematization of specific indicators based on the use of energy consumption.

The researcher should have in his field of view all the stages of the energy movement process in the course of production of goods and services, including the use of energy by company employees. Such scientific principles as consistency, equal access to energy sources, optimality, achievement of the effect and energy efficiency make it possible to obtain significant scientific results. In accordance with the energy theory of the company, the product of production can be measured in energy costs. Approximately, 3 conventional units of energy were expended for the production of the product. In economic science, "conventionality" is actively used. "Conventional unit of fuel", "conditional unit of production", etc. categories find their application in the economic justification of the development of the company. An important element of cost analysis is determining the marginal cost of energy consumption. Marginal cost - an increase in energy costs resulting from the production of one additional unit of output. Energy costs can be divided by type of energy consumed, cost structure, periods of energy consumption, etc. Separately, we can distinguish the calculations of the energy potential of the company, i.e. the company's capabilities in providing energy to its activities.

Each type of energy has its own price, which is created both by producers and consumers of energy (the price of the buyer and the price of the producer (seller). The price of energy is the price of the resources used in terms of the amount of energy. Hypothetically, the price of energy can be a measure of the production and exchange of goods and services, for example, one can argue that 100 units of energy were used in the production of a particular product.

According to GOST R 51541-99 "Energy Efficiency. Composition of indicators" establishes the main types of indicators of energy saving and energy efficiency introduced into regulatory

(technical, methodological) documents, technical (design, engineering, technological, operational) documentation for energy-consuming products, technological processes, works and services. Thus, the energy efficiency of a company is determined by the ratio of energy consumption to the amount of income received. When calculating energy costs, it is necessary to take into account the use of all types of energy - electrical, thermal, light, mechanical, etc., including human. Such an integrated approach requires a review of the methodology for calculating total costs. To analyze energy consumption in terms of consumption of any form of energy, four approaches can be distinguished:

- costs of connection to power grids, including technological aspects inside,
- direct energy consumption costs,
- energy distribution costs;
- costs associated with obtaining comprehensive benefits.

On the income side, it is also necessary to take into account the share of contribution to its formation of each type of energy and total energy. For example, a simple light bulb performs basically two functions - lighting a room and generating heat. Each function has a cost, respectively a price, respectively, it is necessary to find the energy value of a given product. The price of energy depends on the price of each type of energy. Of course, the problem arises of calculating such prices.

As you know, the energy potential of the company consists of technical and biological types of energy (energy of muscles, brain). The correct accounting of the processes of energy consumption of intellectual (mental) forces, energy, nerves and energy of the physical forces of the employees of the enterprise is in demand. However, in economic science there is a gap in this area of research. Therefore, the basis of the calculation can be taken to determine the energy consumption of athletes. To achieve high results, it is necessary to maintain a balance between the energy expended and its replenishment. Using the methods of determining energy consumption, it is possible to calculate how much energy is spent in preparation for the competition and during the competition, in accordance with this, draw up the athlete's mode, which allows to fully replenish the allocated energy. The main methods for determining the energy consumption of personnel include the method of determining energy consumption taking into account the coefficient of physical activity and the magnitude of the basal metabolism, which consists in multiplying the coefficient of physical activity corresponding to a certain type of activity by the magnitude of the basal metabolism. The coefficient of physical activity (CFA) is the ratio of the average daily expenditure of human energy to energy expenditure at rest. CFA can vary from 1.4 with a sedentary lifestyle to 2.4 with heavy hours of physical labor. The main metabolism is the minimum level of energy consumption, which is necessary to maintain the body's vital activity at rest. And the Aldridge method. allows you to learn about the metabolic rate or calculates the rate of energy consumption in calories. Back in Marxism, the relationship between the level of wages and the energy expended by a worker in industrial production was examined.

Digitalization of the economy requires strengthening the role and importance of financial and economic accounting for the consumption of all forms of energy in the activities of the company. In fact, the use of each type of energy should be accompanied by the conclusion of appropriate contracts, which in a generalized form goes through a number of stages, such as:

- preparatory and informational (development of a draft of measures in the field of concluding energy contracts, etc.);
- research and analysis (analysis of energy-saving measures, etc.);
- recommendatory (from the set of projects, the most optimal one, etc.);
- introduction (inclusion of the received energy in the production process);
- monitoring and corrective (monitoring the progress of the execution of concluded agreements, etc.).

Hypothetical, even the use of personnel energy should be of a contractual nature, since the energy potential of each employee of the company varies.

It should also be noted that at each stage of the use of energy, the transaction cost increases. In such a situation, it becomes necessary to combine the use of different types of energy.

Work to reduce the cost of purchasing different types of energy can be carried out in two directions: saving energy and increasing the efficiency of the production process. In

addition, there are a number of effective ways to save energy, such as using equipment that allows you to receive and use different types of energy (for example, equipment can generate heat); the use of energy-saving technologies; reduction of energy losses in power receivers and power supply systems, etc.).

In particular, the manufacturer must choose the options for providing electricity for his production. There are three possible solutions:

- purchase of electricity from outside, that is, through technological connection to energy networks;
- create their own autonomous production of electricity;
- focus on sharing the first two options.

In each case, it is necessary to evaluate the value of the alternative possibilities. In general, when making economic decisions in the field of electricity supply, all costs are of an alternative nature, i.e. depending on the options for the cost of resources, the optimal solution for their use is selected. Accounting for opportunity costs allows you to more accurately evaluate and compare the effectiveness of various economic decisions.

As you know, the explicit costs, depending on the volume of production, can be divided into fixed and variable. Constant - do not depend on the volume of production, and variable costs are not. This also applies to energy costs. So, part of such costs is aimed at constantly ensuring the working condition of technical or technological means. This can be fire or process safety.

An important element of cost analysis is the determination of marginal cost of energy consumption. Marginal cost - an increase in the cost of electricity resulting from the production of one additional unit of output. Marginal costs can be calculated on the basis of variable and fixed costs

Marginal cost of energy consumption - an increase in energy costs resulting from the production of one additional unit of output.

Marginal cost of energy consumption can be calculated on the basis of variable and fixed costs.

$$\text{Marginal cost of energy consumption} = \frac{\Delta \text{Gross cost of energy consumption}}{\Delta \text{volume of output}} \quad (1)$$

$$\text{Marginal cost of energy consumption} = \frac{\Delta \text{Variable cost of energy consumption}}{\Delta \text{volume of output}} \quad (2)$$

where  $\Delta$  shows an increase in indicators.

We also find:

$$\text{Marginal energy efficiency} = \frac{\Delta \text{Change in energy consumption of different types}}{\Delta \text{volume of output}} \quad (3)$$

Any change in the data of the individual types of energy consumed is reflected in a state of energy efficiency.

The process of managing electricity costs is in the field of view of any manager. The larger the production, the more energy will be used up. The presence of a cost management program leads to lower costs, respectively, positively affects the energy efficiency of the enterprise.

Since all costs must be controlled at a certain organizational level, the enterprise must clearly determine at what level these or those costs are controlled. Optimization of energy consumption can occur due to control of energy losses and their reduction; use of secondary energy resources; optimization of technological process modes; development and coordination of a start-up schedule for energy-intensive equipment; minimize heat loss; equipment modernization

#### 4. Conclusion

Thus, the current level of development of new technologies based on the efficient use of all types of energy, the creation of new financial and economic relations on this basis objectively requires a review of the methodology for calculating energy saving and energy efficiency indi-

cators. In this aspect, the content of this article has a certain scientific novelty. More specific scientific results include conclusions that:

- at existing enterprises, energy conservation is achieved only by saving and optimizing the use of electricity;
- there is uncertainty in the scientific definition of the essence of "energy", its types and forms,
- enterprise management in the activity should focus on the use of all types of energy;
- a special role in obtaining energy efficiency is played by the energy of living organisms, in particular the labor resources of the enterprise personnel;
- the need to take into account all types of energy has led to the creation of an energy-consuming theory of a company that has no analogues in world economic science;
- given the substantial part of the energy theory of the company, its principles of research;
- the product of production can be measured in energy consumption, which allows to obtain more accurate data on energy efficiency indicators;
- calculation of energy costs from the side of employees allows optimizing their labor input, comparing energy costs and wage levels, as well as increasing labor productivity depending on the capabilities of each employee. The use of certain methods of accounting for energy costs of personnel depends on the maturity of company management;
- an important element of energy conservation and energy efficiency is the determination of the marginal cost of energy consumption, given the methodology for their calculation;

In general, the development trends of the innovative and digital economy, the use of nanotechnology require taking into account all factors of energy efficiency growth. More specific factors include the increased use of energy of various kinds and forms as a result of digital changes; increase in the cost of energy in determining the cost of exchange operations; development of automation and control tools based on digital technologies that allow energy measurements; control and planning of consumption parameters of all types of energy.

The very need to take into account all forms and types of energy in the methodology for calculating energy saving and energy efficiency indicators poses new challenges for the leadership of the enterprise, industry and government. And economic, technological, social phenomena or processes associated with energy consumption must be measurable. The researcher and practitioner should have in their field of vision all the stages of the energy movement process in the production of goods and services, including the use of energy by employees of the enterprise. Also, in accordance with the energy theory of the company, indicators of the financial and economic activities of the enterprise should be reviewed taking into account data on the costs of various types and forms of energy.

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