



## Methodological Approaches to Research Resource Saving Industrial Enterprises

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### ABSTRACT

Paper proposes the method of evaluating the performance of the company based on the use of production functions and factor models, which include the assessment of the entire apparatus and a set of performance indicators (appropriate) use of resources, resource saving. The method of assessing the performance depends on the use of the Cobb-Douglas production function. This function allows you to receive information about the appropriateness of the use of production resources, as well as timely carry out the correction of deviations of indicators of resources spent from standard values. Two-factor approach is using only the resources of labor expended and capital resources to calculate the required values.

**Keywords:** Energy, Resource Saving, Industrial Enterprises, Cobb-Douglas Function, Level of Technical Condition of Production Equipment

**JEL Classifications:** C30, D12, Q41, Q48

### 1. INTRODUCTION

In economics, often along exist and are used as a well-established theoretical principles and concepts defined by the classics of the economy, such as the identification of content resource business - processes of industrial enterprises with their efficiency and effectiveness, and the use of resource-saving as a result of certain activity and its organization costs and exercise. There is also a wide variety of theoretical and methodological developments in the specific terminology of concepts and content of resource saving, arising, from the point of view of the authors, because of the versatility of this concept, approaches to the process of its use, as well as a significant type of obtained results.

Resource saving can be understood as the achieved results in improving product quality, customer service, development of a sales network or the introduction of new resource-saving technologies (Brown, 2001; Hanemann, 1984; Feng et al., 2013; Mikhaylov, 2019). The general concepts in the content of these

categories, according to the authors, is the evaluation of the results of the operation with regard to the resources spent (Gillingham and Palmer, 2014; Mikhaylov, 2018b; Branch, 1993).

The efficiency of resource management at the enterprise implies the development of the efficiency of all subsystems of the enterprise and the business processes taking place in it, and the efficiency of the enterprise's resource saving is in turn regarded as one of the key indicators in evaluating the effectiveness of managing all businesses - processes of the enterprise. It should be noted here that management, as an independent subsystem, can be carried out with different levels of costs and achieve management goals in different ways, depending on the costs incurred (Baker et al., 1989; Mikhaylov et al., 2018).

Therefore, efficiency (efficiency of resource saving management) is an independent economic category. But in analytical studies, it can be used as one of the key factors for the efficiency of the enterprise resource saving (Mikhaylov, 2018a).

## 2. LITERATURE REVIEW

The resource approach to understanding the efficiency of resource saving that is widespread in research generates a variety of concepts related to the effectiveness of the use of certain types of resources - capital, knowledge, labor, finance, land, investment resources, also gives rise to many different categories that structurally implement the general processes of efficiency formation of industrial enterprises (Balestra and Nerlove, 1966; Davis, 2008; Davis, 2011).

Differences in methodological approaches to the assessment of resource conservation, among other things, are associated with differences in assessment objectives and facilities used, as well as with a large variety of valuable tools, since the value of resource saving indicators is associated with the use of mathematical, quantitative tools that give a numerical value (Blanchard, 1983).

In the management of industrial enterprises play an important role resource-saving technologies used in the operational management of business processes (Cameron, 1985; Gerarden et al., 2015).

Production plans are the long-term plans of the enterprise, and, often, taking into account strategic goals that have a certain period of their implementation with the expenditure of certain resources.

Resource-saving industrial enterprises in modern conditions allows to identify the reserves of the enterprise, using which, it can increase its efficiency of activity (Halvorsen, 1978; Gillingham et al., 2012).

Resource conservation and reserves of the company are linked directly proportional dependence. It is possible to optimize resources and evaluate them using production functions that give an estimate of the use of various production factors (Mikhaylov, 2019; Halvorsen and Larsen, 2001).

Production functions can be single-factor, two-factor and multi-factor (Gillingham et al., 2009).

Analysis of these publications shows that the problem of energy conservation is interdisciplinary and representatives of various technical and economic specialties should deal with its theoretical and practical solution (Nyangarika et al., 2019a; Nyangarika et al., 2019b).

In the technical and economic group of energy saving factors, the leading role is played by replacing outdated equipment with new ones, accelerating the introduction of technological innovations that ensure comprehensive intensification of resource use: labor productivity growth based on the growth of its capital-labor ratio and energy ratio, growth of capital productivity, reduction of material intensity, energy intensity, capital intensity and labor intensity (Brown, 2001; Hanemann, 1984; Feng et al., 2013).

Considerable efforts should be made to eliminate the loss of energy resource (DeCanio, 1998; Dubin and McFadden, 1984; Nyangarika et al., 2018).

## 3. METHODS

Using the differentiation of production functions, it can find the maximum values used in the production of resources, and the value of resources can be set such that is required by the governing body. Resources can be rationed and optimized using production functions. A number of authors apply the Cobb-Douglas production function to the assessment of the efficiency of industrial enterprises, since it is expressed by the ratio of factors used in production and the results of operation.

The two-factor Cobb-Douglas model is represented by the function:

$$Q=A L^{\alpha} K^{\beta} \quad (1)$$

Where  $Q$  - the volume of industrial production;  $K$  - capital expenditure;  $L$  - labor expended;  $A$  is a technological coefficient reflecting innovation and the level of production modernization;  $\alpha$  is the coefficient of elasticity according to labor;  $\beta$  is the coefficient of capital elasticity.

Using this function can be optimized, i.e., reduce the amount of resources used in production, thereby increasing resource conservation.

The remaining part of the resources can also be used in production for additional output, which increases the efficiency of the enterprise.

One of the main methodological problems of estimating the resource saving of a company when applying the general system of indicators reflecting the resource saving processes is the task of determining the integral (complex) indicator, which allows to make both horizontal comparisons (between different enterprises) and to represent the dynamics of the process of resource-saving technologies of enterprise business processes with multidirectional changes in particular indicators (vertical comparisons).

Energy resources, their sufficiency and effective use are an important aspect of the industrial and post-industrial development of human society. Energy, including electricity, is necessary for it both for the development of production processes and the service sector, and for the consumption of the population. The growth of household equipment with household appliances and labor-saving production technologies that increase the technical equipment of labor, economic growth are factors that increase the need for energy resources.

And on the contrary, the use of innovative technologies and practices of energy-saving management, the implementation of energy-saving programs in municipal utilities of cities is only part of the general directions of reducing energy consumption while maintaining and increasing the volumes of national production and consumption. The need to increase the use of energy saving mechanisms is due to many factors. The first positions here are: - Exhaustion of reserves of modern efficient energy carriers, oil, gas; - instability of energy prices on world markets - striving

for energy independence, especially in countries importing significant amounts of energy resources; - environmental motives also stimulate the search for ways to save electricity and energy resources.

Many of these motives are well illustrated by the energy saving policy in the European Union.

#### 4. RESULTS

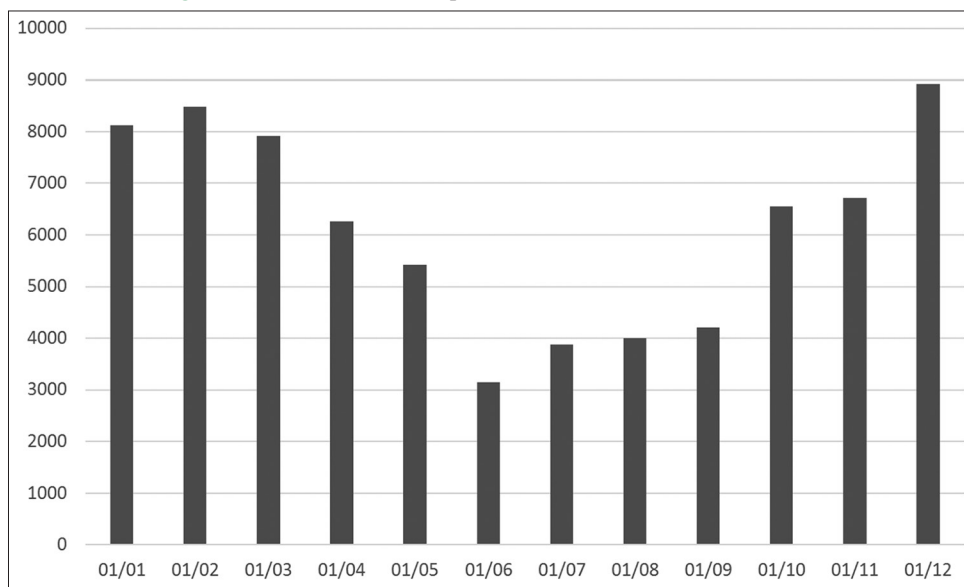
Many countries of the world with different levels of development are already moving towards an energy-saving development model. For example, France has set a goal to reduce primary energy consumption by 5050 by 2050.

For example, with the volume of GDP, which had strong fluctuations and multidirectional dynamics over the past 25-30 years, but by now in real terms remains approximately at the 1990 level, primary energy consumption has decreased by 27%.

In the analysis of energy conservation processes, the national, regional and sectoral aspects of the implementation of this process are important. Long-term energy development strategy was developed and is in effect in the Russian Federation (Figures 1-6).

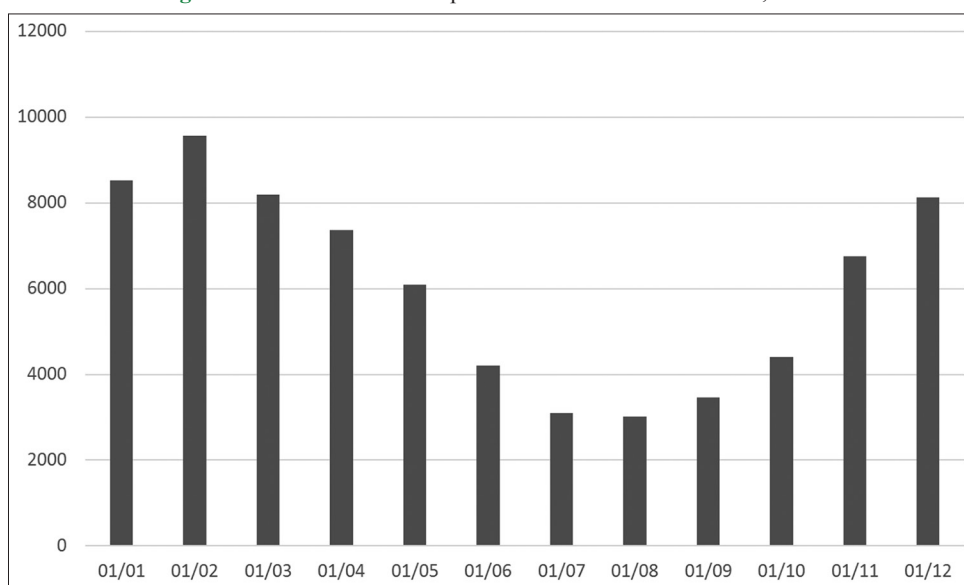
Some experts believe that these documents do not sufficiently take into account the possibilities and need for energy saving. We will cite at least the fact that only in 2014 in the country the Order of

**Figure 1:** Combined heat and power in Eastern Russia in 2017, GWh

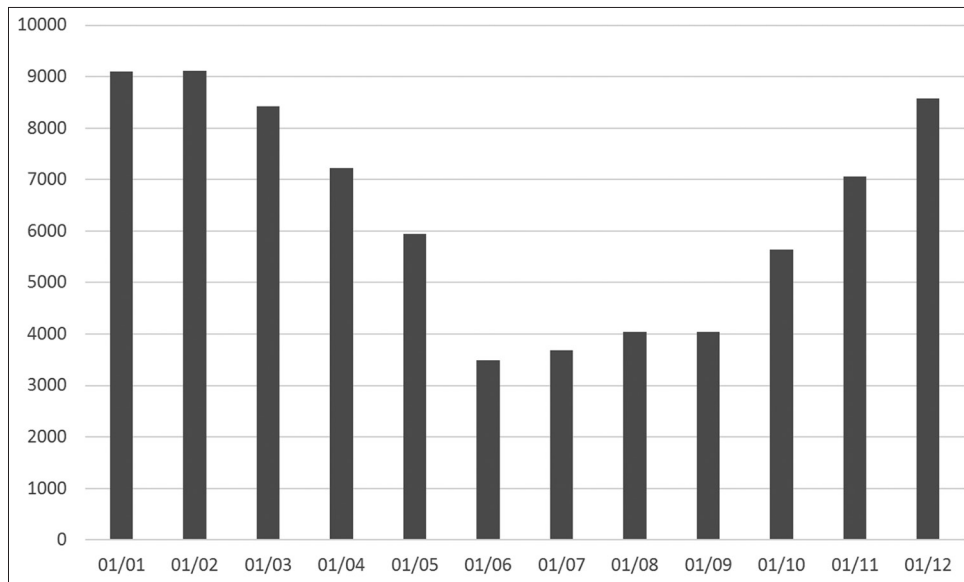


Source: Thomson Reuters

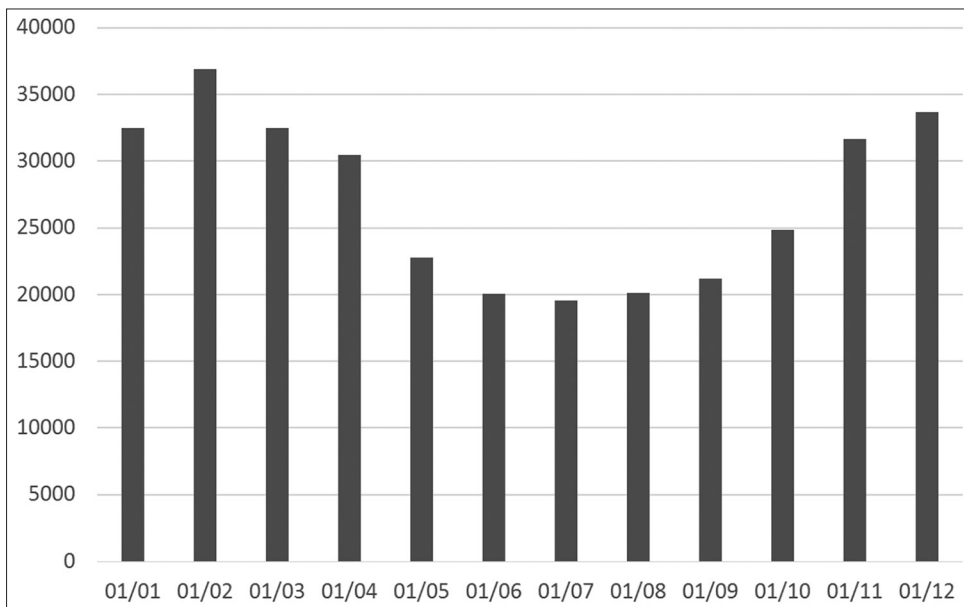
**Figure 2:** Combined heat and power in Eastern Russia in 2018, GWh



Source: Thomson Reuters

**Figure 3:** Normal level of combined heat and power in Eastern Russia, GWh

Source: Thomson Reuters

**Figure 4:** Combined heat and power in European Russia in 2017, GWh

Source: Thomson Reuters

the Federal State Statistics Service was issued on the use of such tools as the fuel and energy balance of the Russian Federation.

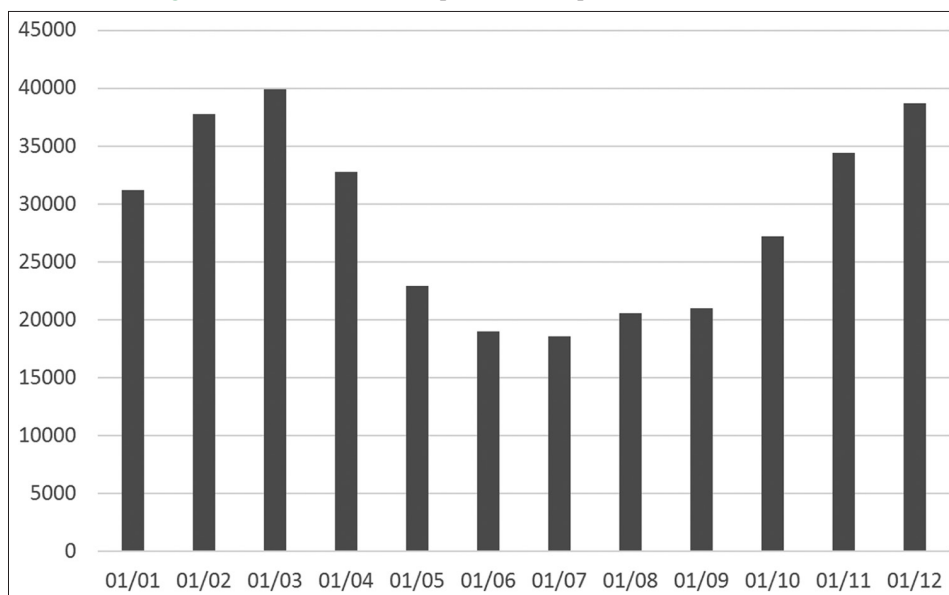
The range of changes in the energy intensity of GRP regions ranges from a growth of 43% in some regions, to a decrease of 31% in others.

Energy intensity increased in every fifth of the analyzed regions. Among the many factors shaping the energy intensity of GRP, the branch structure of the regional economy plays a significant role. Different types of activity are characterized by a specific cost structure, in connection with which it is customary to allocate material-intensive, labor-intensive, capital-intensive and energy-intensive production.

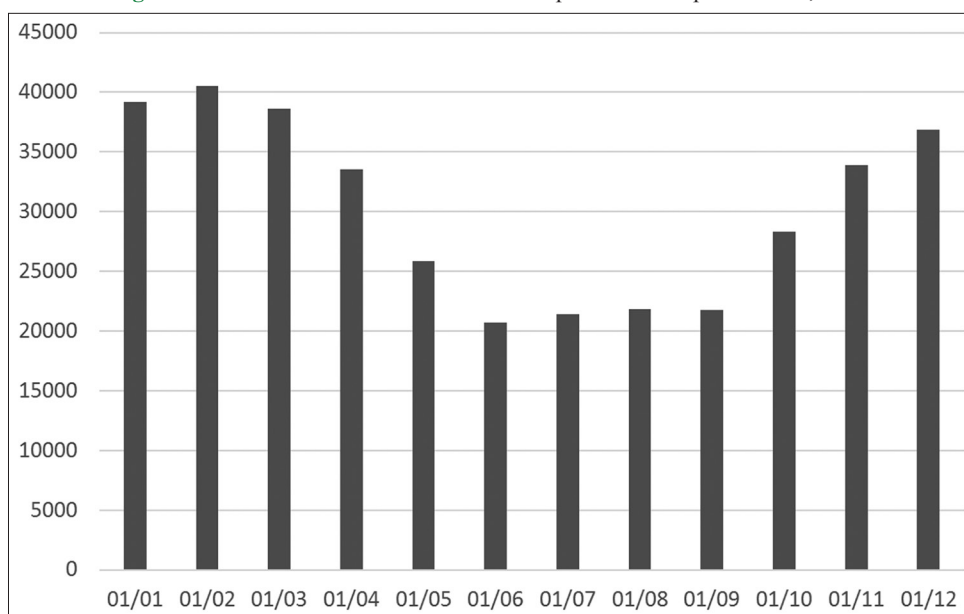
Baseline data for assessing the performance of enterprises and the results of calculations of the volume of costs and profits, as well as the optimal amount of resources used and the volume of products are shown in Table 1.

On the basis of this model, the work calculated the appropriate parameters of the functioning of enterprises: Tversky Carriage Works (1), Siberian Carriage Works (2), Moscow Carriage Works (3) in 2018.

Further, it is necessary to clarify that the economic interpretation of the variation of elasticity coefficients:  $a$ ,  $b$  and  $c$  in the Cobb-Douglas function is that if capital investment increases by 1% of its average value for any indicator, the real output will increase by  $a$ ,  $b$ ,  $c$  as a percentage of its average.

**Figure 5:** Combined heat and power in European Russia in 2018, GWh

Source: Thomson Reuters

**Figure 6:** Normal level of combined heat and power in European Russia, GWh

Source: Thomson Reuters

**Table 1: The results obtained in the approximation of the integrated model**

Indicator	Parameter	1	2	3
Company revenue	TC	594.8	1,035	5,761
Net profit of the company, mln. rub	RK	17,303	121,279	418,532
Cost of units of the product mln. rub	R	8.5	Eight	9
Number of manufactured products	N	163.00	202.00	418.00
Costs, mln. rub	Vehicle	448.00	464.00	3286.00
Costs of innovative software, mln. rub	M	1.8	1.4	1.71
Restrictions on resources, mln. rub	V	570.00	600.00	3761.00
Estimated value of the resource, mln. rub	*TO	318.14	746.95	970.51
Estimated value of the resource, mln. rub	*s	93.82	73.50	176.23
Estimated value of the resource, mln. rub	*M	1.57	1.31	1.63
Estimated value of revenue, mln. rub	*TC	630.22	952.04	4,600.71
Estimated cost, mln. rub	*Vehicle	460.00	210.00	3180.35
Calculated value of net profit, mln. rub	*RK	40.22	242.04	620.36

Source: Calculated by the author

**Table 2: Results of approbation of the Cobb-Douglas model with changing parameter M**

Company	1	2	3	1	2	3	1	2	3
M	1.0	1.0	1.0	2.0	2.0	2.0	3.0	3.0	3.0
K*	318.14	746.95	970.51	318.14	746.95	970.51	318.14	746.95	970.51
L*	93.82	73.50	176.23	93.82	73.50	176.23	93.82	73.50	176.23
TR*	330.11	812.14	4,706.63	720.13	993.11	4759.89	996.21	995.33	4763.18
TC*	580,10	463.30	3108.14	421.1	385.2	2961.14	381.00	382.00	2889.35
PR*	32.21	420.12	731.15	52,12	592.48	930.47	53.41	593.04	931.36

Source: Calculated by the author

But it is impossible to raise investments to infinity, because here there appears the effect of the lack of demand for a resource. The authors also studied the changes in the value of the production function due to the variation of the information parameter. Table 2 presents the change in the indicator information and its impact on output. With this model, you can determine the appropriate volume of output, minimize costs and maximize the profits of the enterprise, using various amounts of information used in production.

The change in the information parameter has a significant value: As it decreases, indicators of output and profit fall, and the costs of resources used increase. With an increase in the amount of information used, vice versa. But the continuous further increase of this resource reduces the efficiency of the enterprise, as the information becomes unprofitable (Table 2).

In addition, scientific and technological progress and energy-saving innovations are distributed unevenly in industries, which leads to different rates of change in energy costs in various activities. Table 1 shows the dynamics of the energy intensity of the production of certain types of products manufactured in the Russian Federation.

The examples of energy intensity given in the table indicate its significant inter-sectoral differences.

Thus, the specific energy consumption is in the range from 15 kilowatts per ton of coal to 5000 kWh per ton of ferroalloys. The production of rubber, paper, and steel is high-energy.

There were unequal trends in the dynamics of specific energy consumption. In the most energy-intensive activities, such as the production of non-ferrous metals, the chemical industry has dominated the trend of energy conservation.

Energy saving opportunities were also realized in the production of the least energy-intensive products, in the primary distillation of oil and in the production of coal. In the energy-intensive steel industry, energy saving was not observed.

## 5. CONCLUSION

In the article, the authors propose a methodology for evaluating the performance of industrial enterprises in order to form an effective system for managing production resources. The method allows to determine, calculate and provide the indicators necessary for the formation on the basis of the enterprise of the optimal structure

of operational management of business processes, combining the production process.

This approach is not without reason and is acceptable according to the following provisions: information itself without physical capital, even if combined with labor and capital, cannot produce a product. But the information should be evaluated, implemented in the production process, further capitalized, i.e. reduced to its level of use, when it can be used to produce improvement of certain elements of physical and intellectual capital.

Information acts as an integral part of all labor processes, i.e. may be a means, and the subject of labor, and even part of the labor force. Multifunctionality and multidimensional use of information provides it with one of the leading roles in modern production.

As conclusions, it can be noted that: (1) To assess the effectiveness of resource conservation, it can use the Cobb-Douglas function, which allows to optimize the resources of an industrial enterprise. (2) In terms of practical activities of industrial enterprises for the efficiency of resource conservation, information support is important. When oil is mined and rolled ferrous metals, the specific electricity consumption has also increased, which may be associated with an increase in the capital-labor ratio and the energy intensity of labor in these activities. In industry as a whole, in 2010-2015, there was a tendency to increase the energy intensity of labor as a process accompanying the growth of its capital-labor ratio.

In the extractive industries, this figure is three times higher than in manufacturing. The energy intensity of labor grew in almost all types of industrial activity. In the extractive industries in 2010-2019, efficiency increased from 129.8 to 152.8 thousand kilowatt-hours per worker, in the processing sector from 49.7 to 55.6 thousand kilowatt-hours.

The growth of the energy supply of labor, other things being equal, is a factor in the growth of the energy intensity of GDP and GRP. However, on condition of faster growth of labor productivity, the energy intensity of a unit of production may decrease, which indicates the interrelation of various forms of resource saving, in this case labor saving and energy saving.

Data on the electric balance of the Russian Federation indicate that about 10% of electricity is lost in electrical networks. Organizational and economic measures for energy conservation include the development of resource-saving management, including planning for resource-saving measures, staff motivation for this activity, personnel training in resource-saving methods,



accounting and monitoring of resource-saving processes, information support for activities in this direction. The importance for Russia of the holistic strategic development of the energy complex has led to the need to develop special documents of strategic development for a longer period until 2030. Discussion of the strategy in the scientific community and practitioners shows that the issues of energy efficiency and energy saving have not been adequately reflected in them.

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