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**A comprehensive approach to assessing the effectiveness of the use of the energy pipeline transport of gas**

In work basic method analysis of hierarchies to assessing energy efficiency in the enterprises of the main transport of gas, which allows you explore in detail the consumption of energy resources of each equipment, consumption of resources in technological operations and the creation of favorable conditions, to asses the state of accounting systems and the organization works to improve the efficiency use to energy.

**Key words:** energy resource, effectiveness, use of resources, main transportation of gas, compressor stations.

FEC of Russia has always played an important role in the economy of the country. During the years of reforms in connection with the sharp decline in production in all sectors of the economy, its role increased.

In the basis of raising the efficiency of all production is saving production of industrial resources of all kinds. Due to continuous increase in the cost of energy resources in the country, the increase in cost of gas transport, невозобновляемостью natural resources, the most important directions of work in the field of pipeline transport of gas should be considered a development aimed at the reduction and savings in energy costs and will be relevant to modern approaches to the assessment of sustainable consumption and saving resources. As the object of study was chosen subsidiary of JSC «Gazprom», engaged in transport backbone gas.

At the enterprise the estimation of consumption of energy resources is fragmented and does not fully reflect the efficiency of their use in General. Therefore there is a need for application of such methods, which allow to estimate efficiency of use of power resources on the enterprise and the work of the energy sector in General, in particular in relation to pipeline transport of gas.

In the previous study [2], the authors considered the point method of estimation of effective energy consumption at the enterprises of the main gas pipeline transport.

In this study, the authors propose to apply the method of analysis of hierarchies (designed So Sahati) for generalized evaluation of the efficiency of energy consumption in pipeline transport of gas

To conduct analysis method of hierarchies is to identify areas of non-rational consumption of energy resources in the enterprise by the ranking of these areas on the importance and priority.

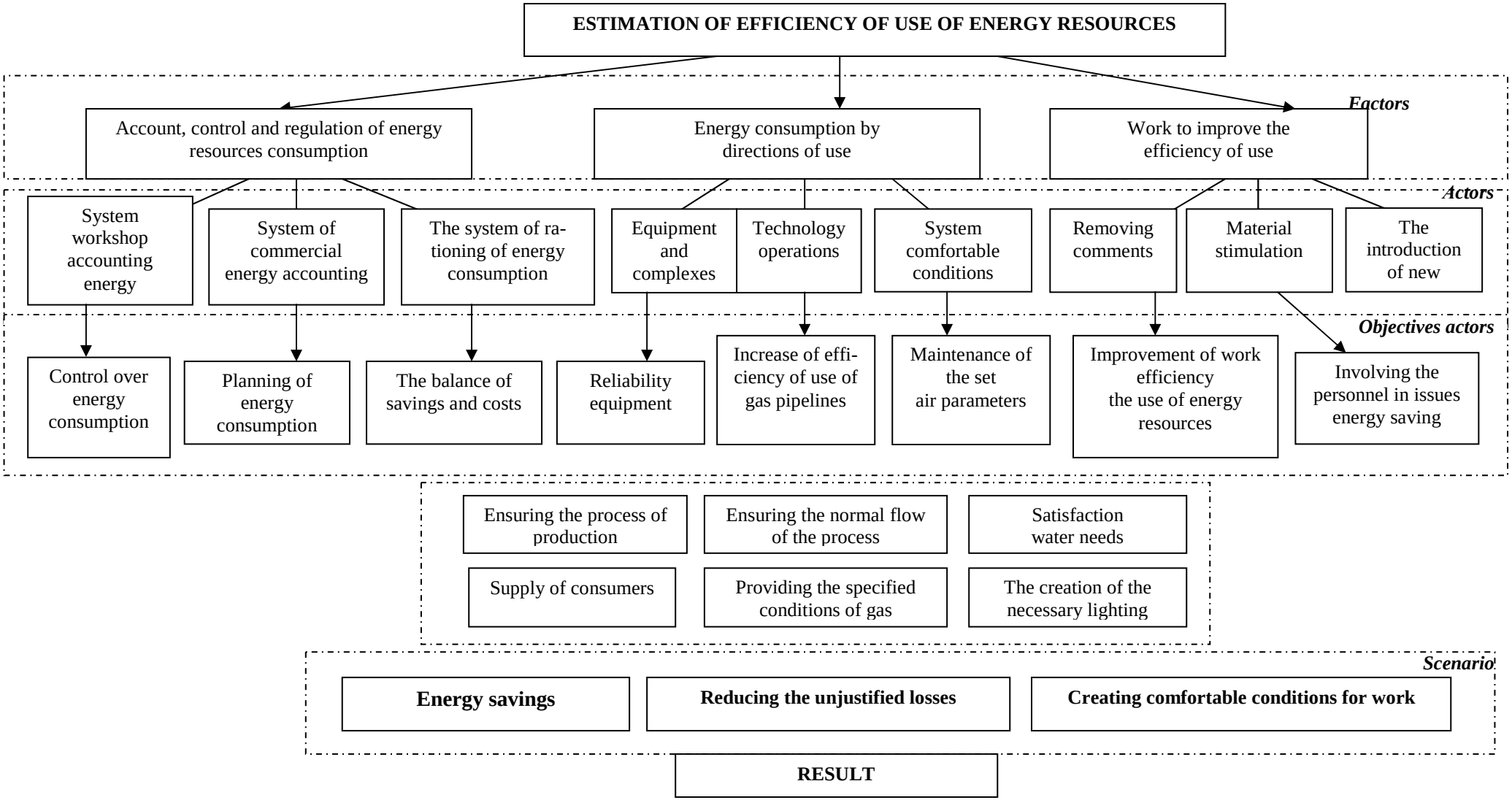


Fig.1. Structure of energy resources by types and directions of use at compressor stations of main pipelines

In accordance with the proposed methodology, the conclusion about the efficiency of consumption of energy resources is given on the basis of verification of such areas as accounting, control and regulation of energy consumption; consumption энергоре-resources on directions of use and organization of work on improving energy efficiency.

At the first stage was built hierarchy, which includes six levels: focus on primary factors, actors, targets actors, contrasting scenarios and a generic script (Fig.1).

Then constructed set of matrices of pairwise comparisons for each of the lower levels of one matrix for each element adjacent top level (table 1 - 2). To establish the relative importance of the elements of the hierarchy used a scale of relations [1].

At the second level of hierarchy is only one matrix of pairwise comparisons, which determines which factors affect the rational use of energy. The calculation is carried out of the main eigenvector W, consisting of *($W_1$, $W_2$, $W_3$)*: $W_1$= 1,4 / 16,73 = 0,08; $W_2$= 9 / 16,73 = 0,54; $W_3$= 6,33/ 16,73 = 4,20.

Table 1

The degree of influence of factors on the rational use of energy

| ***Factors*** | ***Factors*** | | | All factors |
|---|---|---|---|---|
| | Account, control and regulation of consumption of resources | Energy consumption by industries | Work efficiency | |
| Account, control and regulation of consumption of resources | 1 | 1/5 | 1/5 | 1,4 |
| Energy consumption by industries | 5 | 1 | 3 | 9 |
| Work efficiency | 5 | 1/3 | 1 | 6,33 |
| All factors | 11 | 1,53 | 4,20 | 16,73 |
| W | 0,08 | 0,54 | 0,38 | |
| $\lambda_{max}$ | 3,34 | | | |

Table 2

The degree of influence of actors on the factors of rational use of energy

| **Actors** | **Factors** | | |
|---|---|---|---|
| | Account, control and regulation of consumption of resources | Energy consumption by industries | Work efficiency |
| System workshop accounting energy | 0,35 | | |
| System of commercial energy accounting | 0,45 | | |
| The system of rationing of energy consumption | 0,2 | | |
| Equipment and complexes | | 0,5 | |
| System comfortable conditions | | 0,3 | |
| Technology operations | | 0,2 | |
| Removing comments | | | 0,35 |
| The introduction of new | | | 025 |
| Material stimulation | | | 0,4 |
| $\lambda_{max}$ | 5,38 | 6,7 | 5,91 |

The calculations show that the most dominant factor is the energy consumption by destination - 0,54, on the second place of work on to improve the efficiency of energy use - 0,38. Each pair of actors compares the relative extent of impact factors. The results are given in table 2.

Next, you must determine the importance of the objectives of actors. The purpose of each of 8 actors were compared in pairs.

In the result, the vectors of priorities, reflecting the streamlining and weight, and thus on the basis of table 2 to build the matrix of decision-making table 3.

Table 3

Building a matrix of decision-making

| A | B | C | ∑ |
|---|---|---|---|
| 0,35 | - | - | 0,0294 |
| 0,45 | - | - | 0,0378 |
| 0,2 | - | - | 0,0168 |
| - | 0,5 | - | **0,269** |
| - | 0,3 | - | **0,1614** |
| - | 0,2 | - | 0,1076 |
| - | - | 0,35 | 0,1323 |
| - | - | 0,25 | 0,0945 |
| - | - | 0,4 | **0,1512** |

The next stage is the degree of importance of the actors regarding factors on the future of the rational use of energy. To determine the impact of factors on the future of the rational use of energy resources in the enterprise which is under the following calculation. Each value A is multiplied by the corresponding value of W. the result obtained by The amount of each actor and we can make a conclusion as to which of them has the greatest impact on primary factors of influence of the rational use of energy resources in the enterprise.

Because the actors equipment and complexes, system of comfortable conditions and financial incentives account for more than 50 % of the impact on primary facto-ry influence of the rational use of energy in the future we will use these actors are able to obtain weights script.

Now we find important goal for actors, multiplying eigenvector purposes by the corresponding weight actor:

1. For consumption of electric energy and natural gas:

$$\begin{vmatrix} 0,4 \\ 0,35 \\ 0,25 \end{vmatrix} \times 0,269 = \begin{vmatrix} 0,1076 \\ 0,0942 \\ 0,0673 \end{vmatrix}$$

2. For consumption of thermal energy:

$$\begin{vmatrix} 0,33 \\ 0,27 \\ 0,4 \end{vmatrix} \times 0,1614 = \begin{vmatrix} 0,0533 \\ 0,0436 \\ 0,0646 \end{vmatrix}$$

3. For material incentives:

$$\begin{vmatrix} 0{,}2 \\ 0{,}15 \\ 0{,}15 \\ 0{,}5 \end{vmatrix} \times 0{,}1512 = \begin{vmatrix} 0{,}0302 \\ 0{,}0227 \\ 0{,}0227 \\ 0{,}0756 \end{vmatrix}$$

Using six goals, with a maximum value and normalizing their weight, we obtain the following result vector of weights purposes. You must find the ratios-UNT normalization.

Knorms = 1/ S the most important goals = 1/ 0,4255 = 2,351. (1)

Multiplying a vector of important goals for the actors on the normalization factor, semitea next resulting vector of weights purposes. The sum of the weights of the goals of the result vector is equal to one.

$$\begin{vmatrix} 0{,}1076 \\ 0{,}0942 \\ 0{,}0533 \\ 0{,}0646 \\ 0{,}0302 \\ 0{,}0756 \end{vmatrix} \times 2{,}351 = \begin{vmatrix} 0{,}253 \\ 0{,}221 \\ 0{,}126 \\ 0{,}152 \\ 0{,}071 \\ 0{,}177 \end{vmatrix}$$

The resulting vector of priorities to be applied in the future to obtain weights scenarios.
At the next stage is to determine the degree of impact of the scenarios on the target actors. The results of processing matrix of pairwise comparisons are presented in table. 4.

Table 4

The results of processing the matrix of pairwise comparisons

| **Scenario** | **Objectives actors** | | | | | |
|---|---|---|---|---|---|---|
| | Reliability of the equipment | Providing the production process | Maintenance of air parameters defined the | Creation of the necessary light level | Control over the energy consumption of | Attracting staff to power supply issues |
| Energy saving: | | | | | | |
| 1. Gas | 0,3 | 0,55 | | | 0,3 | 0,15 |
| 2. Electric energy | 0,15 | | | 0,3 | 0,15 | 0,2 |
| 3. Thermal energy | | | 0,2 | | 0,15 | 0,2 |
| Reducing the unjustified losses of energy resources | 0,55 | 0,45 | 0,2 | 0,2 | 0,4 | 0,45 |
| Creating comfortable conditions for work | | | 0,6 | 0,5 | | |

To obtain weights scenarios concerning the hierarchy focus (rational use of energy resources) multiply the matrix composed of the values of the vectors of priorities for the scenarios, the vector of weights purposes (table 5).

Table 5

Matrix values of vectors priority scenarios

| A | B | C | D | E | F |
|---|---|---|---|---|---|
| 0,3 | 0,55 | - | - | 0,3 | 0,15 |
| 0,15 | - | - | 0,3 | 0,15 | 0,2 |
| - | - | 0,2 | - | 0,15 | 0,2 |
| 0,55 | 0,45 | 0,2 | 0,2 | 0,4 | 0,45 |
| - | - | 0,6 | 0,5 | - | - |

Then each value of the vector of priorities for the scenarios of matrix multiply the resultant vector of weights goals and get:

Gas economy= (0,3×0,253)+ (0,55×0,221) +(0,3×0,071)+ (0,15×0,177) = 0,246.

Economy of electric energy= (0,15×0,253) + (0,3×0,152) + (0,15×0,71) + (0,2×0,177) = 0,13.

Saving of heat energy= (0,2×0,126) + (0,15× 0,071) + (0,2 × 0,177) = 0,096.

Reducing the unjustified losses of energy resources= (0,55× 0,253) + (0,45× 0,221) + (0,2× 0,126) + (0,2× 0,152) + (0,4× 0,071) + (0,45× 0,177) = 0,4.

Creating comfortable conditions for work= (0,6× 0,126) + (0,5×0,152) = 0,165.

Analysis of the result vector priorities shows that the scenario of «reduction of unnecessary losses» has the highest weight - 0.4 and, therefore, most likely.

The last step is to define the implications of introducing the most probable scenarios, and provides an assessment of the generalized script. Knowing the relative weighting scenarios obtained in the previous step, you can create a generalized scenario. Poincare simplified measure of the scale for the variable status is determined by summing the works of weights scenarios on the corresponding state variable value.

Common value for all scenarios= 1,031 + 1,031 + 1,047 + 4,142 + 3,401 + 3,366 + 2,002 + 3,195 + 2,094 = 21,309. Value on an aggregate scale, equal 21,309, not a «weight» or rank priority, as it is used simply as a global measure or benchmark against which can be measured by the degree of similarity between the probable and the desired future. The results of the analysis of calibration PE-belt States concerning the examined scenarios are presented in table. 6.

In conclusion it can be noted that the application of the method of analysis of hierarchies were more in detail all the qualitative and quantitative sources of resource consumption. Analysis of the result vector of priorities, which showed that the scenario of «reducing the unjustified losses» has the highest weight - 0,4 and, therefore, most likely. Define the consequences of making the most of the ve-роятных scenarios and estimation of generalized script. Value on an aggregate scale was 21,309 (out of 30).

Assessment of the calibration of the state variables concerning the examined scenarios allowed to make the following conclusions:- the Situation with the economy of the gas in the gas

Table 6

The definition of the consequences of the adoption of the most probable scenarios

| State variable (criteria for impact assessment) | Script and its weight | | | | | Generalized weight | Optimal variant |
|---|---|---|---|---|---|---|---|
| | Gas saving | Saving electrical energy | Saving thermal energy | Savings Reducing the unjustified losses | Creation of comfortable conditions | | |
| Weight | 0,246 | 0,13 | 0,096 | 0,4 | 0,165 | | |
| *Account, control and regulation of consumption of resources* | | | | | | | |
| System of commercial energy accounting | + 1 | + 1 | +1 | +1 | +1 | +1,031 | + 1,5 |
| System workshop accounting energy | +1 | +1 | +1 | +1 | +1 | +1,031 | + 1,5 |
| The system of rationing of energy consumption | +2 | +2 | +1 | +1 | +1 | +1,047 | + 2 |
| *Energy consumption by industries* | | | | | | | |
| Equipment and complexes | +5 | +3 | +2 | +5 | +2 | +4,142 | + 5 |
| System comfortable conditions | +1 | +5 | +5 | +3 | +5 | +3,401 | + 5 |
| Technology operations | +4 | +2 | +2 | +4 | +2 | +3,366 | + 5 |
| *Work efficiency* | | | | | | | |
| Removing comments | +1 | +1 | +1 | +3 | +2 | +2,002 | + 3 |
| Material stimulation | +2 | +3 | +3 | +3 | +5 | +3,195 | + 4 |
| The introduction of new | +3 | +1 | +1 | +2 | +2 | +2,094 | + 3 |
| Common value for all scenarios | | | | | | + 21,309 | + 30 |

transportation system in the near future, is likely to change for the better. The greatest impact is strongly affected by changes of the work of the energy-consuming equipment and systems in General or the types of finite energy at the expense of the more reliable of their work and ensure a smooth production process. Also the savings of gas to the influence of technological processes, which can be achieved by improving the efficiency of operation of trunk gas pipelines, ensure the normal course of technological process and maintain the technical condition of the equipment. Reduction of gas losses is possible due to implementation of new technologies.

- Economy of electric and thermal energy takes place mainly at the expense of changes in the system of comfortable conditions. The work showed that for workers of the enterprises of gas transportation systems needed for comfortable conditions and they paid a special attention. It is important to note that also the savings of electrical and heat-howl energy affects the material stimulation of the personnel. In the gas transportation system, IU has a system of bonuses for the rational use of energy. The study [1] a scale of penalties for inefficient use of energy горесурсов.

- Reducing the unjustified losses occur at the expense of more effective use of equipment and complexes, technological operations, and also by removing comments and improvement of the system of material incentives.

The survey identified the main areas which must be addressed to improve the rational use of energy owls, namely: equipment and systems; the system of comfortable conditions; financial incentives.

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