

Comprehensive evaluation of gas producing companies in the sphere of energy saving

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Abstract. A multilevel system of indicators to assess the effectiveness of energy consumption in the gas producing companies is formed. The methodical approach to the evaluation of a gas producing company in the field of energy conservation reflecting the management and production aspects of energy use is proposed. The criterion scale systematizing complex index of energy-saving activities is developed.

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Introduction

Change in energy policy priorities of developed countries in the sphere of energy efficiency at all stages of production and creation of incentives for investment in energy saving resulted in the major strategic orientations of technological development of the Russian Federation for reducing energy intensity of the economy by 40% by 2020 compared to 2007 levels by rational energy consumption [1,2]. The problem of efficient use and conservation of energy is particularly relevant in gas industry as the gas share in fuel and energy balance of Russia exceeds 50% [3].

For Open joint stock company Gazprom, which is a monopoly in the gas sector of the Russian economy, the problem of increasing energy efficiency is not new. Since 1998, the Cost Optimization (Reduction) Program has been realized in its subsidiaries where adequate attention to energy conservation is paid. Currently the Program of energy conservation and energy efficiency is implementing in Gazprom due to the recognition of energy saving as a relevant and priority activities. However, in recent years there has been a decrease of energy-saving effect of program implementation: energy savings in the production of Gazprom for the last 8 years has decreased by 92%. It should be noted that the energy saving program in the subsidiaries is mainly limited to the activities of technical and technological nature, which do not require a significant investment and long term for the implementation, and it does not allow to fully realize the potential for energy savings.

Development of existing potential of energy savings requires the creation of methodical approach to ensure assessment of the gas producing company in the field of energy conservation in order to identify priorities for improvement.

The authors' review of the literature showed that the methodological base of assessment of energy efficiency of gas production contains a limited set of

indicators, which does not adequately evaluate the activities of the company in this sphere of activity. In this connection a multi-level system of indicators is proposed including integral, generalizing, and private indicators of energy use (Fig. 1). When building a system of indicators, the aggregation method was used in the context of types of energy consumed in the gas enterprises (electricity, heat and natural gas).

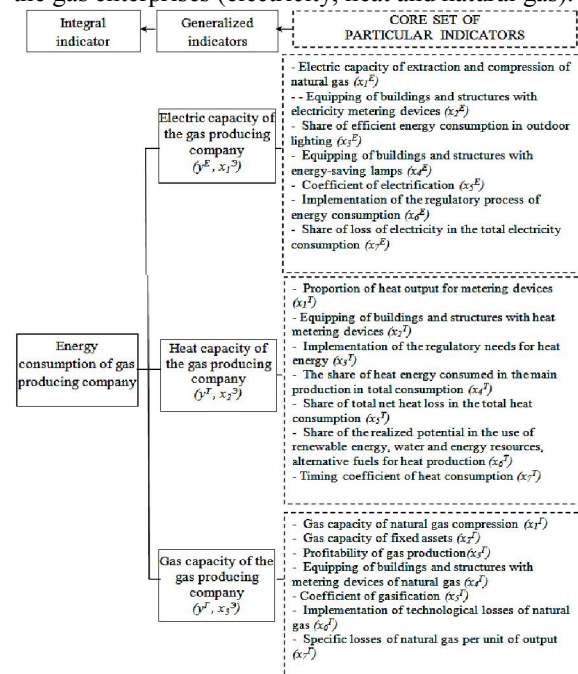


Fig.1. The system of indicators to measure the efficiency of gas production

The initial set of particular indicators was formed of indicators used in various international and Russian procedures, corporate standards, federal and regional programs for energy conservation, as well as proposed in the scientific literature of domestic and foreign scholars [4,5]. Inclusion of particular indicators in the basic set was based on the ranking made in accordance with the following conditions:

- importance of each specific indicator in determining the effectiveness of a certain type of energy resource consumption (estimated by experts);
- compliance with the traditional criteria when creating a balanced scorecard (connection with the strategy, quantitative expression, accessibility, clarity, balance, relevance, uniqueness of interpretation of the indicator);
- the degree of influence of each particular indicator which characterizes a certain type of energy consumption on the synthesis rate (electric capacity, heat capacity or gas capacity in the gas enterprise) and the strength of links between particular indicators (to avoid multicollinearity) determined with the help of correlation analysis.

During the study we found that the private information included in the basic set is characterized by fairly strong linear statistical dependence that allows us to represent the interrelation of studied parameters in the form of regression models and to assess their relevance and adequacy of using the coefficient of determination:

$$\begin{aligned}
 &1) \quad \text{electrical capacity } (R^2=0,931) \\
 &y^E = 10,86 + 0,17 \cdot x_1^E - 11,06 \cdot x_2^E - 2,15 \cdot x_3^E - \\
 &5,31 \cdot x_4^E + 8,3 \cdot x_5^E + 1,35 \cdot x_6^E + 0,8 \cdot x_7^E \\
 &2) \quad \text{heat capacity } (R^2=0,984) \\
 &y^T = 0,07 - 0,004 \cdot x_1^T - 0,012 \cdot x_2^T + 0,03 \cdot x_3^T - \\
 &0,07 \cdot x_4^T + 0,14 \cdot x_5^T - 0,15 \cdot x_6^T + 0,0003 \cdot x_7^T \\
 &3) \quad \text{gas capacity } (R^2=0,999) \\
 &y^G = 0,017 + 0,401 \cdot x_1^G + 0,00009 \cdot x_2^G - \\
 &0,0001 \cdot x_3^G - \\
 &0,0004 \cdot x_4^G + 0,00002 \cdot x_5^G + 0,00076 \cdot x_6^G + 1,294 \cdot x_7^G
 \end{aligned}$$

Calculation of standardized regression coefficients based on the constructed models allows to estimate the force of impact and to rank the influence of particular indicators on synthesis rate for each type of energy. Thus, change in the share of thermal energy consumed in the main production in the total volume of consumption has the greatest influence on the heat capacity of gas production rate (Table 1). This suggests that management decisions to ensure efficient use of thermal energy in the gas production should be primarily aimed at reducing the volume of consumption in the main production.

Currently used approaches to assess energy efficiency in the domestic gas production enterprises mainly cover the technical aspects, which does not allow to fully characterize their activity in the field of energy conservation. In foreign practice, by contrast, the approach of assessing the state of energy management in the enterprise is widely used [6,7]. In this regard, the authors propose a methodological approach providing an integrated assessment of activities considered in two aspects: management and manufacturing ones (Fig. 2) [8]. Management aspect involves the assessment of energy-saving activities in

the context of the three blocks (organizational, economic and socio-psychological), reflecting the traditional management techniques. Manufacturing aspect allows us to estimate the consumption of each type of energy in the gas production.

Table 1. Standardized coefficient of regression of particular indicators to measure the effectiveness of thermal energy consumption

| Indicator | Standardized coefficient of regression | Rating of indicator impact |
|--|--|----------------------------|
| Heat capacity of gas production | | |
| The share of heat consumed in the main production, in total consumption | 1,244 | 1 |
| The share of heat energy according to metering devices | 0,307 | 2 |
| Equipping of buildings and structures owned with heat meters | 0,224 | 3 |
| Share of total net losses of thermal energy in the total volume of its consumption | 0,207 | 4 |
| Execution of the normative needs for heat energy | 0,173 | 5 |
| The share of realized potential of using renewable energy, water and energy resources, alternative fuels for heat production | 0,122 | 6 |
| Timing coefficient of thermal energy consumption | 0,030 | 7 |

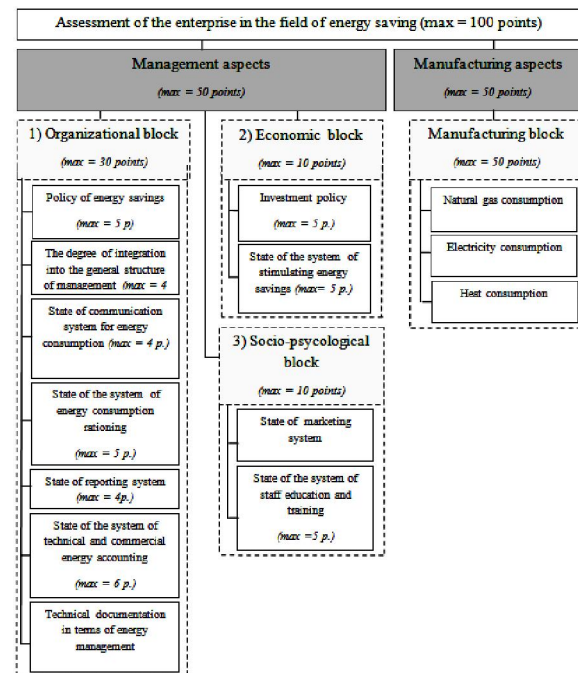


Fig.2. Comprehensive assessment of the gas producing company in the field of energy saving

The complex indicator reflecting the effectiveness of the activities of the gas producing company in the field of energy saving is estimated by point rating method, while its maximum possible value is 100 points. For the purposes of the practical use of the complex indicator, the criterion scale is developed, which systematizes its values: activity of the enterprise in the field of energy conservation is

recognized wasteful in the evaluation of less than 40 points, from 40 to 69 points it is considered limited, from 70 to 84 points - sparing, 85 points or more - effective.

Elements of blocks 1-3 are assessed by an expert according to the established list of characteristics where the range of possible values is defined for each of them. The maximum rating of blocks 1, 2 and 3 are 30, 10 and 10 points respectively.

When considering the manufacturing block, the assessment of the effectiveness of electricity, heat and natural gas consumption is based on indicators of electric, heat and gas capacity in gas production. The maximum rating of the final indicator is 50 points due to the high influence of the fourth block on its amount. Maximum rating of each type of energy consumption is proportionate to the share of the costs for its consumption in the total energy consumption. On this basis, the upper limit of intervals in assessment of natural gas, electricity and heat effectiveness for Private company with limited liability Gazprom dobycha Nadym in 2012 is set at 30, 7 and 13 points, respectively. According to the authors, a maximum point value can be assigned to the individual elements of the manufacturing if a reduction in the specific consumption of the relevant type of energy is achieved not less than 2%, which is consistent with the target setting of the regional energy saving program of YaNAO for the period of 2010-2020 [9]. In the case if the specific indicator of energy consumption of specific type of energy declined by less than 2%, the point value of the corresponding element of the manufacturing block is determined by the product of its maximum rating and this indicator.

Assessment of the effectiveness of a gas enterprise in energy conservation involves the comparison of assigned values with the maximum possible ones for each block of integrated assessment. The greatest deviation of particular indicators of the maximum value indicates the need for urgent measures to strengthen activities in this direction. The evaluation results are presented in the form of recommendations for the development of measures aimed at eliminating (reducing the negative impact) of problem areas in the field of energy saving [10].

Approbation of the proposed methodological approach on the example of Gazprom dobycha Nadym led to the conclusion that the energy-saving activities of this subsidiary continue to be wasteful

for the past three years because the value of the complex indicator in 2010 is estimated at 33.2 points, in 2011 - 33.7 points, and in 2012 - 19.7 points. Energy saving opportunities in Gazprom dobycha Nadym are related to the implementation of energy saving measures of not only manufacturing, but also organizational, economic and socio-psychological nature [11].

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