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Improvement of performance efficiency of the enterprises making part of innovative integral production systems in the region

Mejora de la eficiencia de desempeño de las empresas que forman parte de los sistemas innovadores de producción integral en la región

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ABSTRACT:

Sound use of energy resources, implementation of measures and technologies aimed at energy conservation, and, consequently, reduction of operating expenses and financial risks are considered to be the main prerequisites for obtaining value added and improvement of the economic efficiency of industrial enterprises. The authors in this research offer a methodological approach that have been tried out by them with the aim of providing assessment of the energy conservation factors interrelation, their influence on the production cost structure, financial risk level, improvement of performance efficiency and sustainability of the enterprise making part of the regional cluster.
Keywords: Innovative integral production systems, cluster, efficiency, energy conservation, risk, region

RESUMEN:

El uso racional de los recursos energéticos, la implementación de medidas y tecnologías orientadas a la conservación de la energía y, en consecuencia, la reducción de los gastos operativos y los riesgos financieros se consideran los prerrequisitos principales para obtener el valor agregado y mejorar la eficiencia económica de las empresas industriales. Los autores de esta investigación ofrecen un enfoque metodológico que han sido probados por ellos con el objetivo de proporcionar una evaluación de la interrelación de los factores de conservación de la energía, su influencia en la estructura de costos de producción, el nivel de riesgo financiero, la mejora de la eficiencia del rendimiento y la sostenibilidad de las empresas que forman parte del ramo en el sector regional.
Palabras clave: Sistemas innovadores de producción integrada, ramo empresarial regional, eficiencia, ahorro de energía, riesgo, registro

1. Introduction

One of the strategic focus areas being emphasized in terms of the regional economy development is the performance efficiency improvement backed by intensification of energy conservation measures at the industrial enterprises making part of the innovative integral production systems functioning as cluster-type formations. Without laying emphasis on that issue, it would not be possible to achieve full-scale implementation of the cluster-oriented policy aimed at promoting the competitive strength and innovative performance of the region (Dyrdonova et al., 2019).

It should be noted that at the backdrop of the electric power sector realignment, energy prices escalation, as well as the wide-range modifications taking place in the industry due to the globalization and intensification trends, the industrial enterprises functioning inside the regional cluster should have intrinsic potential substantial enough not only to help expand enterprise's own production capacities but also increase the regional gross product output (Dyrdonova, 2019).

When it comes to improvement of industrial enterprise's performance efficiency, the focus areas should be:

– reduction of energy resources consumption per one product item produced by the enterprise;

– reduction of payments for energy resources and overall expenditures of the enterprise;

– generation of value added through reduction of production costs and raising the product output margin;

– lowering the enterprise's risk level.

The objectives above outlined could be achieved through mastering state-of-the-art energy-saving technologies, implementation of energy efficiency measures, and development of financial and economic leverage for production management.

2. Literature Review

The issues related to sound use of energy resources and improvement of economic efficiency of energy conservation measures and technologies mastered at industrial enterprises have been widely studied. From the perspective of the interests pursued by the economy of different countries, the energy efficiency topic has been discussed in the studies by G.-M. Shi, J. Bi, J.-N. Wang (Shi, Wang, 2010), J. Bing, L. Rui (Bing, Rui, 2011) and J.-L. Hu, S.-C. Wang, F.-Y.Yeh (Hu et al., 2006), S. Honma and J.-L.Hu (Honma, Hu, 2009). From the point of view of investments peculiarities, the issue of energy resources sound utilization has been studied by R.U. Ayres, J.C.J.M. van den Bergh, D. Lindenberger and B. Warr (Ayres et al., 2013). From the perspective of country-to-country regularities, the energy efficiency issue in respect of the enterprises making part of integral production systems has been defined and discussed by M. Filippini and L.C. Hunt (Filippini, Hunt, 2011). The industry-related cross-culture comparisons conducted by way of seeking solutions for energy efficiency improvement can be found in the investigations carried out by E. Cagno, E. Worrell, A. Trianni andG. Pugliese (Cagno et al., 2013).

The issue of energy conservation focus areas definition, as well as improvement of energy efficiency at the level of particular enterprises has been studied by E. Worrell, J.A. Laitner,M. Ruth, H. Finman (Worrell et al., 2003).

However, analysis of the literature above listed showed insufficient coverage of a number of issues relating to financial risks management through tailoring of a package of energy conservation measures followed by assessment of the influence produced by energy conservation projects on the performance efficiency and sustainability of a particular industrial enterprise. Lack of a multifaceted methodological approach focused on interrelation of various energy conservation related factors, their influence on the production cost structure, financial risk level, and improvement of performance efficiency and sustainability of a particular enterprise underlies selection of a topic of this study.

3. Methodology

The ultimate economic efficiency (effectiveness) of financial and operational performance of any enterprise is to a great extent conditional upon risk level and possibility of risk mitigation. The risk level, in its turn, is dependent on the enterprise's generated earnings to profit ratio, as well as on the correlation between aggregate profit and the same amount but reduced by a sum of obligatory expenditures and payments deducted from the profit, the size of which are not dependent on the size of the profit itself. It is clear that the higher the earnings to product sales profit ratio is, the greater risk is faced by the enterprise.

The product sales proceeds to sales profit ratio is called as the operational leverage that characterizes the risk level faced by the enterprise in case of any change (decrease) in the sales proceeds.

The operational leverage level is measured and assessed in different ways depending on which of the factors may affect the sales proceeds. In the context of the topic being discussed (reviewed), the authors suggest picking out the following factors that influence the enterprise's potential risk level:

– change in energy prices;

– change in the physical quantity of energy resources consumption:

– combination of the two factors above mentioned.

Subject to the business environment, these two factors in this or that extent may facilitate the enterprise's risk management.

The financial leverage, as opposed to the operational leverage, is aimed at measurement of the risk associated with insufficient profit remaining available with the enterprise rather than the risk arising in the course of sales of the enterprise's products (works, services). When studying this indicator, the following aspects should be considered:

– such a risk may only occur in the case when the enterprise's profit goes down;

– the profit dynamics is not necessarily dependent on the earnings dynamics;

– the enterprise generates its profit not only through sales of products, or works, or services (the core business) but owing to other areas of activity (investment, financing etc.).

The operational leverage (L_O) and financial leverage (L_F) facilitate making a common assessment of enterprise's financial risk as follows:

$$L_O = V / P_S \text{ or } L_O = (V - EC) / P ; \tag{1}$$

$$L_F = P_N / P_U , \tag{2}$$

where V – sales proceeds;

EC – variable energy costs;

P_S – sales profit;

P_N – net profit;

P_U – retained (free) profit.

In case we input the correlation coefficient k= P_S / P_N , the two formulae can be combined in a single one:

$$L_O \times L_F = (V/P_S) \times (P_S / k \cdot P_U) = V / (k \cdot P_U) \tag{3}$$

or

$$L_O \times L_F = (V - EC) / (k \cdot P_U). \tag{4}$$

Let us try out the suggested methodological approach as illustrated by the performance of an industrial enterprise represented by the Nizhnekamskneftekhim Public Joint-Stock Company making part of the petrochemical cluster in the Republic of Tatarstan.

4. Results

The Nizhnekamskneftekhim Public Joint-Stock Company is a major energy user among other enterprises functioning in the industrial cluster formed in the Republic of Tatarstan [1, 10], therefore energy efficiency improvement and energy conservation measures intensification become the top-of the-agenda issues in the current context.

Table 1 below shows the energy resources consumption by PJSC Nizhnekamskneftekhim during 2012–2016. As can be seen, the Nizhnekamskneftekhim's energy consumption rate goes up year after year.

Table 1
Energy resources consumption by Nizhnekamskneftekhim, RUB mln (without VAT)

Energy resource type	2012	2013	2014	2015	2016
Electricity	4,522	5,150	5,414	5,600	6,089
Thermal energy	7,064	8,731	9,790	10,204	10,952
Fuel	102	98	92	83	70
Gas	1,744	2,132	2,268	2,602	2,696
Total	**13,432**	**16,111**	**17,564**	**18,489**	**19,807**

Source: Compiled according to the annual reports of PJSC Nizhnekamskneftekhim

Table 2 below demonstrates the Nizhnekamskneftekhim's financial performance indicators

along with the enterprise's computed overall financial risk level over five years. It should be noted here that any change in one of the factors considered in Table 2 would result in a change in the enterprise's overall financial risk pattern.

Table 2
Overall financial risk level faced by Nizhnekamskneftekhim over 2012–2016, RUB mln

Indicator	2012	2013	2014	2015	2016
Earnings	125,247.1	119,826.1	132,893.0	150,597.4	153,412.7
Variable costs	96,783.7	98,149.6	109,810.5	112,075.3	117,005.2
incl. energy (variable) expenses	11,614.0	11,778.0	13,177.3	13,449.0	14,040.6
Fixed costs	8,779.8	9,231.0	9,804.6	11,237.3	14,133.7
Sales profit	19,683.6	12,445.5	13,277.9	27,284.8	22,273.8
Net profit	16,953.5	6,089.1	9,269.2	26,482.6	25,052.0
Correlation coefficient	1.2	2.0	1.4	1.0	0.9
Free profit	16,908.5	6,033.7	9,247.0	26,450.6	25,052.0
Financial risk level1	**6.38**	**9.72**	**10.03**	**5.53**	**6.89**
Financial risk level2	*5.79*	*8.76*	*9.04*	*5.03*	*6.26*

Source: Calculated by the author.
1 Calculated using the formula no. (3).
2 Less energy costs – based on the formula no. (4).

As is seen from the obtained data, the enterprise's highest financial risk level was in 2013, while the lowest – in 2015. The financial risk level calculated based on the formula no. (2) is lower than the one calculated using the formula no. (1), which is due to the lower operational leverage indicator. So, the enterprise's overall risk level is determined based on the substantial sales profit loss risk and the risk of sudden decrease in the free profit. If any decrease in sales proceeds is forecast, it is essential to ensure a minimum amount of fixed costs in the sales proceeds, as well as a minimum amount of fixed payments through the net profit.

As long as the overall financial risk level depends on the operational leverage, let us analyze how the risk level may vary in consequence of any change in the relevant influential factors. We will take as a basis the factual data demonstrating the NKNK's performance over 2016.

In Table 3 below we will consecutively replace the constituents of the earnings without changing, however, the overall amount of the earnings. We will furthermore leave unchanged the prices (of energy resources) and the natural quantity (of energy consumption).

Table 3
Operational leverage level in case of variable earnings structure

Indicator	2016	Version 1	Version2
Energy (variable) expenses	14,040.6	15 444.7	16 989.1

Fixed costs	117,098.3	105,388.4	94,849.6
Sales profit	22,273.8	32,579.5	41,573.9
Earnings	**153,412.7**	**153,412.7**	**153,412.7**
Decrease in sales proceeds	15	15	15
Due to prices drop	10	10	10
Due to natural quantity reduction	5	5	5
Operational leverage			
(A) In case of prices drop (related to energy resources)	6.89	4.71	3.69
(B) In case of natural quantity reduction	6.26	4.23	3.28
(C) Operational leverage level	**6.68**	**4.55**	**3.55**

Source: Calculated by the author

Based on the calculations shown in Table 3 above the following conclusions can be made:

– the operational leverage level appreciably changes under influence of the earnings structure;

– the higher the fixed costs in the earnings amount are the higher the risk level is;

– in all cases, from the risk level perspective, decrease in the natural quantity of energy consumption (B) is more preferable than decrease in energy prices (A);

– the operational leverage level calculated with due consideration of the influence of both factors (C) leading to decrease in the enterprise's earnings will be closer to the level calculated for the case relating to decrease in the energy prices (A) since the price drop factor is higher in terms of the quantity that the consumption volume reduction factor.

Thus, the practical conclusion is that if the enterprise's earnings in future will tend to go downwards, this enterprise in the first place should seek a way to reduce its fixed costs, and then implement the relevant energy conservation measures owing to which the natural quantity of energy resources consumption would be reduced. Table 4 below shows the calculated operational leverage if the earnings proceeds structure is invariable.

Table 4
Operational leverage in case of invariable earnings structure

Indicator	2016	Version 1	Version 2
Energy (variable) expenses	14,040.6	15 444.7	16 989.1
Fixed costs	117,098.3	105,388.4	94,849.6
Sales profit	22,273.8	32,579.5	41,573.9
Earnings	**153,412.7**	**153,412.7**	**153,412.7**

Decrease in sales proceeds	15	15	15
Due to prices drop	5	+10*	25
Due to natural quantity reduction	10	25	+10*
Operational leverage			
(A) In case of prices drop (related to energy resources)	6.89	6.89	6.89
(B) In case of natural quantity reduction	6.26	6.26	6.26
(C) Operational leverage level	**6.47**	**15.02**	**15.65**

Source: Calculated by the author
* The plus ("+") sign signifies an increase rather than a decrease in the factor.
However, the other factor has decreased to a greater extent, overlapped
the increase and resulted in decrease in the enterprise's earnings.

The calculations show that even in the case of just a simple rearrangement of the pricing factor and the natural quantity of energy consumption factor, with all other conditions maintained, the operational leverage has decreased from 6.68 (Table 3) down to 6.47 (Table 4).

Cases I and II are based on special conditions under which a decrease in the enterprise's earnings occurs due to the following factors:

– increase in the energy prices in line with the growing natural quantity of energy consumption that partially compensates the decrease in the enterprise's earnings (Case I);

– increase in the energy resources consumption rates in line with the energy prices drop that partially compensates the decrease in the enterprise's earnings (Case II).

It should be noted here that the risk level in Case II is higher as compared to Case I, which is due to the fact that the decrease in the natural quantity of energy consumption has resulted in the decrease in the variable energy costs, and, consequently, to a relatively lower reduction in the amount of profit as compared to Case II.

The practical conclusion that could be made on the basis of the demonstrated calculations is that at the backdrop of the continuously growing energy prices it would be more beneficial for the enterprise (if the energy resources are delivered from the same suppliers) to substantially reduce the natural quantity of energy consumption rather than put into operation own gas turbine units for the sake of the pricing factor reduction. In that case the profit losses would be appreciably lower.

Thus, the suggested methodological approach would help forecast an expected operational leverage level in respect of the industrial enterprises making part of the cluster, while timely implementation of energy conservation measures aimed at risk mitigation would allow energy cost reduction, generate value added, improve the energy efficiency, and substantially reduce the overall financial risk.

5. Conclusions

Lack of a multifaceted methodological approach in the studies carried out by Russian and overseas scientists, which would make allowance for interrelation of various energy conservation related factors, their influence on the production cost structure, financial risk level, improvement of energy efficiency and sustainability of a particular enterprise, has justified the necessity of further investigations in this area.

In our opinion, accommodation of Nizhnekamskneftekhim's business activities to the changes taking place in the macroeconomic environment in respect of the industrial enterprises functioning predetermine the necessity of addressing a whole set of crucially new issues of methodological, methodical and organizational nature that relate to definition of a strategy of enterprises' behavior in the competitive electrical energy market. Settlement of these issues, however, would contribute to broadening of enterprise's opportunities in terms of seeking capabilities for improvement of production process efficiency, inclusive of energy efficiency and competitive fitness of the enterprise's products whilst allowing shifting the energy conservation related activities to another level at which the challenges faced by the enterprise could be adequately addressed.

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