DIAGNOSTICS OF COMPETITIVENESS OF POWER-GENERATING COMPANIES

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ABSTRACT
The paper presents the results of a study of the processes of development of power-generating companies in the conditions of high risks and uncertainty. To reduce the impact of uncertainty on the prospects of energy business development in the field of energy generation, a system of diagnostics of the competitiveness of power-generating companies is proposed. This system makes it possible to identify the threats associated with the reduction of competitiveness and provide information and analytical support to the management of companies to create effective management decisions. The developed system of diagnostics is based on mathematical modeling using procedures of discriminant and cluster analysis. The diagnostic process identifies and evaluates the factors that affect the increase in risks and reduce the investment attractiveness of the energy business in the energy generation sector by centralized energy sources. This makes it possible to use the potential advantages of the market situation to improve the competitiveness of power-generating companies. The system of diagnostics of competitiveness of the power generating companies developed by authors is the effective analytical tool which raises quality and objectivity of the made administrative decisions. This will make it possible to avoid the appearance of adverse consequences, which may lead to a decrease in the competitiveness of power-generating companies in the electricity and heat markets.
Keywords: power industry, efficiency, competition, strategy, reliability, risks, mathematical economic models, uncertainty, centralized energy sources.

1 INTRODUCTION

Increased competition in Russian power industry caused by recent reforms in this sector brought into existence two interconnected systems in the field of power generation. The first system includes the power-generating facilities of large nuclear, hydraulic, and thermal power plants which are mainly used for maintaining the power balance in electricity supply networks, ensuring the safe operation of the state unified energy supply system, and for maintaining the standard power quality in this system. The second power generation system is located at the territorial level. It forms a so-called territorial power generation system that has a separate niche in the territorial energy market.

The development of the territorial power generation system depends on its internal organization on the one hand, and on its interaction with the environment and climatic conditions on the other hand. From the system approach point of view, it possesses the integral unity of interconnected parts, i.e. the centralized and the distributed energy generation systems each of which can be divided into cogeneration power sources and separate cogeneration plants that can be characterized by the lower level of concentration and centralization of power-generating facilities.

The centralized energy cogeneration system includes thermal-type cogeneration facilities, the heat and power plants, which constitute the basis of a centralized heat supply system. These facilities cover 37% of the installed capacity of all power stations and up to the half of the thermal power generation in Russia. Usually these facilities are owned by territorial power generation companies. Steam turbine plans form the basis of the generating capacities

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in the centralized cogeneration systems (up to 80%), however combined cycle gas turbine plants and gas turbine plants are considered to be very competitive.

The distributed energy cogeneration system consists of high-capacity and medium-capacity cogeneration power facilities located near power demand centres, including facilities catering the needs of separate consumer groups and units (typically located in remote areas of a region).

Therefore, the competitiveness of power generation companies can be described as a system of relations between the thermal and electrical power generation companies as regards creating, implementing, and maintaining competitive advantages. These organizational and economical features influence the efficiency of cogeneration power facilities and allow the improvement of cost and quality parameters of supplied energy.

For the evaluation of competitive advantages of cogeneration and conditions of the territorial energy market positioning, it was necessary to create a set of procedural tools allowing the user to determine the level of competitive capacity of a power generation company.

This aim can be achieved using a power-generating company competitiveness diagnostics method, created with an aim to:

- identify the causes of development risk occurrence and increase;
- identify the measures and capabilities of development risk minimization;
- develop the information and methodological basis for determining the perspective competitiveness level.

The identified goals can be achieved only by means of detailed analysis of power-generating company development tendencies using system analysis methods. Besides that, it is possible to use regular methods with heuristic procedures based on expert analysis, since the diagnostics of competitiveness of a power-generating company is similar in nature to a simulation system [1]–[3].

2 PROCEDURAL ASPECTS OF POWER-GENERATION COMPANY COMPETITIVENESS DIAGNOSTICS

From the procedural point of view, the determination of limit levels of indicators is of a fundamental importance for diagnosing the competitiveness of a power generation company. Too high or two low values of these indicators may cause the formation of negative processes. The variation of these indicators may have an individual effect or may be combined with other factors increasing negative consequences that may affect the competitiveness level of a power-generating company [4], [5].

Proposed competitiveness diagnostic diagram for power-generating companies is shown in Fig. 1 below.

When conducting the diagnostics of power-generating company competitiveness it is very important to take into account the range of indicators reflecting the condition of the territorial energy market and competitive capabilities of each energy source. This approach allows identifying competitiveness level reduction causes and concentrating resources on the weakest units of a power-generating company [1], [6].

The first stage of the diagnostics consists of the preparation of time series of indicators (this is achieved by means of monitoring the business environment of the territorial energy market). For this purpose, the developed database is associated with an indicator analysis algorithm. It allows increasing the accuracy of diagnostics and processing larger amounts of data for every monitoring object for the given time period. Then, the total quantity of obtained indicators is divided into indicator blocks corresponding to the monitoring objects of the territorial energy market business environment.

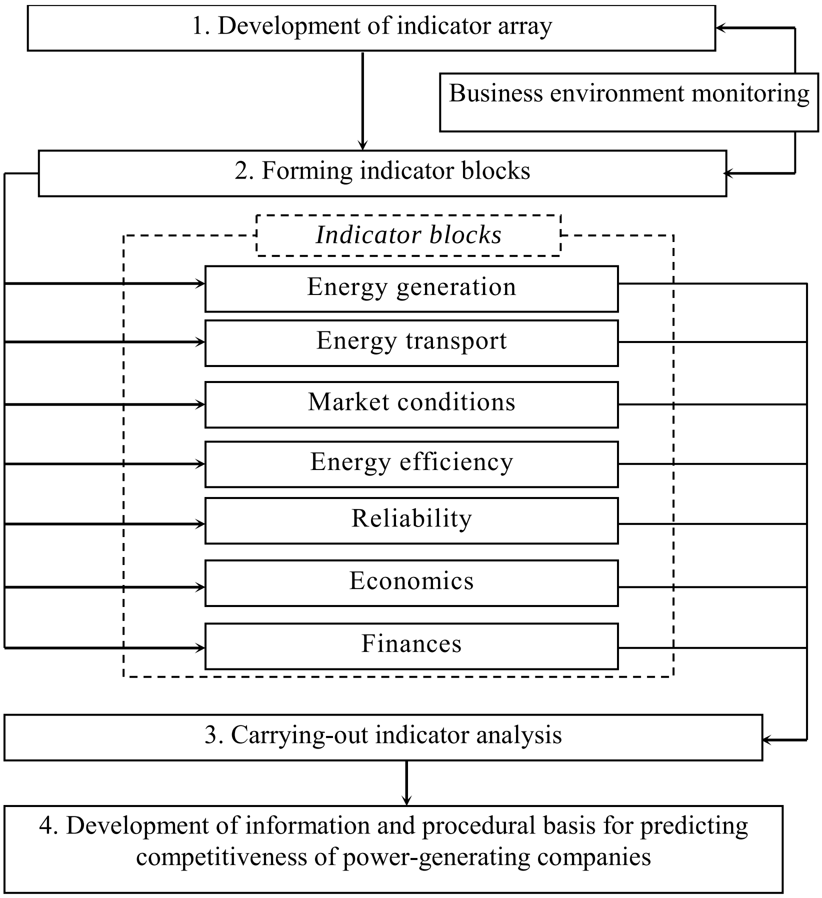

Figure 1: Diagram of procedure for diagnosing competitiveness of power-generating companies.

These indicator blocks are used for the competitiveness diagnostics of power-generating companies considering the distinctive features of each indicator included in a block.

The indicator blocks developed for the competitiveness diagnostics of a power-generating company shall comply with the following principles:

– they shall reflect the regularities of competitive development of power cogeneration systems;
– it is necessary to identify the most significant monitoring objects that can be classified as criterion-type objects which can be used for assessing the competitiveness level;
– monitoring objects shall be aggregated according to similar features of their nature and the character of influence on the development process;
– information support of parameters determining the value of each analyzed indicator;
– convenience and possibility of classification of the competitiveness levels by the monitoring objects in qualitative and quantitative forms.

- At the second stage the indicators are aggregated into indicator blocks. It is necessary for considering the peculiar features if realization of competitive advantages of a power-generating company.
- At the third stage an indicator analysis is carried out for each indicator block and for the whole object basing on cluster and discriminative analysis principles [7]–[13].
- At the final fourth stage the information and procedural basis for the prediction of competitiveness level of a power-generating company is prepared.

3 ASSESSMENT OF COMPETITIVENESS OF POWER-GENERATING COMPANY BUSINESS UNITS

The practical implementation of the proposed approach to the indicator analysis was tested by means of the competitiveness diagnostics carried-out for the power stations of Sverdlovskiy branch of T+Group JSC company (installed electrical power: 1256 MW, installed thermal power: 5886 Gcal/h). Sverdlovskiy branch of T Plus Company Group includes power generation and heat distribution facilities located in seven cities of Sverdlovsk region. The branch includes 6 heat and power plants: Nizhneturinskaya, Akademicheskaya, Verkhneturinskaya, Novo-Sverdlovskaya, Sverdlovskaya, and Pervouralskaya.

Series of imitation calculations were conducted basing on statistical data provided in the company reports for the year 2017. The first stage of analysis aimed at determining the level of competitiveness of the power-generating company business-units involved the calculation of normalized threshold values of competitively levels for each indicator block (Table 1). Upon that, these values were used as a basis for the evaluation of competitiveness of the power-generating company (Sverdlovsk branch).

The authors' experience in the field of diagnostics tells that the division into three groups is not sufficient for differentiating the qualitative status of an object and does not allow the reliable determination of the rate of reaction to the decrease in the competitiveness level for each business-unit of the power-generating company. Therefore, it is reasonable to identify three levels consisting of different stages of reduction of the competitiveness level in the transient and critical groups (Table 2).

Table 1: Normalized threshold values.

Indicator block	Threshold level					
	B	*C*	*D*	*E*	*F*	*G*
Energy generation	0.258	0.371	0.484	0.597	0.731	0.866
Energy transport	0.198	0.298	0.398	0.498	0.665	0.833
Market conditions	0.456	0.556	0.656	0.756	0.837	0.919
Energy efficiency	0.245	0.325	0.405	0.485	0.657	0.828
Reliability	0.387	0.524	0.661	0.798	0.865	0.933
Economics	0.309	0.415	0.521	0.627	0.751	0.876
Finances	0.248	0.339	0.431	0.523	0.682	0.841
Overall situation	0.300	0.404	0.508	0.612	0.741	0.870

Table 2: Classification of statuses as per the level of competitiveness.

Groups	Level of competitiveness (LoC)	Designation
Normal (N)	Weak	*A*
Transient (T)	Low	*B*
	Medium	*C*
	Unstable	*D*
Critical (K)	High	*E*
	Ominous	*F*
	Grave	*G*

Table 3: Results of power-generating company business units competitiveness diagnostics.

Business unit (heat and power plant)		Indicator block							Overall situation	Rating
		Energy generation	Energy transport	Market conditions	Energy efficiency	Reliability	Economics	Finances		
Pervouralskaya	*r*	0.326	0.308	0.487	0.472	0.529	0.418	0.447	0.497	3
	h	*C*	*D*	*C*	*E*	*D*	*D*	*E*	*D*	
Akademicheskaya	*r*	0.154	0.134	0.259	0.248	0.388	0.312	0.247	0.290	1
	h	*B*	*B*	*B*	*C*	*C*	*C*	*C*	*B*	
Nizhneturinskaya	*r*	0.484	0.614	0.706	0.397	0.809	0.621	0.798	0.738	6
	h	*D*	*F*	*E*	*D*	*F*	*E*	*G*	*F*	
Sverdlovskaya	*r*	0.254	0.322	0.543	0.395	0.511	0.589	0.423	0.506	4
	h	*B*	*D*	*C*	*D*	*C*	*E*	*D*	*D*	
Verkhneturinskaya	*r*	0.325	0.196	0.612	0.307	0.651	0.573	0.487	0.525	5
	h	*C*	*B*	*D*	*C*	*D*	*E*	*E*	*E*	
Novo-Sverdlovskaya	*r*	0.198	0.271	0.496	0.438	0.315	0.419	0.257	0.399	2
	h	*B*	*C*	*C*	*E*	*B*	*D*	*C*	*C*	

Note: *r* – calculated value; *h* – current status.

The results of the power-generating company business unit competitiveness evaluation (as exemplified by Sverdlovsk branch of T+ Group JSC) carried-out using the indicator blocks are given in the Table 3 with overall situation assessment index and ratings.

The results of the diagnostics showed that Akademicheskaya and Novo-Sverdlovskaya heat and power plants have the highest competitiveness level, and Nizhneturinskaya and Verhneturinskaya heat and power plants have the lowest competitiveness level.

In the course of diagnostics, it had been established that the most significant risk factor related to the decrease in the competitiveness of the power-generating company is the insufficient reliability of heat distribution networks that require regular repairs. This is the main reason why many heat power consumers reject centralized heat supply and opt to use individual power sources instead. Power supply network losses are influenced by a power generation equipment reliability factor that impacts on the index of availability of a power source for serving a load. However, one of the main causes of power network loss is the deterioration of network equipment due to high wear. Besides that, the increase in the share of low and medium voltage consumers, that is currently observed, causes power network losses and changes in the electrical load pattern, thus affecting the efficiency of cogeneration equipment application in heat and power plants. Probably this situation can also be attributed to insufficient investments that cause the decrease in the reliability of cogeneration plants due to high wearing.

The development of a decentralized heat supply system leads to the increase in competition and decrease in the share of a power-generating company in the thermal energy market. This, in turn, affects the technical and economical performance of cogeneration plants and also causes higher aggregate fuel consumption and escalation of costs.

The increase in the installed power of heat and power plants is a very significant competitiveness growth factor that in turn requires additional investments. It is worth mentioning, that the reduction of the competitiveness level is largely influenced by the operating conditions of cogeneration plants that are often far from optimal. Also, the important point is the fact that fuel management optimization and used fuel type diversification (where necessary) are often neglected.

It is evident that the one of the major impediments to the growth of competitiveness of the power-generating company business units is related to their financial improvement problems mainly caused by heavy indebtedness of power consumers. This factor significantly influences the investment potential and chosen financing options of a power-generating company.

4 CONCLUSIONS

The study of the global issue of competitiveness improvement in the electric power industry sector necessitated the development of a system for diagnosing the competitiveness of power-generating companies with a purpose to identify risks and assess their influence on territorial energy market positioning prospects. Analytical tools capable of identifying individual and integral characteristics of competitiveness were developed to achieve this aim.

In the future it is planned to use the proposed system for assessing the costs of development risks for the power-generating companies. It will allow analyzing the possibilities of realization of competitive advantages of cogeneration power sources. The proposed diagnostics system makes it possible to monitor changes in the business environment and take corrective actions that would allow the management of a power-generating company to timely minimize financial losses and use potential advantages of the current market situation.

It shall be noted that the significant enhancement of competitiveness of a power-generating company can be achieved by means of comprehensive solutions in the field of strategic goals prioritization: 1) increasing the efficiency of structure of generating plants; 2) fuel consumption optimization; 3) construction of highly flexible combined cycle gas turbine plants and cogeneration gas turbine plants. Proposed strategic priorities may be considered as a basis for increasing the competitiveness of a power-generating company at the local energy market and enhancing the economic efficiency of the electric power business.

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