Development of risk management for power generating companies in developing countries

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Abstract

One of the facets in the development process of power generating companies is to achieve a high level of investment potential. Taking into account the unstable development of the world economy and world-wide transformations in the global power sector, one of the lines aimed at the solution of the problem set is to improve the corporate management system for the sectorial, including investment-related, risk. This article presents a comparative analysis of alternative proprietary approaches to the assessment of risks specific for power generating companies in developing countries, which are characterised by elevated level of inflation, dearness of credit, and volatility of primary commodity markets. During the performed study, specific requirements were developed relating to the up-to-date sectorial risk management system for power generating companies in developing countries under the conditions characterised by multi-criteria nature and uncertainty of factors in business conduct.
Keywords: electric power industry, developing countries, power generating company, business competitiveness, investor attractiveness, sectorial risks, risk expert assessment, statistical distribution.

1 Introduction

It is common knowledge that electric power industry, one of the most important sectors of economy in any country, exerts versatile and profound effect on the operation of both industrial and non-industrial outfits. The power sector appears for a factor of global corporate competitiveness enhancement and an economic development driver (Domnikov *et al.* [1, 2]).

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Therefore, to ensure the integrated stepwise development of the power sector it is necessary to establish an efficient sectorial risk management system to enable the power generating companies to promptly reveal and minimise the effect of emerging threats. However, at present, due to variety of approaches, a problem of risk management method choice is emerging; the chosen method should improve the accuracy of assessing the investment potential of companies. Therefore, the authors were faced by a vital task of comprehensive study into the existing alternative approaches to the risk assessment in the power sector.

The result of the study is the development of specific requirements relating to the process of and tools for the assessment of sectorial risks for power generating companies in developing countries. The obtained results are of practical significance and used in the elaboration of innovative methodologies for the assessment of specific risks for power generating companies.

2 Current development of risk management system

A historical analysis of risk management system has shown that the issues relating to the development of risk management became the most relevant and common beginning from the 20th mid-century. This is when the first works dedicated to the comprehensive study of risk and into problems relating to the risk assessment and management were published. There are the several authors who developed the basis of the modern risk management system (Markowitz [3], Sharpe [4], Smith [5], Merton [6], Gorby [7], Vasicek [8]).

Currently, in the world-wide practice the risk management process is regulated by such basic international norms as: Integrated Risk Management Model adopted by the Committee of Sponsoring Organizations of the Treadway Commission (COSO-ERM model); Risk Management Standard of the Federation of European Risk Management Associations (FERMA, RMS model); standards adopted by the Bank for International Settlements (Basel II) (Domnikov *et al.* [2]).

2.1 Development of risk management system for power generating companies in developing countries

Sectorial risk management system for power generating companies in developing countries is characterised, as a rule, by the absence of own unique risk management system. The study conducted by KPMG analysts (KPMG [9]) allowed the most popular methods for quantitative risk assessment to be identified: scenario analysis (58% of the respondents), Value-at-Risk method (29%), stress testing (13%), Gross Margin-at-Risk (13%), etc. Also, the Monte Carlo method offered by D. Hertz in 1984 is generally regarded as a classical simulation modelling method.

A number of analytical studies (Domnikov *et al.* [2], KPMG [9]) identified the problems that are the most vital for the sectorial risk management system in the electric power industry of developing countries:

1. 83% of companies do not have in place a documented policy for sectorial risk management;

2. Non-existence of specialised bodies to implement the comprehensive risk management system;
3. In the management of sectorial risks, the power companies are oriented at the financial result for a certain period, rather than at the share value or balance-sheet value;
4. Limited use of hedging as a risk management tool;
5. Limited use of professional market models for forecasting etc.

This non-exhaustive list of problems corroborates the low level of current development of risk management system for power generating companies in developing countries. Therefore, the main objective for this study becomes the analysis of up-to-date alternative methods for sectorial risk level assessment with regard to the sector's companies, as well as identification of the base improvement vector for this line of activity.

3 Methodological approaches to risk assessment for power generating companies

This section covers the theoretical aspects of alternative methodological approaches to the sectorial risk assessment for power generating companies in developing countries.

3.1 Particular features of expert assessment method for sectorial risks

The expert assessment method as applied to the risk management for power generating companies is based upon the graphic-analytical approach to the diagnostics and assessment of hazardous sectorial risks run by the companies.

A particular feature of this method is the use, in the course of study, of quantitatively expressed expert opinion on the current state and trends of the sectorial risks including the investment-related risks run by the power generating company.

In general, the phases of the expert assessment method for sectorial risks are shown in Fig. 1 (Domnikov *et al.* [1]).

The estimation of cumulative sectorial risk for power generating company which directly affects the overall level of investment potential is made according to eqn (1) (Domnikov *et al.* [1, 11]):

$$S_{\text{int}} = \frac{\sum \left[R_i \times R_{i+1} \times \sin \left\{ \frac{\left(\sum \alpha_{R_n}(P_i) + \sum \alpha_{R_n}(U_j) \right)}{m+k} \right\} \right]}{2}, \quad (1)$$

where S_{int} - cumulative risk value indicator; R_i, R_{i+1} - sides of polygons determined by graphical estimate; $\frac{\left(\sum \alpha_{R_n}(P_i) + \sum \alpha_{R_n}(U_j) \right)}{m+k}$ – angle contained by the conjugate sides of polygon; $\alpha_{R_n}(P_i)$ – expert assessment value for the effect of

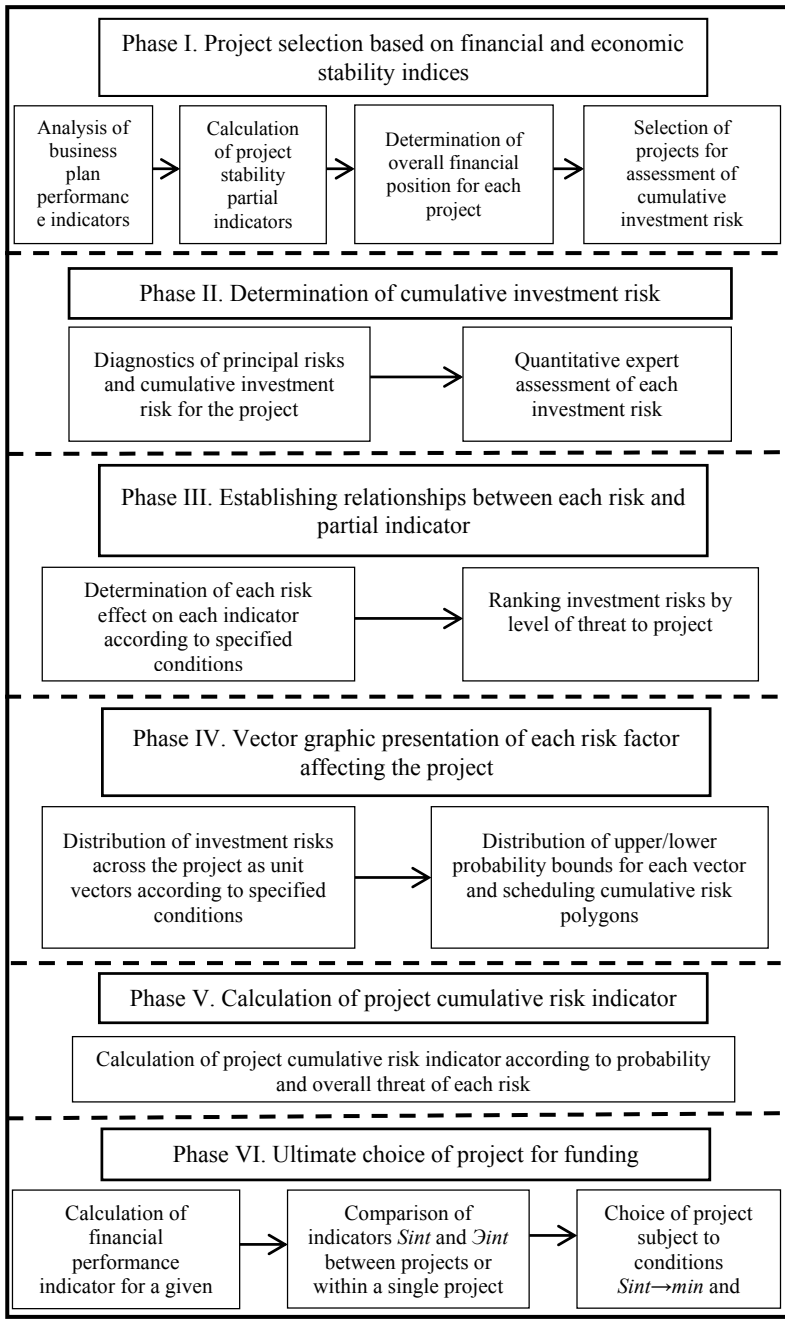

Figure 1: Stages of sectorial risk assessment for power generating companies according to expert assessment method.

factor n on project financial and economic stability indicator i; $\alpha_{R_n}\left(U_j\right)$ – expert assessment value for the effect of factor n on project ultimate financial result indicator j; k – number of estimated indicators of project financial result; m – number of estimated indicators of project financial and economic stability.

3.2 Particular features of sectorial risk assessment method based on statistical data distribution

A particular feature of this method consists in the replacement of each identified sectorial risk by an implicitly respective economic indicator. This technique enables the researcher to conduct a comprehensive analysis of sectorial risks, basing him on the indicator statistical distribution over a certain period.

The phases of sectorial risk assessment according to the statistical distribution method are shown in Fig. 2 (Khodorovsky *et al.* [12]). The ultimate assessment of sectorial risk level is obtained using eqn (2) (Khodorovsky *et al.* [12]):
In

$$(c_i q_i) - 0.5\times[(X - M_i)^T \times S_i^{-1} \times (X - M_i) - \ln|S_i|] - [\ln(c_{i+1}\, q_{i+1}) - 0.5\times [(X - M_{i+1})^T \times S_{i+1}{}^{-1} \times (X - M_{i+1}) - \ln|S_{i+1}|] = 0, \quad (2)$$

where X – variable vector in the space of risks under study; M_i, M_{i+1} – expectations; S_i, S_{i+1}-covariance matrices; q_i, q_{i+1} -prior occurrence probability for objects of classes i and i+1; c_i, c_{i+1} – costs of error in the reference of objects to classes i and i+1.

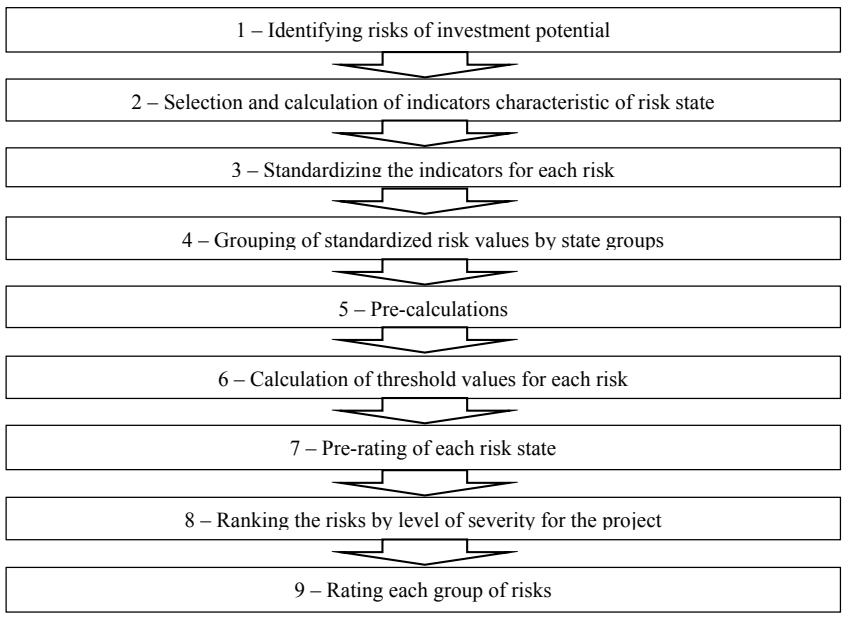

Figure 2: Stages of sectorial risk assessment for power generating companies according to the data statistical distribution method.

4 Comparison between methods based on the practical results of risk assessments

4.1 Sectorial risk specificity

Confining the numerosity of theoretical approaches for the purposes of this study, a sectorial risk as applied to the electric power industry should be read as the existence of potential threats, which possess a high level of likelihood to implement in the power generating company which, in turn, may worsen its competitiveness on the market.

Within the framework of this study all risks are grouped into exogenous and endogenous risks (Domnikov *et al.* [1, 13]). Exogenous risks are independent of operations conducted by the power generating company and are beyond its control.

The second-group risks under study, i.e. endogenous risks, are the outcome of assessment and analysis into all spheres of operations and financial-and-economic activities undertaken by the company and related outfits.

Types of sectorial risks run by power generating companies are presented in Table 1 which, in the author's opinion (Domnikov *et al.* [2]), reflect the specificity of developing countries and companies to the fullest extent possible, whereas the indicators characteristic of such risks were considered by the authors in the previous works (Domnikov *et al.* [11, 13]).

4.2 Practical results of sectorial risk assessment alternative methods

Table 1 presents the quantitative results of sectorial risk assessments according to the stated alternative methods. Within the framework of sectorial risk study using the expert assessment method (expert method in Table 1) a questionnaire poll was conducted among heads of departments and divisional superintendents of an power generating company in Russia with respect to the risk threat levels according to the specified scale (Domnikov *et al.* [14]).

Sectorial risk assessment using the data statistical distribution method (statistical method in Table 1) involved the analysis of actual risk indicators over the period of 2003 to 2014. The sectorial risk value is normalised and expressed in degrees. Maximum and minimum probabilities of sectorial risk realisation are calculated according to the 12-year (2003 to 2014) trend of statistical data, with the cut-off risk horizon of 50%.

4.2.1 Comparison between alternative methodological approaches based on the practical results of sectorial risk assessments

Comparison of sectorial risk study results between the alternative approaches shows that the data statistical distribution method yields higher estimated risk level than the expert assessment method does.

Generally, the degree value rise for cumulative sectorial risk calculated using the statistical method is 143.18%. The exogenous risk assessment is 176.96% higher, while the endogenous risk assessment is 120.83% higher.

Table 1: Quantitative presentation of sectorial risks according to assessment methods and risk realisation probabilities.

Group of risks	Risk value, degrees		Risk realisation probability	
Exogenous risks	Expert method	Statistical method	Maximum	Minimum
1. Regional economy sphere (R_1)	*R*	X_i		
1	2	3	4	5
Gross regional product ($R_{1.1}$)	11.11	0.10	*0.0909*	*0.0000*
Development of regional specialty sectors ($R_{1.2}$)	10.56	49.5	*0.6364*	*0.3636*
Investment in regional fixed capital ($R_{1.3}$)	12.89	0.90	*0.2727*	*0.1818*
Cumulative risk R_1 value	***34.56***	***50.50***		
2. Fuel and power balance sphere (R_2)				
Technology diversification ($R_{2.1}$)	12.89	51.30	*0.3636*	*0.1818*
Level of availability of recoverable resources ($R_{2.2}$)	14.56	18.00	*0.3636*	*0.1818*
Cumulative risk value R_2	***27.45***	***69.30***		
3. Institutional sphere (R_3)				
Tariff policy ($R_{3.1}$)	15.67	0.40	*0.0909*	*0.0000*
Foreign exchange policy ($R_{3.2}$)	17.44	89.90	*0.5455*	*0.3636*
Credit policy ($R_{3.3}$)	24.78	10.80	*0.5455*	*0.3636*
Cumulative risk value R_3	***57.89***	***101.10***		
4. Power consumption sphere (R_4)				
Efficiency of using electric power resources in industrial sector ($R_{4.1}$)	34.11	0.18	*0.0909*	*0.0000*
Efficiency of using electric power resources in industrial sector by the public ($R_{4.2}$)	23.12	64.8	*0.3636*	*0.2727*
Power efficiency ($R_{4.3}$)	35.22	89.90	*0.9091*	*0.8182*
Cumulative risk value R_4	***92.45***	***154.88***		
Cumulative exogenous risk value R_{ex}	**212.35**	**375.78**		
5.Corporate finance sphere (R_5)				
Direct financial losses ($R_{5.1}$)	42.00	89.90	*0.8182*	*0.5455*
Company's operating profit ($R_{5.2}$)	37.88	51.30	*0.3636*	*0.2727*
Investment in the company ($R_{5.3}$)	42.23	4.50	*0.3636*	*0.2727*
Company value ($R_{5.4}$)	67.45	0.10	*0.0909*	*0.0000*
Stock market position ($R_{5.5}$)	50.22	62.10	*0.3636*	*0.1818*
Cumulative risk value R_5	***239.78***	***207.90***		
6.Economy sphere (R_6)				
Reliance on imported equipment ($R_{6.1}$)	43.33	89.90	*0.9091*	*0.7273*
Capital consumption ($R_{6.2}$)	37.78	89.90	*0.6364*	*0.3636*
Cumulative risk value R_6	***81.11***	***179.80***		
Cumulative endogenous risk value R_{end}	**320.89**	**387.70**		

The comparative analysis of individual groups shows that the degree value of sectorial risk calculated using the expert method in most cases is at least 150% lower than the alternative value. Meanwhile, for the regional fuel and power balance the value rise in the alternative method is as high as 252.46%. At the same time, in the opinion of sector's experts, the corporate finance sphere of a power generating company should give a risk value higher by 115.33% as compared to the result of the statistical distribution method.

The graphical interpretation of sectorial risk for each of the alternative methods is presented in Figs 3 to 7. According to the graphically identified regular patterns, the refining calculations of the cumulative sectorial risk were conducted. The calculations gave the ultimate rise in the cumulative risk indicator: 126.05% for the statistical approach; 1.2374 and 0.9817 for calculations using the expert assessment method.

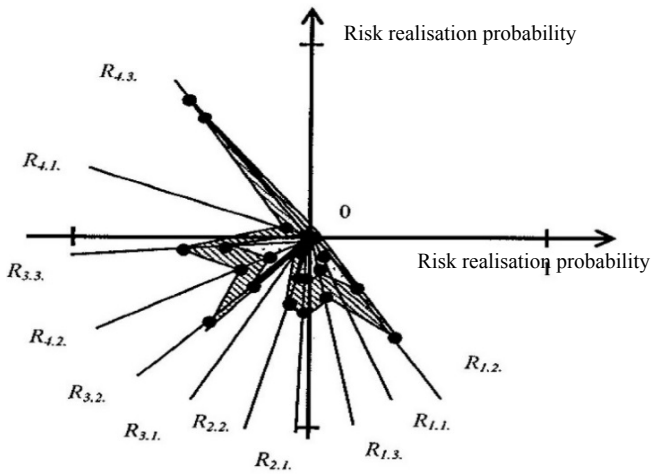

Figure 3: Graphical interpretation of exogenous sectorial risk calculated using the expert assessment method.

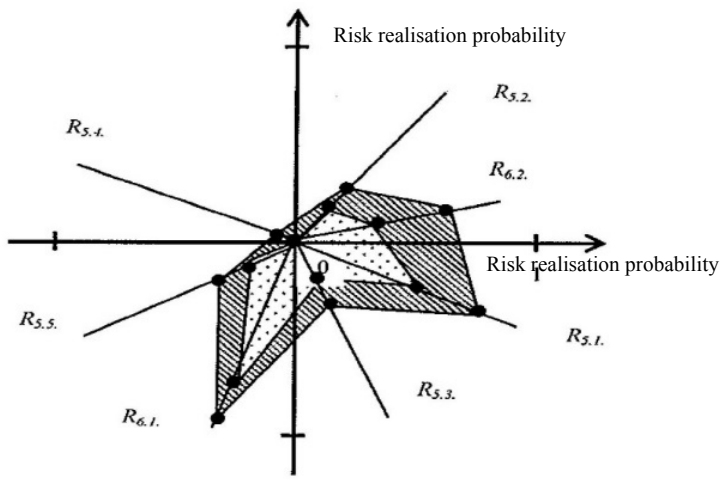

Figure 4: Graphical interpretation of endogenous sectorial risk calculated using the expert assessment method.

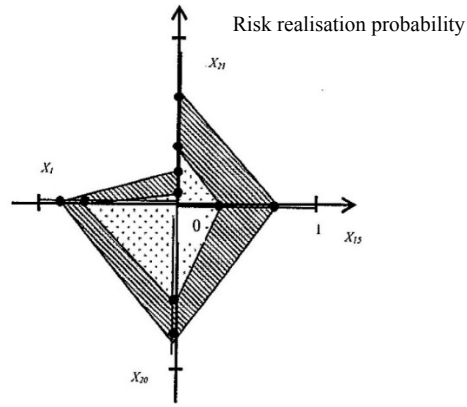

Figure 5: Graphical interpretation of sectorial risk calculated using the statistical method (part 1).

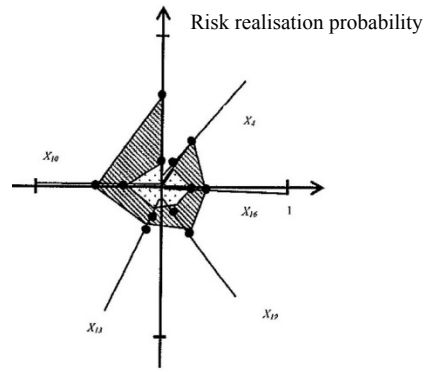

Figure 6: Graphical interpretation of sectorial risk calculated using the statistical method (part 2).

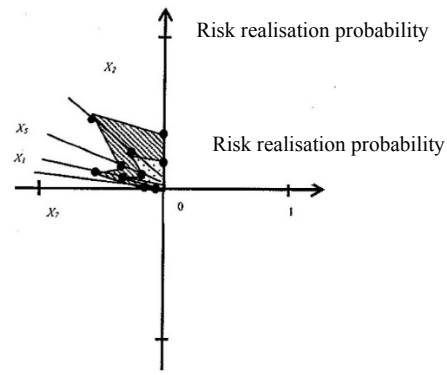

Figure 7: Graphical interpretation of sectorial risk calculated using the statistical method (part 3).

5 Risk management system development outlook for power generating companies in developing countries

5.1 Pros and cons of alternative assessment methods

During the analysis of obtained practical sectorial and the stepwise correlation between the presented alternative methods of sectorial risk assessment for power generating companies, the following strengths and weaknesses of these approaches were revealed. The approach based on the sectors' expert opinions allows estimating the company's investment potential by using the combination of analytical, graphical and expert-opinion methods, and by using certain mathematical tools. In the course of calculations, this method includes such components as the assessment of value for each identified risk according to the specified scale and the cumulative value of project risk as compared to the average sectorial value. At the same time, the expert assessment method takes into account experts' personal opinion, which disallows the sectorial risk current states and development outlooks to be accurately estimated.

The analysis of correlation between the practical results corroborated the interest of sector's experts, first of all, in the assessment of financial performance indicators of power generating companies: the risk level in the corporate finance sphere was estimated higher by the experts than using the statistical approach. Also, the study identified methodological drawbacks related to the formalisation of the assessment scale threshold levels of which use is made during the pre-calculations.

Statistical distribution method allows significant increasing the objectivity level and solving the problem consisting in high degree of financial decision-making dependence on the experts' opinion. Also, this technique assumes feasibility of scenario analysis into the electric power industry development processes due to introduction of a floating variable, i.e. risk horizon cut-off (risk realisation probability).

5.2 Risk management for power generating companies in developing countries – up-to-date requirements

During the analysis of alternative approaches to sectorial risk assessment and the study into the current state of risk management systems applied in power generating companies of developing countries, the following practical and methodological requirements for the up-to-date sectorial risk management system were marked out:

1. Development and implementation of adaptive policy for sectorial risk management in developing countries;
2. Establishment of specialised bodies to implement the comprehensive risk management system and to be responsible for the results taking into account the market volatility and uncertainty;
3. Formulation of own documented policy for sectorial risk management in power generating companies and Automation of risk management process;

4. Customising the modern financial derivatives (including the usage of sectorial risk hedging instruments) with a view to the regional specifics;
5. Integrating the risk management system of power generating outfit and market professional models with a view to forecast the development of sectorial risk processes;
6. Preference of statistical approaches to sectorial risk assessment over the expert-opinion methods and Definition of sectorial risk rating model;
7. Orientation on annual financial reporting in the course of analysing world market changes, etc.

6 Conclusions

The study undertaken by the authors into particular features of establishment and development of risk management system at power generating companies in developing countries, as well as the analysis of alternative methods for sectorial risk assessment have revealed the existing drawbacks and identified the potential growing points in this sphere. The lack of comprehensive methodological approach to sectorial risk assessment should be considered one of the key features. Moreover, the accelerating development trend faced by corporations in the power sector creates the demand for methodological tools, which would allow comprehensive consideration of rates of change for the risks, including the latent risks, and the respective threat level.

The remedy of identified deficiencies and aspiration to comply with the international requirements contribute, in the first place, to fundamental and applied development of risk management system in electric power industry. At the same time, the online sectorial risk management will give a push to the investment potential increase and competitive growth of power generating companies in developing countries and define their sustainable growth vector in future.

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