

# **A risk-oriented approach to capital management at a power generation company in Russia**

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## **Abstract**

One of the challenges facing the energy industry today is how to improve investment attractiveness and business competitiveness in energy generation. It is becoming particularly important to enhance the sectoral risk management systems in order to ensure long-term growth and sustainable development in the energy sector amidst numerous factors and uncertainties created by the globalization of the financial markets. This paper presents the authors' approach to assessing sectoral risks in the energy industry based on capital management for the purpose of achieving a certain level of long-term financial stability. The practicalities of applying the proposed approach to sectoral risk assessment are considered using a power generation company as an example.

*Keywords: power industry, energy company, competitiveness, risks, risks management, economical capital, market risks, credit rating, financial sustainable, investments.*

## **1 Introduction**

It is common knowledge that the energy industry is one of the key and most important sectors of the economy in any country. Producing a profound and complex impact on the activities of both industrial and non-industrial companies, the energy sector acts as a factor of growth in global competitiveness for companies and a driver of development for economies.

In the course of its evolutionary development, however, the energy sector as a whole and companies within it come to face considerable problems arising in the form of sectoral risks. These, in turn, have a negative impact on the



competitiveness of this sector. The authors therefore see it as an important task to carry out a complex analysis of modern-day risks in the energy sector and develop a methodological toolkit for assessing them allowing for contemporary developments in risk management.

The outcome of this study is the authors' methodological approach to economic capital estimation that allows risks to be identified in a timely manner and the threat they present to the energy company to be assessed by evaluating the cost of this threat. The results have practical importance and are used for evaluating the investment attractiveness of energy companies.

## **2 Basics of risk assessment and management in the modern energy sector**

A review of risk management systems in the historical context has shown that risk-management related issues became crucial and widespread in the middle of the 20th century. That period of time saw the first publications devoted to comprehensive studying of risks and issues related to risk assessment and management. Among the authors who developed the basis of the contemporary risk management system are Alle [1], Markowitz [2], Miller [3], Sharpe [4], Kahneman [5], Smith [6], etc.

In today's international practice, risk management is regulated by such basic international acts as the integrated risk management framework adopted by the Committee of Sponsoring Organizations of the Treadway Commission (the COSO-ERM model); the risk management standard of the Federation of European Risk-Management Associations (FERMA, the RMS model); and the standards adopted by the Bank for International Settlements (Basel II).

In the economic science, there are various definitions of risk. Limiting the plurality of theoretical approaches for the sake of this study, risk may be understood as an uncertainty in the economic performance of an energy company whereby the financial outcome is represented by a probabilistic estimate.

Unfortunately, the lack of risk assessment models that could be readily used by energy companies (taking into account their specific features) presents a barrier to consideration of this issue. Admittedly, the study carried out by KPMG Market Risk Management at Russian Power Companies [7] lists the most popular methods of quantitative risks assessment: scenario analysis (58% of responses), Value at Risk (29%), stress testing (13%), Gross Margin at Risk (13%), etc. Also, the Monte-Carlo method of project risk simulation proposed by Herz in 1964 is considered to be classical [8].

Due to the low level of development characterizing risk management systems in the electrical energy industries of the developing countries, the companies of this sector face considerable difficulties in risk analysis and management. A number of analytical studies [7] have made it possible to identify problems sought after in this study:

1. 83% of companies lack a documented policy of sectoral risk management;
2. Companies lack a dedicated division implementing a comprehensive risk management system;



3. In their sectoral risk management, energy companies focus on their financial performance for the period rather than shareholder or balance sheet value;
4. Limited use of hedging as a risk management tool;
5. Limited use of professional market models in forecasting, etc.

This incomplete list of problems confirms the low level of development of risk management systems at power companies in developing countries. The authors therefore regard it to be the main goal and further focus of this study to be the development of their own methodological approach based on the assessment of industry-specific risks through the estimation of their costs.

### 3 Risks the power companies face at the present stage

Long-term comprehensive studies of development factors for energy companies [9, 10] have allowed us to identify a number of specific risks that are most important and significant to this sector at the current stage of its development. These risks, arranged in groups and provided with short characteristics, are presented in Table 1 [9, 10].

Table 1: Industry risks of the power companies.

Risks group	№	Risks names	Risks characteristics
Exogenous risks	1	Gross regional product	Region economic activity
	2	The development of region industries	Major industries of the region, the city-forming enterprise
	3	Investments to the region capital	Costs financial to the BPA making and reproduction
	4	Technological diversification	Composition and structure of the region resources
	5	Concentration of production capacities	The maximum possible capacity of the power objects
	6	Bandwidth of inter-territorial energy relations	Ratio bandwidth electrical connections between areas to the greatest power shortages
	7	Energy self-sufficiency	Using your own types of energy
	8	Tariff policy	Company dependence on changes in tariffs by type of energy produced
	9	Tax policy	Influence the actions of tax authorities on the activities of company
	10	Currency exchange	Company dependence of exchange rate changes
	11	Interest rates on loans	Company dependence on changes in the cost of resources involved
	12	Fuel price	Company dependence on changes in prices by fuel type
	13	Efficiency of electric power resources use	The ratio of volume, resources and profit derived structure of company
	14	Consumption efficiency of electricity and heat	Total volume of energy losses during delivering to consumer
	15	Company position in a competitive market	Company position in the ranking of making activity indicators, dynamic and trends of factors

Table 1: Continued.

Risks group	№	Risks names	Risks characteristics
Endogenous risks	16	Unforeseen financial loss	Profit reducing, capital losses, depending on increase in borrowed funds, etc.
	17	Position in the stock market	Company position in the stock market, shares dynamic, short-term trends, total stocks turnover, etc.
	19	<i>Technical and economic risks:</i> The total TGC demand for fuel	The volume of consume fuel in period
	20	Dependence on imported equipment	The share of imported equipment in the total technical volume of TPGC
	21	<i>Environmental safety risks:</i> Air pollution	Compliance with the legislation on environmental safety , quantitative/qualitative mismatch introduced environmental technologies
	22	Water pollution	
	23	Contamination of the lithosphere	
	24	Technical equipment of PGC	The availability level of innovation technical equipment
	25	Physical deterioration of BPA	The average time of deterioration
	26	Need to upgrade of production facilities	The volume of BPA remaining life

Figure 1 shows the map of risks, demonstrating which of the factors are less or more risky [9, 10].

The borderline that passes through the centre of the risk map divides it into two parts depending on the importance of a sectoral risk. Movements in relation to this boundary value point to a decreasing or increasing threat in relation to the initial level of threat presented by the risk factor.

The left part of the map shows less dangerous risks, including: tax policy, physical wear and tear of fixed assets, development of region’s specialty industries, etc.

The right part of the map shows risks that produce the greatest impact on the development of a power company and its projects: technological risks, fuel price risks, changes in prices on the electric power market, etc.

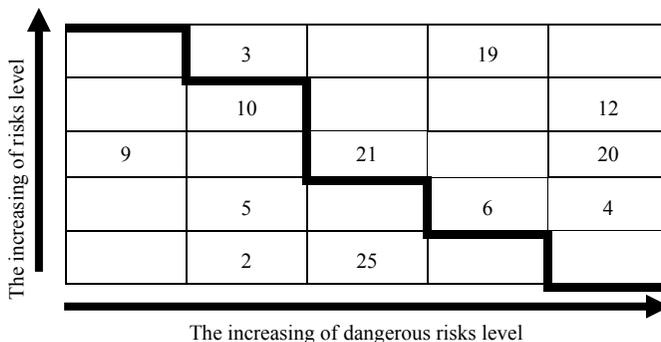


Figure 1: Energy company development risk map (with reference to Russia).

#### 4 A methodological approach to assessing sectoral risks for a power company

The methodological approach developed by the authors of this study to managing the sectoral risks of an energy company is based on the concept of economic capital, which is popular in risk management. Economic capital is the amount of capital that a company requires to cover the risks that it is running in order to secure maintenance of a certain standard of solvency or in case of default [11]. In other words, it is the amount of capital, which the company needs to have for the purpose of covering losses that may arise as a result of risk realization. Economic capital is estimated from aggregated distribution of risks for a given confidence level, which, in turn, is determined by the company's target financial stability. Economic capital allows the company to protect itself against losses due to risk realization. The target financial stability is usually expressed in terms of credit rating: the higher the credit rating, the higher the probability of the company staying solvent and the less the probability of default, respectively.

In a context where it is essential to enhance the investment attractiveness of power generating assets it becomes important to be able to determine the strategic level of financial stability identified as a long-term target within the framework of sectoral risk management. Such target level of financial stability can be determined by the target long-term credit rating that the power generating company aims to achieve. An important factor in assessing and managing risks is thus the net worth of the company and its development strategy. Each credit rating may be assigned a certain level of default probability corresponding to it depending on the forecasting horizon. One of the variants of correspondence between credit rating and default probability is presented in Table 2.

The probability of default determines the confidence level required for calculating unforeseen losses and economic capital for a power generating company (1):

$$\gamma = 1 - PD \quad (1)$$

where  $\gamma$  – confidence level, which determines the probability of non-bankruptcy,  $PD$  – level of default probability, corresponding to the target credit rating.

Identification of sectoral risks allows the group of the most serious risks to be identified for a power company. The extents of estimated sectoral risks may be different depending on the influence the operating specifics of a power generating company may have, on the territorial location features of the power assets, and on the sensitivity of the power company capital to individual risk factors. In our approach, we have identified three most important risks for a power company: the risk of price changes in the power and capacity markets, the risk of price changes in fuel markets, and the operating and technology risk. These risks have been chosen on the basis of the study carried out by KPMG, who surveyed managers of Russian power companies [7]. In this the study, these risks are mentioned as the principal threats to the energy business, risks associated with changes in electricity and fuel prices being the least manageable. That these risks need to be assessed and managed is also confirmed by our earlier studies [9].



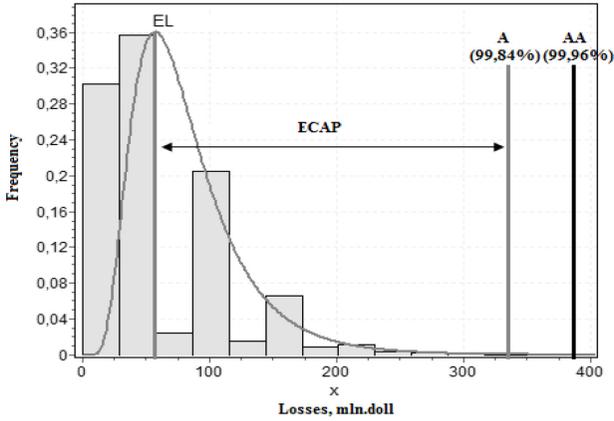


Figure 2: Assessment of the economic capital for different financial stability criteria.

Table 2: Correspondence between the probability of default and credit rating.

Rating	1-Y PD	3-Y PD	5-Y PD
AAA	0.008%	0.03%	0.1%
AA	0.04%	0.16%	0.28%
A	0.16%	0.4%	0.58%
BBB	0.3%	1.4%	3%
BB	1.15%	8.6%	15%
B	5.8%	15.4%	32.6%
CCC or lower	26.57%	45.5%	60%

The extent of each type of EL risk was measured individually on the basis of the VaR methodology. For assessing market risks, we chose the parametric approach. This approach involves risk assessment based on the construction of a statistical model for the financial outcome in relation to the portfolio of assets. In parametrical models, the probability distribution function for risk factors features a certain shape, for example, a normal probability distribution with parameters estimated on the basis of historical data. This approach to risk management is implemented in the system developed by Morgan [12]. The parametric approach assumes normal distribution of risk factors. In risk assessment, the measure of risk is variance or mean-root-square deviation (or volatility). Thus, the main objective in estimating VaR by the delta-normal method is to find the variance of return for a single position at risk or for a set of several positions (2):

$$ML_i = VaR_i = k_\gamma \cdot \sigma \cdot V \cdot \sqrt{T} \tag{2}$$

where  $ML_i$  – maximum losses from the  $i$ -th type of risk,  $VaR_i$  – VaR value for the  $i$ -th power generating company risk,  $k_\gamma$  – confidence factor (determined by the confidence level),  $V$  – the current value of the position;  $T$  – time horizon;  $\sigma$  – standard deviation.



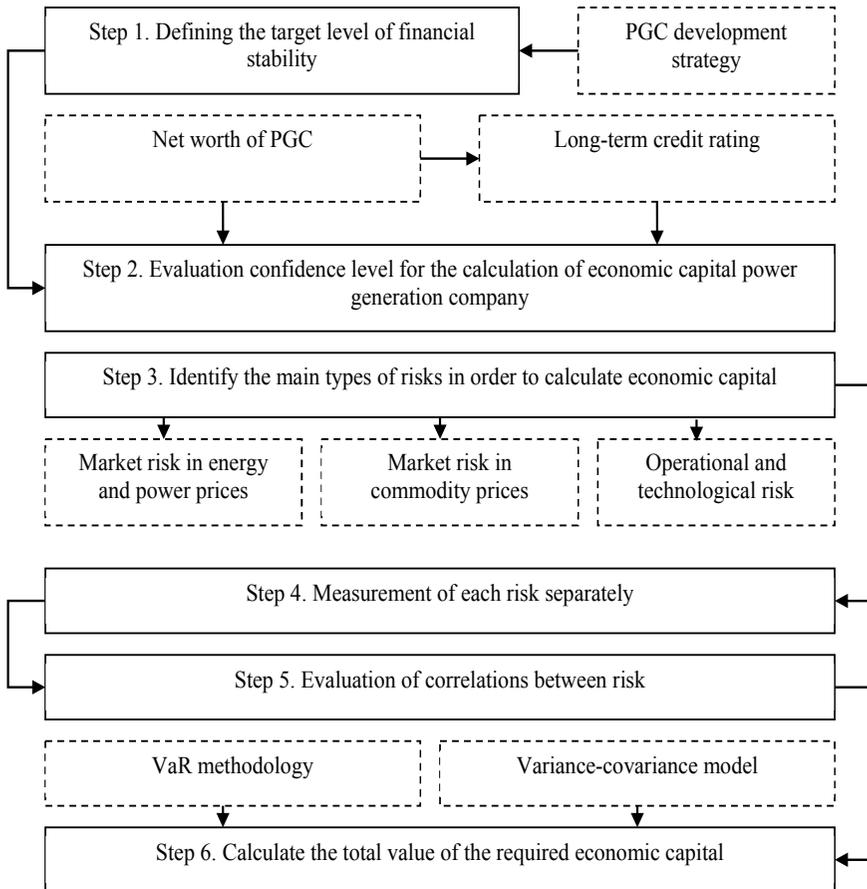


Figure 3: Methodology for energy company risk assessment.

Loss from the operating and technology risk depends on individual factors characterizing a power facility, such as unintentional failures in operation, incorrect choice of operating and process equipment, violation of operating and maintenance procedures, irregular inspection and maintenance of equipment, technical condition of the equipment, loss as a result of failures and breakdowns, repair and recovery costs, etc. Modeling this type of risk implies identification and aggregation of risks factors on the basis of mathematical and econometric constructions. Because the level of operating and technology risk is individual in each case, estimating loss due to operating and technological risk for the purpose of this study will be performed based on historical simulation. This method involves constructing an empirical distribution function using a certain number of

losses due to the operation and technology risk from a historical series. Such construction enables one to easily find the  $\alpha$ -quantile, which is just the value of  $VaR$ .

Economic capital for the  $i$ -th type of risk is determined taking into account maximum and expected losses (3):

$$ECAP_i = ML_i - EL_i \quad (3)$$

where  $ECAP_i$  – economic capital of  $i$ -type risk  $EL_i$  – mathematical expectation of losses from the  $i$ -th type of risk.

Within the framework of the modern approaches, risks are assessed taking into account their correlations. In particular, VaR assessment can be performed for both non-diversified VaR, making a rough assumption that correlation coefficients are equal to 1, and for diversified VaR, enabling one to obtain more precise quantitative risks estimates. Correlation coefficients are determined from historical data for individual risk components. To begin with, we can use risk VaR time series for estimating historical correlations (for computation it is essential to take a period of at least a year). Correlation coefficients required for the analysis can be determined on the basis of Pearson correlation coefficient determined on the basis of the historical series.

An aggregated estimate of economic capital is obtained by means of the variance-covariance method. According to this method, individual risks are aggregated in an overall estimate of economic capital taking into account existing correlations. With regard to the risks included by us into the model, the amount of economic capital is given by (4):

$$ECAP_{PGC} = \sqrt{ECAP_{EMR}^2 + ECAP_{CMR}^2 + ECAP_{TR}^2 + 2ECAP_{EMR}ECAP_{CMR}\rho_{EMR,CMR} + 2ECAP_{EMR}ECAP_{TR}\rho_{EMR,TR} + 2ECAP_{CMR}ECAP_{TR}\rho_{CMR,TR}} \quad (4)$$

where  $ECAP_{PGC}$  – aggregate economic capital energy company,  $ECAP_{EMR}$  – economic capital market risk in energy prices and power,  $ECAP_{CMR}$  – market risk economic capital energy prices,  $ECAP_{TR}$  – economic capital operational and technological risk,  $\rho_{i,j}$  – the correlation between the two components  $i$  and  $j$  risk. The final estimate of economic capital shows the capital requirements of the energy needed to maintain the financial stability of the appearance of losses from unexpected losses with a given probability level.

## 5 Practical implications of risk assessment for a power company

Consider application of this methodological approach to risk assessment with reference to a power company. The main performance indicators of the power company are presented in Table 3.



Table 3: Key economic indicators studied energy companies.

Indicator	Value
<b>Technical and economic indicators</b>	
Annual electricity production, thsd.megawatt-hour	20,000
The consumption of fuel (gas – 100%), mcm	15,000
<b>Financial indicators</b>	
Sales for the year, mln.doll.	70
Net income for the year, mln.doll.	2
Assets, million dollars	53
Own capital, млн.долл.	25
<b>Target credit rating:</b>	<b>BBB</b>
<i>Confidence level</i>	<i>98.85</i>

Based on the technical and economic indicators of the power company, we set baseline factors for the model. The power company chosen sells electricity at prices quoted at Moscow Energy Exchange. The daily average base load price index in the “Center” hub and the distribution of prices are shown in Figures 4 and 5. The fuel market risk factor (natural gas in this case) was simulated on the basis of spot prices for natural gas traded at NYMEX. In a real situation, the fuel price risk can be simulated taking into account the consumption of various types of fuel (gas, coal, fuel oil), as well as cumulative or country price statistics. The distribution of losses due to operating and technology risk was simulated using cumulative historical values. Correlations between risk factors were estimated by comparing the values in time intervals. The main risk-factor correlation indicators are presented in Table 5.

Based on the data from Table 4 and Table 5, and formula (4), the aggregated economic capital for the three types of risk amounts to 1,510,070 dollars. Thus, the required level of economic capital need for ensuring financial stability sufficient for achieving the BBB rating is 1,510,070 dollars. As follows Table 2, the current level of the company’s equity is enough to form economic capital to cover the market risk of power and capacity price changes, the market risk of fuel price changes and the operating and technology risk.

Table 4: Calculation of economic capital for energy company risk factors.

Indicator	$V$	$k_{98,85}$	$\sigma$	$T$	$VaR$	$EL$	$ECAP$
$ECAP_{EMR}$	50,000	2.27	2.91	90	3,133,358,63	1,562,269,12	1,571,089,51
$ECAP_{CMR}$	12,000	2.27	0.57	90	147,300,2	58,630,1	88,670,06
$ECAP_{TR}$	-	-	-	-	610,284,4	502,214,43	108,070

Table 5: Correlation matrix of major energy company risk factors.

	$ECAP_{EMR}$	$ECAP_{CMR}$	$ECAP_{TR}$
$ECAP_{EMR}$	1		
$ECAP_{CMR}$	-0.54	1	
$ECAP_{TR}$	0.21	-0.18	1

## 6 Risk-based management of power company capital

Being a measure of unforeseen losses, economic capital determines the capital requirements of a power company. To set up reliable protection against risks and achieve a target level of financial stability, the capital of a power company needs to be managed with a view to increasing its sufficiency.

The capital of a power company can be formed at the expense of internal and external sources. The internal sources are represented mainly by profit; however, since many of the power companies are running at a loss due to the low production efficiency of the sector and to the volatility of the incoming fuel prices, high operation and maintenance costs impose constraints on long-term use of this source of capital. In particular, in 2013 acceptable ROE (within 14–15%) was achieved by few power companies, mainly those with majority nonresident shareholders. In most cases, rates of return fluctuate on average from 3% to 5% in the generation sector and from 1% to 3% in the distribution companies, and only the sales segment shows higher sectoral rates of return on equity. No doubt, such low profitability of the sector impairs its investment attractiveness, particularly for western companies with ROE at 15%–25%, which makes it difficult to attract capital from external sources. External sources of capital may include both sales of additionally issued shares and issuance of capital debt securities. Prospects for an IPO are in many respects determined by the investor sentiments and overall liquidity of the market, which suggests that this method may only be used whilst keeping an eye the business cycle stages and the securities markets. As for the placing of stocks and debt instruments on the OTC market, it boils down to finding an investor for these instruments. These securities would be of most interest for institutional investors, such as private equity funds, power company’s related firms, investment banks, or energy holdings managing assets in various areas of business operation [14, 15].

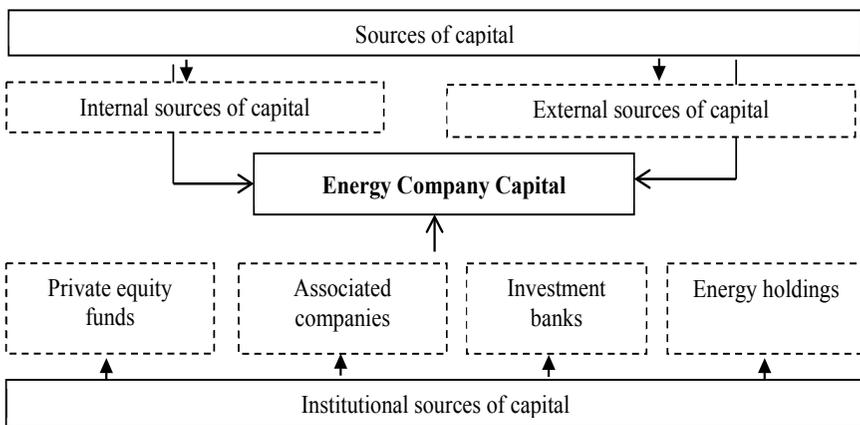


Figure 4: The main sources of capital in the energy sector.

## 7 Conclusion

In today's complicated economic context, sectoral risk management is key to sustainable development and long-term growth of companies. Our study has shown that a power company is faced in its activities with various sectoral risks which can cause substantial losses and have an adverse effect on its production and financial performance.

The authors of this paper have proposed a methodological approach to assessing sectoral risks based on the concept of economic capital. This approach involves estimation of a specific indicator, i.e. economic capital characterizing the amount of capital that a power company needs to ensure a certain level of financial stability with a certain probability of staying solvent determined by the target credit rating. This model takes into account three important sectoral risks: the risk of price changes in the power and capacity markets, the risk of fuel price changes, and the operating and technology risk.

The practical importance of the proposed approach to sectoral risk assessment lies in the fact that it enables one to carry out a comprehensive review of a power company's investment attractiveness. This approach allows sectoral risks to be identified, estimated and minimized in a timely manner. This, in turn, helps enhance the competitiveness of the power company and influences the financial decisions made by investors [16, 17].

In general, this approach may be further developed in the following directions. Firstly, given the plurality of sectoral risks, it is becoming important to expand the model to include other specified risks. Development of formalized loss estimation techniques for other risks will allow the accuracy and quality of the model to be enhanced. Secondly, an important area for improving this approach is adaptation of more advanced methods of economic capital estimation of individual sectoral risks and their aggregations, particularly in contexts where losses feature distributions other than normal. Thirdly, sectoral risk assessment and management implies the need to take into account a broader range of strategic areas for power facility development. In addition to financial stability, it is essential to estimate the production and investment factors of capital management at a power company.

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