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The Risk Management of Thermal Power Enterprise under Tradable Green Certificate System

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Abstract **Review Article**

Green certificate trading is an important measure to solve the development problem of green power by establishing market regulation mechanism, but it also brings certain risks to traditional thermal power enterprises. Based on the theory of enterprise risk management, this paper reconstructs the risk index system of thermal power enterprises under the green certificate mechanism, adopts matter-element expansion method to evaluate the risk of thermal power enterprises, and draws the conclusion that TGC policy has brought some controllable risks to thermal power enterprises, and provides risk control strategies for the enterprises.

Keywords: Thermal Power Enterprises; Tradable Green Certificate; Risk Management; Comprehensive Evaluation; Matter-element Extension.

INTRODUCTION

Tradable Green Certificate System is a support policy for renewable energy industries that is generally promoted internationally currently. TGC is based on the Renewable Portfolio Standard (RPS) system and uses market mechanisms to ensure the achievement of renewable energy targets. Tradable Green Certificate System is conducive to optimizing the energy structure, accelerating the transformation of traditional thermal power enterprises, and further alleviating the pressure of government subsidies.

The current power supply of China has shifted from stable and slightly tight to sufficient power supply or even surplus. As a traditional power generation company, thermal power companies will inevitably be affected in today's environment. At present, it is still in the preliminary stage for the research on the risk management of thermal power enterprises following the introduction of green certificate system, and some of the assessment methods adopted are not specific to the risk assessment of thermal power enterprises in the new situation. Therefore, the application of risk management theory in the research of thermal power enterprises in the new context is of great research value and practical application value.

In this paper, the green certificate mechanism is introduced into the risk evaluation index system of thermal power enterprises, and the matter-element extension evaluation method is used for risk assessment of the thermal power enterprise A under the green certificate mechanism, thus putting forward suggestions for risk management of the thermal power enterprise A.

Reconstruction of the risk index system of thermal power enterprises under TGC system

Reconstruction of the risk index system of thermal power enterprises

The external risk indexes reconstructed under TGC system include natural risk, technical risk, market risk, policy risk and economic risk. Natural risk includes natural disasters that thermal power enterprises may be encountered with and the availability of fuel resources. Technical risk refer to the risk that new technologies and products generated by scientific development and progress may cause losses to traditional thermal power enterprises. Market risk refers to the risk that the demand for thermal power may decrease with the introduction of TGC and the change of supply-demand relationship in the power market. Policy risk refers to the impact of the adjustment of national macro policies and laws on the operation and development of power generation enterprises. Economic risk mainly refers to the macro-economic risk, including the direct economic impact caused by the state's macro-control and financial market fluctuations, and the indirect economic impact caused by residents' expenditure in power consumption.

The internal risk indexes reconstructed by TGC include organizational risk, decision risk, operation risk and production risk. Organizational risk refers to the risk of loss caused by contradictions among the internal organizations of an enterprise. Decision risk refers to the risk that the enterprise may suffer losses due to the mistakes of decision makers. Operational risk refers to the risk that an enterprise may be encountered with during the operation, in which the bidding risk with greater impact is mainly subject to the cost of power generation and the total power demand, and information risk refers to the impact of data on the enterprise behavior during the operation. Production risk refers to the risk that some unforeseen factors may threaten personal safety or property safety during the production process of thermal power enterprises.

Impact of TGC on the Risk Index System

Tradable green certificate (TGC) system

In January 2017, three ministries and commissions including National Development and Reform Commission jointly issued the Notice on trial implementation of renewable energy green power certificate issuance and voluntary subscription trading system [1], stipulating that the trial implementation of renewable energy green power certificate issuance and voluntary subscription trading would start on July 1, 2017. Since then, the TGC system has been implemented in China. The green certificate will be issued by the government and registered in the institution designated by the government. In China, one unit of green certificate is provided for 1Mwh power with category, serial number and production date of clean power marked on it.

During the process of green certificate trading, it is the responsibility of the government to specify the proportion of renewable energy power produced by power enterprises. Green power generation enterprises may obtain the green certificate by producing clean power. Traditional thermal power enterprises may complete clean energy production index by purchasing the green certificate. Green certificate trading and renewable energy trading are in parallel. Clean energy power generation companies may sell both renewable energy and green certificates directly. The green certificate may be sold, assigned and recycled in the market. In order to ensure that it will not be reused, once it is purchased by the end consumers, its number will be cancelled in the database.

Impact of TGC on the risk index system

The impact of green certificate trading system on thermal power enterprises is mainly reflected in policy risk, and it also urges the internal adjustment of thermal power enterprises. It includes organizational risk, decision-making risk, operation risk and production risk.

The impact of policy risk is mainly reflected in that the government stipulates that power generation enterprises must supply a certain proportion of clean power, which may allow thermal power enterprises to purchase clean energy in lieu of fines, and increase the expenditure of thermal power enterprises on clean energy production.

The changes in external conditions result in the adjustment of internal management. Thermal power enterprises must plan the risk control strategy under the introduction of TGC in advance, adjust the operation strategy appropriately, ensure that they can still move forward steadily in case of any new risk, and seize the opportunity to extend the industrial chain or develop comprehensive energy service providers.

Risk analysis and evaluation of thermal power enterprises under TGC system

Data collection and index weighting

In this paper, the literature research method and the questionnaire method are used for data collection, and the questionnaire is distributed to the managers of A thermal power plant and the experts of Electric Power Design Institute. Finally, the representative results are obtained.

① Based on the scores given by experts to various risk indexes, the risk indexes are weighted by the order relation method with the numbers 1-9 representing the most important risk to the least important risk, respectively. ② the relative importance of any risk index is determined by the comparative judgment between x_{k-1} and x_k given by experts. ③ the weighting coefficient w_k is calculated with the equation (1), as shown in Table-1.

$$w_k = \left(1 + \sum_{k=2}^{m} \prod_{i=k}^{m} r_i\right)^{-1} \quad \text{……………………… (1)}$$

$$w_{k-1} = r_k w_k, \quad k=m-1,\dots,2$$

Table-1: Weighting coefficient

Expert	**W1**	**W2**	**W3**	**W4**	**W5**	**W6**	**W7**	**W8**	**W9**
1	0.0638	0.0766	0.1853	0.1544	0.1544	0.0532	0.1103	0.0919	0.1103
2	0.0464	0.0557	0.2263	0.1886	0.1572	0.0668	0.1123	0.0802	0.0668
Average	**0.0551**	**0.0662**	**0.2058**	**0.1715**	**0.1558**	**0.0600**	**0.1113**	**0.0861**	**0.0886**

Risk Evaluation

① Determine the classic domain. According to matter element extension theory, scores 1-10 are divided into five classical domains: R1 (8.750-10.750); R2 (6.750-8.750); R3 (3.750-6.750); R4 (1.750-3.750); and R5 (0.000-1.750). R1-R5 represent that the risk of the impact on the enterprise changes from maximum to minimum. ② Determine the weighting coefficient, as shown in Table-1. ③ Calculate the value of correlation function and determine the level. Refer to the equations (2) and (3), where w is the weighting coefficient, D is the correlation degree, and k is the normalization of the comprehensive correlation degree. When the comprehensive correlation degree is the maximum and k is 1, the corresponding D reflects the impact of the risk on the enterprise. The risk assessment results before and after the introduction of TGC are shown in Table 2 & 3.

$$K_j(v_i) = \begin{cases} -\dfrac{\rho(v_i,\ v_{oij})}{|v_{oij}|}, & v_i \in v_{oij} \\ \dfrac{\rho(v_i,\ v_{oij})}{\rho(v_i,\ v_{pi}) - \rho(v_i,\ v_{oij})}, & v_i \notin v_{oij} \end{cases} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

$$K_j(P_0) = 1 - \sum_{i=1}^{n} w_i D_{ij} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Table-2: Risk evaluation of thermal power enterprises before the introduction of TGC

Index	Weighting value	Score	D1 correlation degree	D1*w	D2 correlation degree	D2*w	D3 correlation degree	D3*w	D4 correlation degree	D4*w	D5 correlation degree	D5*w
X_1	0.055	1.000	-9.750	-0.537	-7.750	-0.427	-5.750	-0.317	-2.750	-0.152	1.000	0.055
X_2	0.066	2.000	-8.750	-0.579	-6.750	-0.447	-4.750	-0.314	0.250	0.017	0.250	0.017
X_3	0.206	3.000	-7.750	-1.595	-4.750	-0.978	-2.750	-0.566	0.750	0.154	0.750	0.154
X_4	0.172	3.000	-7.750	-1.329	-4.750	-0.815	-2.750	-0.472	0.750	0.129	0.750	0.129
X_5	0.156	4.000	-6.750	-1.052	-3.750	-0.584	-1.750	-0.273	1.250	0.195	1.250	0.195
X_6	0.060	3.000	-7.750	-0.465	-5.250	-0.315	-3.250	-0.195	0.250	0.015	0.250	0.015
X_7	0.111	3.000	-7.750	-0.863	-5.750	-0.640	-3.250	-0.362	0.250	0.028	0.250	0.028
X_8	0.086	4.000	-6.750	-0.581	-4.250	-0.366	-2.750	-0.237	2.250	0.194	2.250	0.194
X_9	0.089	2.000	-8.750	-0.775	-6.250	-0.554	-4.750	-0.421	0.250	0.022	0.250	0.022
Comprehensive correlation degree			**2.2238**		**4.87505**		**6.84415**		**9.39855**		**9.192**	
k			**0.000**		**0.370**		**0.644**		**1.000**		**0.971**	

Table-3: Risk evaluation of thermal power enterprises after the introduction of TGC

Index	Weighting value	Score	D1 correlation degree	D1*w	D2 correlation degree	D2*w	D3 correlation degree	D3*w	D4 correlation degree	D4*w	D5 correlation degree	D5*w
X_1	0.055	2.000	-8.750	-0.482	-6.750	-0.372	-4.750	-0.262	0.250	0.014	0.250	0.014
X_2	0.066	2.500	-8.250	-0.546	-6.250	-0.414	-4.250	-0.281	0.750	0.050	0.750	0.050
X_3	0.206	10.000	2.250	0.463	2.250	0.463	4.250	0.875	5.750	1.183	7.750	1.595
X_4	0.172	8.000	0.250	0.043	0.250	0.043	2.250	0.386	3.750	0.643	5.750	0.986
X_5	0.156	8.000	0.250	0.039	0.250	0.039	2.250	0.351	3.750	0.584	5.250	0.818
X_6	0.060	3.500	-7.250	-0.435	-4.750	-0.285	-2.750	-0.165	0.750	0.045	0.750	0.045
X_7	0.111	5.000	-5.750	-0.640	-3.750	-0.417	0.750	0.083	0.750	0.083	2.250	0.250
X_8	0.086	3.500	-7.250	-0.624	-4.750	-0.409	-3.250	-0.280	1.750	0.151	1.750	0.151
X_9	0.089	4.500	-6.250	-0.554	-3.750	-0.332	0.750	0.066	0.750	0.066	2.750	0.244
Comprehensive correlation degree			**7.26365**		**8.3156**		**9.2269**		**7.18025**		**5.8478**	
k			**0.419**		**0.730**		**1.000**		**0.394**		**0.000**	

Analysis of Results

Before the introduction of TGC, the comprehensive correlation degree of A thermal power enterprise reached the maximum, D4 when k was 1, that is, the lower the correlation degree, the less the risk; however, after the introduction of TGC, the comprehensive correlation degree of A thermal power enterprise reached the maximum, D3 when k was 1, that is, the correlation degree was general, and the risk was higher than that before the introduction of TGC. It can be found that the promulgation of TGC policy has brought certain risk to thermal power enterprises, which is general and falls within the controllable scope.

Risk Control Strategy for Thermal Power Enterprises under TGC

Following the identification, reconstruction and calculation of the above-mentioned risk indexes, it can be concluded that the implementation of TGC policy has caused certain risks to thermal power enterprises, but such risks are general. The implementation of TGC policy is the inevitable outcome of the development of domestic power industry at this stage. It not only brings certain risks to thermal power enterprises, but also provides opportunities for the development and transformation of thermal power enterprises.

Domestic thermal power enterprises should learn from the cases of international similar energy power generation enterprises that integrate power generation, distribution, sales and energy services, and utilize their location advantages to become a comprehensive energy company by transforming itself from a production-oriented enterprise to a business-oriented one. Through upgrading their technology and equipment, it can give full play to its ability of peak load regulation in the system and promote the consumption and adoption of new energy resources. At the same time, in view of internal risks of the enterprise, efforts should be made to reduce the cost from the source of production, strengthen the building of internal rules and regulations, clarify the responsibilities of each position, establish a sound standard system, ensure the internal information communication of the enterprise and improve the performance appraisal system, thus improving the management ability of the enterprise from the grass-roots level.

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