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STRATEGIC ANALYSIS OF CHINESE POWER GENERATION ENTERPRISES PARTICIPATING IN BILATERAL ELECTRICITY TRANSACTIONS UNDER THE LATEST POWER INDUSTRY REFORM

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ABSTRACT

Due to the recent electric power system reform, power generation enterprises should seize opportunities, avoid unfavourable factors and develop suitable strategies to participate in bilateral transactions. According to bilateral transactions status and electric power system reform policies in China, a SWOT analysis system is employed to research a bilateral transacting environment for power generation enterprises, followed by strengths, weaknesses, opportunities and threats under the PEST framework, including political, economic, social and technical factors. Four different strategies of power generation enterprises are put forward according to a SWOT matrix. A quantitative analysis model based on a polar coordinates method is proposed to determine strategies under the background of the power industry reform. Strength-threat strategies should be performed by power generation enterprises. Some appropriate recommendations are put up to ensure the smooth implementations of strength-threat strategies on bilateral transactions.

Key Words: latest power industry reform; power generation enterprises; bilateral electricity transactions; SWOT-PEST analysis; polar coordinates method

1. Introduction

Power industry reforms can reflect the development orientation of the power industry in China and are vital to promote industrial structure adjustments, improve economic efficiency and ensure social stable development [1,2]. The State Council issues a vial document named Relative Policies on Deepening the Reform of Power Industry (this also known as theNo.9 Document) on March25, 2015, which is seen as a new round reform of the Chinese power industry. The power industry reform follows the overall idea that the power grid is regulated strictly and a market mechanism is introduced to the electricity sales side and the power generation side in order to break the monopoly of power grid enterprises and reduce electricity bills [3].

The No.9 Document has a vital influence on an electricity market. First, transmission and distribution tariffs are approved by government departments based on acceptable costs and reasonable profits. It means that a previous electricity price system is transformed to build competitive market patterns [4]. A uniform, transparent and predictable pice system contributes to restore a commodity attribute of power and promote the marketization of the electricity sales. Therefore, a new electricity price contains a transaction electricity price, a transmission and distribution tariff and governmental funds. It is seen that the monopoly situation of the power grid enterprises is increasingly weak. Moreover, a sound electricity price system is the basis of bilateral transactions through which end users with high annual electricity consumption can save some bills. Second, electricity trading institutions can achieve independent operations relative to transmission and distribution businesses [5]. Most of generating capacity shoule be used to deal in market transactions, except electricity used by public utilities, agricultural productions and residents. This is the premise of giving independent choices to end users. Then, electirc distributions and sales are opened to social capitals in stages to construct a electricity sale system [6].More and more retail electricity suppliers are allowed in electric power market transactions, including industrial parks and economic development zones, power generation enterprises, public service utilities of water supply, gas supply and heating, distributed power or micro network users etc. They can take a variety of ways to engage in electric distributions and sales, such as direct deals with power generations, centralized auction purchase, power deals with other retail electricity supplier.

Bilateral electricity transactions in the electric market refer that power plants and large consumers in accordance with entry criteria can carry out some power trades according to their own wishes [7]. Power grid enterprises only provide transmission services without any influences on the trades. These transactions have the market structure characteristics of multi buyer and multi seller and have been developing more than ten years in China. The bilateral electricity transactions will be an important breakthrough for China to liberalize an electricity market and deepen a power industry reform.

Facing on the latest power industry reform, power generation enterprises should play their own advantages, seize opportunities and participate in bilateral electricity according to some strategies, which can obtained more and more market shares [5]. Meanwhile, power generation entrepreneurs should have a sense of crisis, understand possible adverse factors and enhance weak links in technology and management.

With the reform deepening, the development and deployment of strategies are vital for power generation enterprises. Strategic management tools, such as SWOT analysis and PEST analysis, should be chosen to collect and analyze the information related to bilateral electricity transactions. SWOT analysis, developed by Andrews [8] in 1971, is used to comprehensively analyze the internal and external environment related to organizations from four critical perspectives, namely strengths, weaknesses, opportunities and threats [9]. SWOT analysis has been widely applied in many fields, such as development of tourism resources [10], the airline industry planning [11], the rare earth industry promotion [12], supplier selection and order

allocation [13], the development of shale gas [14], etc. A PEST analysis is aimed to research macro environment of organizations by reviewing political factors, economic factors, social factors and technological factors [15]. We will propposed a novel strategic management tool by integrating a SWOT analysis and a PEST analysis to deploy the implementation strategy of power generation enterprises in bilateral electricity transactions. A quantitative analysis model based on a polar coordinate method is employed to determine the suitable strategy.

The remainder of this paper is organized as follows: Section 2 describes status quo of China's bilateral electricity transactions. Section 3 describes the basic research methodology and elaborated the model framework. In Section 4, the internal environment and external environment faced by power generation enterprises were reviewed. Section 5 determined the implementation strategies choosen by power generation enterprises in bilateral electricity transactions. Section 6 provided the conclusions.

2 Status quo of China's bilateral electricity transactions

In China, State Electricity Regulatory Commission issued a document, named interim measures of direct power purchase between power plant and end users, to develop direct power purchase pilots in 2004. By the end of 2014, 23 provinces were the direct power purchase pilots, involving 698 end users and 338 power plants [16]. The trading power reached to 149 billion kWh, accounting for 2.7% of China's total electricity consumption. Trading mechanisms in these pilots were improved gradually. The trading power expanded year by year. Part of the direct power purchase pilots are shown in Table 1. There are still some obstacles to hinder bilateral electricity transactions, such as more government intervention, inadequate laws and regulations, imperfect electricity tariff mechanisms and settlement systems, etc. [17].These obstacles will be cleared one by one with the deepening of power industry reform.

Table 1. *The direct power purchase of part in China in 2014*

Region	Transmission-distribution tariff (Yuan/kWh)	Transaction mode	Power plants number	End user number	Settlement agencies	Transaction volume (Billion kilowatt hours)	Proportion
Western Inner Mongolia	0.139	Multilateral autonomous negotiation	33	121	Power grid enterprises	36.19	18.95
Shanxi	0.078	Bilateral autonomous negotiation and	34	57		16.69	9.15
Jiangsu	0.129		24	364		9.5	1.90

Anhui	0.150	centralized matching transaction	20	84		5.2	3.28
Shandong	0.092		30	82		7.82	1.85
Hubei	0.104		17	28		1.44	0.87
Guangdong	0.147	Bilateral autonomous negotiation	28	134	Guangdong electric power trading centers	15.3	2.92

3 Methodology

3.1 SWOT-PEST analysis

A SWOT analysis aims to clear strengths and weaknesses of internal environment factors, and opportunities threats of external environment factors with regard to the organization. It is help to specify favorable and unfavorable factors to achieve specific objectives.

The SWOT analysis of each objective pays close attention to the following:

· Strengths: The internal characteristics of organization which make it better than others.

·Weaknesses: The internal characteristics of organization which place it in a disadvantageous position.

·Opportunities: The external elements of organization which could conducive to the healthy development.

·Threats: The external elements of organization which would hinder the normal development.

In order to clarify the relevant of the four criteria area, an SWOT matrix is employed to reflect various factors and alternative strategies [18]. The strategies include strength–opportunity (SO) strategies, weakness–opportunity (WO) strategies, strength–threat (ST) strategies and weakness–threat (WT) strategies, as shown in Table 2. According the SWOT analysis, strategic decisions in line with the organization could be proposed by performing the strengths, overcoming the weaknesses, seizing the opportunities and eliminating the threats.

Table 2. *The SWOT matrix*

Factors	**Strengths**	**Weaknesses**

Opportunities	SO strategies	WO strategies
Threats	ST strategies	WT strategies

A PEST analysis aims to illustrate macro environment faced by the organization and determine positive and negative impacts of macro environment on the strategic choices. A PEST analysis is applied to review political, economic, social and technological factors with regard to the organization [17].

The PEST analysis is integrated to the SWOT matrix to analyze strategic environment systematically, as shown in Fig.1.

Figure 1. *The SWOT-PEST analysis paradigm*

3.2 Quantitative analysis model

According to a SWOT-PEST analysis paradigm, alternative strategies are presented in the coordinate system, as shown in Fig.2. In Fig.2, the horizontal axis represents strengths (S) and weaknesses (W) of internal environment, and the vertical axis represents opportunities (O) and threats (T) of external environment. Overlapping shaded areas represent the alternative strategies. A, B, C, D represent SO strategies, WO strategies, WT strategies and ST strategies, respectively.

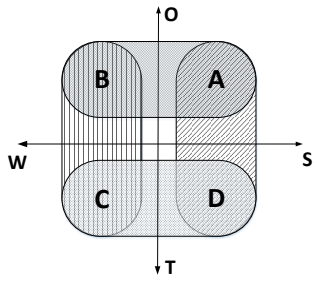


Figure 2. *The spatial distribution map of alternative strategies*

A quantitative measurement method based on a polar coordinate is applied to select the optimal strategy from alternative strategies [19]. The method comprises the following steps.

Step 1: Obtain intensity values and importance values for each factor evaluated by decision makers and calculate an intensity mean value and an importance mean value of each factor by an arithmetic average method.

Step 2: Compute total strength intensity, total weaknesses intensity, total opportunities intensity and total threats intensity, respectively:

$$IS = \sum s_i / N_s ,\ IW = \sum w_j / N_w , IO = \sum o_k / N_o ,\ IT = \sum t_l / N_t \qquad (1)$$

Where *IS*, *IW*, *IO* and *IT* represent total strength intensity, total weaknesses intensity, total opportunities intensity and total threats intensity; N_s, N_w, N_o and N_t represent the number of the strengths, the weaknesses, the opportunities and threats; s_i, w_j, o_k, and t_l represent strength *i* intensity, weakness *j* intensity, opportunity *k* intensity and threat *l* intensity, and they are calculated by multiplying the intensity value and the importance value of each factor.

Step 3: Determine the coordinates of the strategic center *G(x,y)*, as computed in:

$$x = (IS + IW) / 4 \qquad (2)$$

$$y = (IO + I\,T\,) / 4 \qquad (3)$$

Step 4: Conduct azimuth θ and intensity coefficient Φ of strategic center:

$$\theta = \begin{cases} \arctan(y/x) & x \geq 0, y \geq 0 \\ \arctan(y/x) + \pi & x < 0 \\ \arctan(y/x) + 2\pi & x \geq 0, y < 0 \end{cases} \qquad (4)$$

$$\Phi = (IS \times IO) / (IS \times IO + IW \times IT) \qquad (5)$$

Step 5: Select the optimal strategy by comparing the azimuth θ and intensity coefficient with the intensity spectrum distribution (Fig. 3). In Fig.3, the radius of two concentric circles are 0.5 and 1, respectively. The two concentric circles are divided into eight parts by the two axis and the two angle bisectors, including aggressive-oriented strategies, opportunity-oriented strategies, competence-oriented strategies, adjustment-oriented strategies, retreat-oriented strategies and evasion-oriented strategies. If $\Phi \leq 0.5$, the conservative strategies should be selected, otherwise the pioneering strategies are adopted.

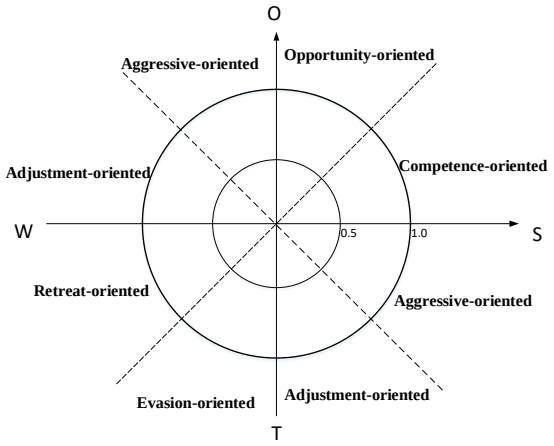


Figure 3. *The strategy types and the intensity spectrum distribution*

4. SWOT-PEST analysis of power generation enterprises

4.1 Strengths

4.1.1 Political factors

Since 2004, China has made a series of policies to promote the development of bilateral electricity transactions between power generation enterprises and large consumers, as shown in Table 3. These policies can be used to improve the environment of electricity transactions and is good for power generation enterprises to participate in the transactions.

Table 3. *Policies of bilateral electricity transactions in Chin**a***

Year	**Name**	**Content**
2004	The interim procedures of direct power-purchase pilot for electric power consumers and power generation enterprises	The direct power-purchase pilot should be launched in qualified areas
2009	Notification about the issues of industrial enterprises participating in the direct power-purchase pilot Basis rules for direct power-purchase pilot for electric power consumers and power generation enterprises (trial implementation)	The direct power-purchase pilots are regulated and promoted comprehensively from the aspects of market entry conditions, trading means, contract signing, electricity measurement and settlement etc.
2010	Notification on cleaning up the preferential price for high energy-	Clean up the preferential price in the name of direct transaction and power supply agreements for high energy-

	consuming enterprises	consuming enterprises
2013	Decision on cancelling and decentralizing a batch of items requiring administrative approvals	Cancel the government review and approval for direct power-purchase pilot
	Notification on matters of carrying out the direct trading of electricity Notification on regulating the direct transaction between users and power generation enterprises	Formulate the trading scheme scientifically and arrangements for transacted electricity quantity rationally by each province; prohibit administrative intervention for direct trading

4.1.2 Economic factors

(1)The sufficient electricity installation capacity

Since Plant-Grid separation in 2002, electricity installation capacities gained a rapid growth trend. Power generation occupied the basic position of a power system for a long time, as shown in Fig.4. The electricity installation capacity reached 1.44 billion kWh in 2015, which satisfied the need of economic development basically. The adequate electricity supply capacity lays foundation to depeen an electric industry reform.

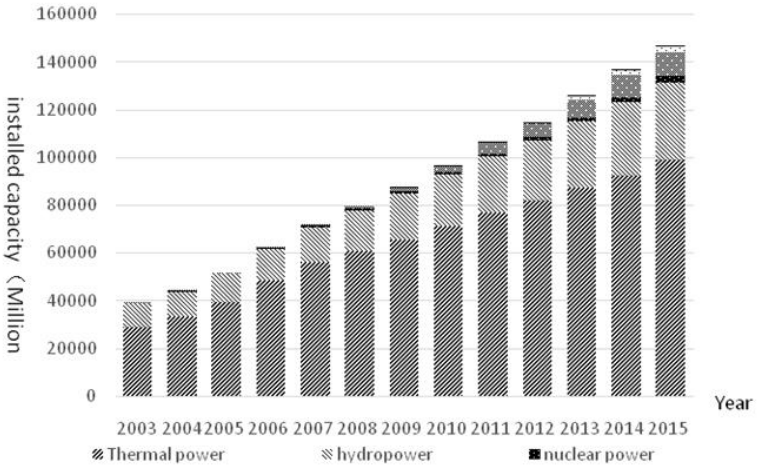


Figure 4. *China's electricity installed capacity in 2003-2015*

(2)The sufficient capital of power generation enterprises for bilateral electricity transactions. Ther power generation industry has the characteristics of capital-intensive with enormous assets, which enhances the ability to fight against economic risks in bilateral electricity transactions. China's five major power generation groups are all in the world top 500 enterprises list, rankings are listed in Fig 5. Their business revenue in 2014 is nearly or more than 30 billion dollars for the

major power generation groups. 52 companies, which take electricity generating as the core business, listed in Shenzhen and Shanghai and have good financial conditions.

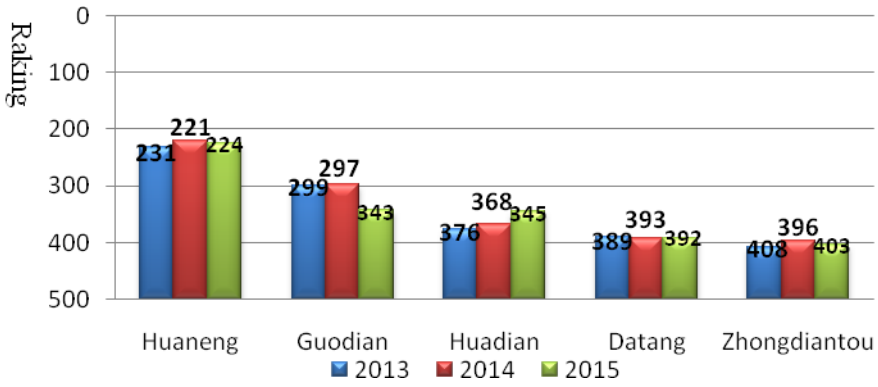


Figure 5. *The rankings of China's five major power generation groups in world top 500 in 2013-2015*

4.1.3 Social Factors

The successful experiences of bilateral electricity transactions. The pilot areas of direct trading developed the normative documents on electricity transactions successively. Most of the pilots adopt bilateral negotiation transactions, concentrated matching transactions, etc. Some of them have established the bilateral electricity transactions platforms and try listed for trading and online centralized competitive trading. These mechanisms of direct trading have tended to be perfect [17]. Power generation enterprises, as the first to participate in direct trading, have adapted these transaction rules and accumulated certain customer resources and electricity selling experience. Power generation enterprises has accumulated some customer resources and electricity selling experiences related to bilateral electricity transactions.

4.1.4 Technological factors

The power generation industry is technology-intensive. Power generation equipment is the core advantage to participate in bilateral electricity transactions. Power generation enterprises, as the upstream of the electricity industry, possess not only the power generation equipment such as boiler, steam turbine, generator, controller and etc., but also the energy resources such as coal and rivers as well as technicians of operation, management and maintenance [16]. Technology levels of the power generation equipment should be constantly updated, which is critical for power generation enterprises to form competitiveness. The power generation enterprises with large-capacity, high efficiency, energy conservative and environment friendly have more competitive in power distribution reliability, coal consumption rate and scale economies effect. Compared with the other competitors, power generation enterprises leave out the link of electricity purchasing, save the transaction costs obviously.

4.2 Weaknesses

4.2.1 Political factors

The standards of energy conservation and emission reduction are rigorous gradually with frequent fog and haze weather and deteriorating living environment increasingly, To deal with a climate change, a series of standards related to energy conservation and emission reduction are improved continually. According to the upgrading and transformation plans of energy-saving and emission reduction for coal-power (2014-2020) in China, the average net coal consumption rate of new constructed coal power units should be lower than 300g/kWh, active coal units' average net coal consumption should be lower than 310g/kWh by 2020. According to air pollutant emission standards (GB13223-2011) for power generation plants, the emission limit of smoke, sulfur dioxide, nitric oxide, mercury and the mercury compound cut by more than 50% compared with the original. Correspondingly, the power generation industry must be added some investment on energy saving and emission reduction technology to meet server energy conservation and emission reduction standard and the operation cost will increase, which effect the enterprise profits.

4.2.2 Economic factors

The annual utilization hours of generating units tends to decrease gradually and the power generation industry competition fierce. Since 2012, China power generating units has presented an obvious downward trend. In 2015, annual utilization hours value is only 3969, fell 8.1% year-over-year. Annual utilization hours of thermal power generating units is merely 4329 hours, fell 8.7% year-over-year. The low annual utilization hours of generating units affect earnings seriously. Meanwhile, according to the No.9 Document, clean energies such as nuclear power, wind electricity, solar power generation etc. can also participate in bilateral electricity transactions, rather than limited to thermal power and hydropower. In China, the power generation enterprises will face more and more fierce competition in bilateral electricity transactions.

4.2.3 Social Factors

Power resources and load center share the unbalanced distribution. The economic development in China is imbalance, most load branch centers centralize in North China, East China and other developed regions relatively, while the electricity generating units centralize in central and western China (as shown in Fig.6 and Fig. 7). Thermal power generating units mostly centralize in the regions where the coal resource is adequate such as Shanxi, Inner Mongolia and so on, the gross of thermal power generating units in these regions has reached at 11.02%, while the total electricity consumption is merely 9.71%. The water power resource in Sichuan province is the most adequate in China, and hydroelectric generating units has reached at 5.13%, while the total electricity consumption is merely 3.64%. The unbalanced distribution between power resources and load center limits the development of bilateral electricity transactions due to the regional restrictions

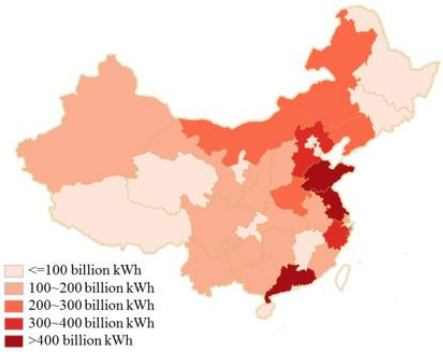
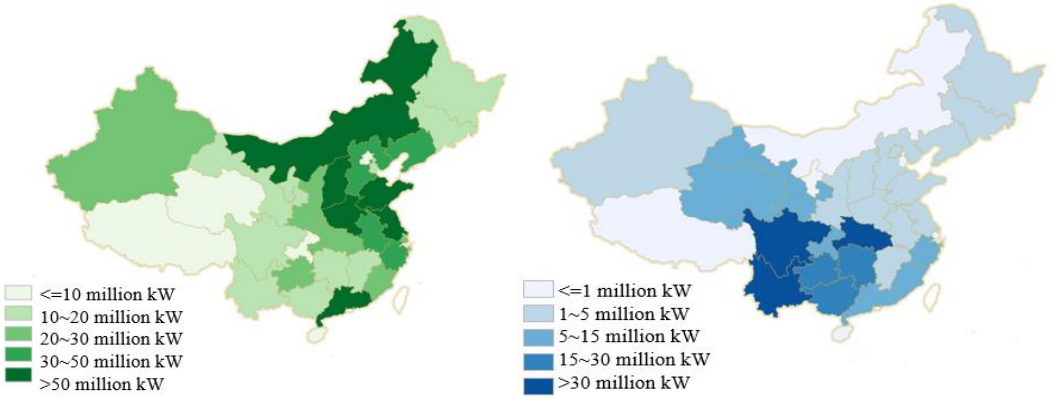


Figure 6. *The regional distribution of total electricity consumption in China*



(a) Thermal power generation installations (b) hydroelectric installation

Figure 7. *The distribution of thermal and water power installation in China's different regions*

4.2.4 Technological factors

(1)Aging of electricity generating system and poor reliability of generating units

In China, thermal power and hydroelectric has developed more than one hundred year, some old thermal power generating units face the issues of lagging in technology, burn-in system, high operating cost, poor power distribution reliability, high cost of emission reduction and etc., which affect the enterprises' economic benefits deeply.

(2)Lack of distribution network assets asset and marketing business ability

In China, power generation enterprises are in the dominant position in electricity transactions, but lack the awareness of servicing to end users and clear understanding of the market competition. Due to the long-term electricity bulk sale to power grid, there are few end-user resources, especially the high quality end-user, for power generation enterprises. They also haven't the appropriate model of marketing, metering and settling with end-user for implementing differentiated sales service. Moreover, the distribution network assets are deficient, which effects the development and consolidation of end-user resources [20]. However, competition in the electricity sale side not only reflects in price competition but also focuses on value-added service according totheNo.9 Document. Compared with the other electricity seller, it

is difficult for power generation enterprises to provide with energy-saving services, energy efficiency management, and comprehensive energy solutions and so on in the short term.

4.3 Opportunities

4.3.1 Political factors

(1) The orderly release of electricity supply and consumption plan and the limitation of captive power plant construction.

The plan of electricity supply and consumption will be gradually liberalized, and the proportion of bilateral trading electricity will also increase. Meanwhile, captive power plants construction for industrial enterprises becomes more and more difficult. In China, the Jing-Jin-Ji region, Yangtze River Delta, Pearl River Delta and other areas have banned to construct the coal-fired captive power plants; and the regions with redundant installed capacity shall not construct(or expand) captive power plants, except heat electricity cogeneration projects [20]. More and more end users are willing to participate in bilateral electricity transactions in future.

(2) Power generation enterprises can expand the scope of business to achieve the whole industry chain management. They can not only carry out the business of selling electricity independently, but also step into the business fields including distribution network construction, energy saving service, energy efficiency management etc. They can get a new business segments and achieve the integration of generation-sale or generation-distribution-sale integration [19].

4.3.2 Economic factors

Due to the industrial structure adjustment in China, the bilateral electricity transactions have big potential and extensive market foreground. In China, the gross domestic production of secondary industry, referred to the industrial sector and construction sector, still shows a dominant position. The electricity consumption of secondary industry still accounts for more than 70% of the total electricity consumption. In 2015,the electricity consumption of secondary industry was 3993 billion kWh, accounting for 72%. The electricity consumption of tertiary industry, referred to the commercial sector and service sector, also showed rapid growth in China. The emerging industries such as information technology sector, high-end equipment manufacturing etc. and services industries such as catering, accommodation etc. have becoming the new driving force for the electricity consumption growth by gradually replacing the traditional energy intensive sectors. The electricity consumption of tertiary industry in 2015 comprises 12.9%, and this contribution to the total electricity consumption reaches up to 122.2%. With the deepening of an electricity industry reform, bilateral electricity transactions can attract more and more large customers' favor from the secondary industry and the tertiary industry for sake of obtaining a preferential price and saving energy costs.

4.3.3 Social factors

Accelerating urbanization and rising electrification level trigger the wide applications of electric energy substitute products. Urbanization, as the important way to eradicate the dual structure in urban and rural areas, can represent infrastructure investment, transform energy utilization structure and trigger the growth of electricity consumption demand. The electrification level reflect mainly the proportions of primary energy consumption used by power generation in total primary energy and the proportions of electricity consumption in terminal energy consumption. According to China's plan energy structure adjustment, the electricity substitution products such as distributed electric heating, electric vehicles, etc. will be widely used with the improvement of electrification levels, which can boost the power consumption.

4.3.4 Technology factors

The accelerating ultra-high voltage (UHV) power line construction can help the power generation enterprises to realize inter-region sell electricity. In 2014, State Council proposed the way of inter-region electricity transmission to the fog haze weather and put UHV construction into the air pollution prevention action plans. By the end of 2016, the projects of Ximeng-Shandong UHV AC, Huainan-Nanjing-Shanghai UHV AC, Ningdong-Zhejiang UHV DC will be completed and put into use, which will form "Two AC and one DC" UHV backbone network. In "the 13th Five-year" period, North China, East China, Central China will built "three vertical, three horizontal and one ring network" UHV backbone grid and implement 13 HVDC transmission projects. The abundant areas of hydroelectric, coal-fired power and renewable energy generation will be connected with the UHV backbone grid, power generation enterprises can involve in bilateral electricity transactions across regions without regional limitation.

4.4 Threats

4.4.1 Political factors

Imperfect mechanism of electricity transaction effects the bilateral electricity transactions [5]. The dual-pricing system for electricity sales, that the large consumer can purchase the electricity at a uniform price or a transaction price in an electricity transactions market, effects sustainability of bilateral electricity transactions. Once the power supply shortage, the electricity price determined by bilateral electricity transactions exceeds the fixed price, the large consumer will be withdraw from the electricity transaction. In addition, these only agreed on the electricity consumption in the bilateral electricity transactions contracts. But electricity loads are ignored in the contracts, which increases the difficulty of a power system balance. Imperfect electricity transactions mechanism will bring transaction risks to power generation enterprises, including a contract default risk, a credit risk, a user default debt etc. [19].

4.4.2 Economic factors

(1)With industrial structure adjustment and industrial transformation and upgrading, China's economic development has stepped into the "new normal", which is expressed that economic growth slows down, energy demand growth becomes weak, and the electricity capacity gets

relative surplus. Since 2010, the electricity consumption of the secondary industry has trended to a slow growth, or even a negative growth in 2015 (as shown in Fig.8). Facing the increased installed capacity and the decreasing electricity consumption in the secondary industry, the competition of power generation enterprises is bound to intensify in bilateral power transactions, especially in the area with serious surplus electricity installation capacity. Even vicious competitions may be induced among power generation enterprises by a alicious low price.

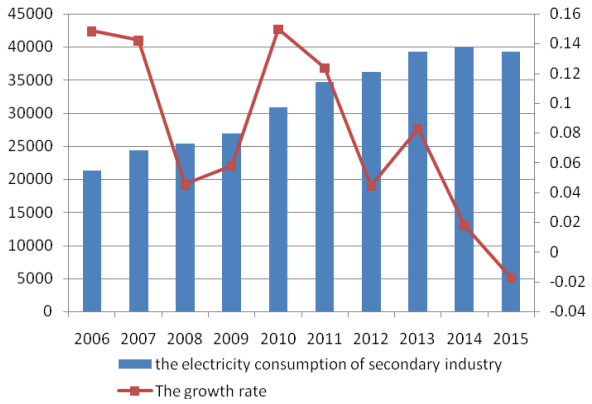


Figure 8. *The electricity consumption of the secondary industry and growth rate in2010~2015*

(2)Power grid enterprises still get a monopoly in electricity market in short term. These are the traditional retail electricity suppliers and have dominated the monopoly situation as the sole purchaser in generation-side and the sole retailer in demand-side for a long time. These have a large number of costumer resources, transmission and distribution line assets and a mature marketing operation system. The market power of power grid enterprises are estimated based on the Lerner index L:

$$L = (P - MC) / P \qquad (6)$$

Where P represents the fixed electricity price determined by government to guide the electricity price of the commerce sector and the industry sector, yuan/kWh; MC represents marginal electricity costs, yuan/kWh. The value of MC is determined by the sum of a transmission-distribution price and a local coal-fired electricity on-grid tariff. The market power of power grid enterprises in any area is calculated using Eq (6), as shown in Table 4. The result shows that all of the power grid enterprises have market monopoly power to a certain extent. Inner Mongolia has the highest to a certain extent, followed by Jilin Province, Heilongjiang province.

Table 4. *Market monopoly power of power grid enterprises in parts of China in 2015*

Region	Shanxi	Shandong	North Hebei	South Hebei	West Inner Mongolia	East Inner Mongolia	Liaoning	Jilin	Heilongjiang

L	0.26	0.205	0.108	0.18	0.392	0.368	0.296	0.335	0.313

(3)The power generation enterprises in bilateral electricity transactions face on the competition fiercely with the diversification of the electricity retailer. Compared with the power generation enterprises, other electricity retailer has the advantage in differentiated value-added services. High-tech industrial parks and economic development zones occupy natural area's customer resources depending on the geographical advantage. The users of distributed power or micro system network can realize the integration of "source, network, load, storage" to save the transaction cost. Public service enterprises can achieve regional monopoly relied on network resources. Energy service companies with energy-saving technology can carry out energy-saving services, consulting, energy management and other personalized value-added services [6]. The electricity market competition faced by the power generation enterprises in the future will tend to be diversified and complicated.

4.4.3 Social factors

Natural resource constraints led by energy crisis become more and more serious. Faced with the grim situation of energy-saving and emission-reduction, China has implemented the policy on energy consumption control, that the total coal consumption should be lower than 42 million tons before 2020. The constrain of coal consumption forces power generation enterprises to change the structure of the power supply as soon as possible and control the development of coal-fired electricity plants. In addition, the conditions of water resources in the arid northwest region also constrain the development of large-scale coal-fired plants.

4.4.4 Technology factors

Energy-saving and emission-reduction technologies are widely used in all walks of life. The distributed power gets rapid development. Owning to energy saving and emission reduction policies, the energy-saving and emission-reduction technology such as green lighting, cold and heat storage, reactive power compensation, are promoted in the field of industry. The electricity efficiency of terminal equipment has improved significantly. In China, distributed photovoltaic power generation, gas distributed generation, combined cooling heating and power technology etc. develop more and more mature. The distributed power generation technology, with the advantages of small investment scale, high energy efficiency, decentralization and flexibility etc., is continuously extended to the users of requiring higher reliability and large electricity demand. The rapid development of distributed power will squeeze the market space of bilateral electricity transactions for power generation enterprises.

5 Development strategies of China's Power Generation Enterprises

5.1 SWOT-PEST analysis matrix

According to the above analysis process, we summarize a SWOT-PEST analysis matrix, including strengths, weaknesses, opportunities and threats of China's power generation

enterprises in bilateral electricity transactions (as shown in Table 5). The SWOT-PEST analysis matrix lays the foundation to choose the implementation strategy of power generation enterprises in bilateral electricity transactions.

Table 5. *SWOT-PEST analysis matrix*

SWOT-PEST		**Policy(P)**	**Economy(E)**	**Society(S)**	**Technology (T)**
Internal factors	Strengths (S)	National policy support (S1)	1.The sufficient electricity installed capacity(S2) 2.The sufficient capital of generation enterprises (S_3)	The successful experience of bilateral transactions	technology-intensiveindustry S_5
	Weaknesses (W)	The rigorous standard of energy conservation and emission reduction.(W1)	The lower and lower annual utilization hours of generating units (W2)	the unbalanced between power resources and load center (W3)	1.Aging power generation system and poor reliability (W4) 2.Lack of distribution network assets asset and business ability(W5)
External factors	Opportunities(O)	1. The orderly release of electricity plan and the limitation for constructing captive power plants(O1) 2.The qualifications of expanding the business (O2)	The big potential and extensive market(O3)	The accelerating urbanization and the rising electrification level(O4)	The accelerating ultra-high voltage power line construction (O5)
	Threatens (T)	Imperfect mechanism of electricity transaction(T_1)	1.Economic development shows 'the new normal' (T2) 2.The monopoly of power grid	Natural resource constraints (T5)	The widely application of energy-saving and emission-reduction technology (T6)

			enterprises in electricity market(T3) 3.the diversification of the electricity retailer (T4)		

5.2 SWOT-PEST strategy formulation

Based on the above analysis process, the four strategies is cleared according to Table 1 and Fig.1. The four type's factors are analyzed by the pair wise combination according to Fig.2. We can get SO strategies, WO strategies, ST strategies and WT strategies for power generation enterprises in bilateral electricity transactions. In Fig2, the abscissa represents internal factors and the ordinate represents external factors; the shadow areas A, B, C and D represent the contents of SO strategies, WO strategies, WT strategies and ST strategies, respectively.

A: power generation enterprises should seize the reform opportunities to build the electricity sale companies to expand the market as soon as possible and restore high-quality customer resources.

B: power generation enterprises should optimize the power sources structure, enhance technical levels and pay close attention to the national policies related to industrial structure adjustment, energy-saving emission reduction, etc. The managers of power generation enterprises should actively strive for customer resources with the processes of China's urbanization, establish a management platform for marketing, metering and settling with end-user.

C: power generation enterprises should lay a comprehensive understanding for the seriousness of the surplus electricity installation capacity and the competition cruelty in a electricity market. They also should strengthen a risk prevention, optimize the power structure and carry out pre-market research to help enterprises to make up for the business short board.

D: power generation enterprises should pay more attention to the surplus electricity installation capacity, control the scale of thermal power and develop the clean-energy generation. They should build a management system to analyze the energy use information of large customers, enhance the awareness of market competition and construct the business operation system to provide the value-added service. They also should build a comprehensive risk prevention system to deal with risks such as the electricity sale cost increase, breach of contract, user default debt etc.

5.3 The optimal strategy selection

In order to determine an optimal strategy implemented by power generation enterprises in bilateral electricity transactions, 37 experts from different fields were selected to build a decision making group to evaluate the intensity and importance of each factor. The intensity and the importance were divided into 9 level, including 4,-3,-2,-1, 0, 1, 2, 3, 4. The intensity and the importance of strengths and opportunities are the positive, and the intensity and importance of weaknesses and threats are the negative. The intensity and importance was evaluated by the decision making group The azimuth and intensity coefficient is calculated by Eq (1)-(5). The result is shown in Table 6. In Table 5, the value of the azimuth is 1.905π and the intensity coefficient is 0.615, belonging to the fourth quadrant (1.75π, 2π) area (as shown in Fig. 3). It is means that these power generation enterprises have obvious strengths but still need to guard against external threats. Due to the value of the azimuth, the aggressive-oriented strategies were optimal power generation enterprises in bilateral electricity transactions. The aggressive-oriented strategies should also reflect the pioneering because that the intensity coefficient is larger than 0.5. Therefore, the D strategies content should be the optimal adopted by the power generation enterprises in bilateral electricity transactions.

Table 6. *The calculation processes and results*

Main-criteria	S					W					O					T..					
Sub-criteria	S_1	S_2	S_3	S_4	S_5	W_1	W_2	W_3	W_4	W_5	O_1	O_2	O_3	O_4	O_5	T_1	T_2	T_3	T_4	T_5	T_6
Intensity	3.8	1.9	2.7	2.2	3.7	-2.2	-3	-1.7	-1.8	-2.4	2.2	2.6	2	1.9	1.7	-3.4	-3	-2.7	-1.9	-2	-1.6
Importance	95%	75%	85%	65%	85%	60%	70%	65%	75%	70%	70%	80%	60%	75%	50%	85%	90%	75%	60%	70%	55%
Intensity of sub-criteria	3.6	1.4	2.3	1.4	3.1	-1.3	-2.1	-1.1	-1.4	-1.7	1.5	2.1	1.2	1.4	0.9	-2.9	-2.7	-2	-1.1	-1.4	-0.9
Intensity of main-criteria	2.36					-1.52					1.42					-1.78					
center	(0.295, -0.09)																				
azimuth	1.905π																				

intensity coefficient	0.615

5.4 The implementation measures of optimal strategy

According to the above results, some implementation measures of power generation enterprises should be proposed for ensuring the D strategies under the background of the latest electricity industry reform. The implementation measures include the follows.

(1)Construct a differentiated service system

In the face of market competitions, power generation entrepreneurs should choose a strategy path of differentiation services, which refers to some special services for different customers. Power generation enterprises should open the electricity sale companies as soon as possible, extend the industrial chain and build a differentiated service system. Therefore, the power generation enterprises must understand electric load demand characteristics of customers, develop personalized electricity sales plans adopted by various customers. They should also make a cooperation with energy service companies, industrial parks etc. through mergers, acquisitions, joint and equity participation. They should carry out differentiated value-added services appropriately in accordance with their own resources and avoid a blind expansion.

(2)Pay attention to benchmarking management

Power generation enterprises should change the development thoughts of "attaching more importance to scale than quality" and reinforce benchmarking management from the aspects of planning's, technology, management and talents [14]. Power generation enterprises should make a plan to control thermal power and develop wind power, solar power generation, cogeneration and others actively. They also should attach importance to the energy efficiency benchmarking indexes, such as coal consumption rate of power supplies, pollutant emissions and so on. A series of costs should be controlled, including a fuel cost, a management cost, equipment and maintenance fee etc. They should organize the personnel training to enhance management levela of staff performance and strengthen the enterprises' low cost competitive advantages to obtain more and more profits.

(3)Expand customer resources

Customer, as the core resource in bilateral electricity transactions, should be expanded by power generation enterprises. The specific implementation measures are follows: excavating the large customer with stable electrical loads and good credit quality, collecting and analyzing the information of high quality customers by big data technology, and building a customer resource management system. The system for customer should be developed to provide a diagnosis analysis, electricity management. Some energy-saving information should be pushed using the Internet technology to cultivate the customers' dependence on generation enterprise.

(4)Strengthen external cooperation

With a market-oriented reform deepening in the electricity industry, a market environment faced by power generation enterprises becomes more and more complex and changeable. Power generation enterprises should strength external cooperation's with other enterprises or utilities to enhance competitiveness and share some risks. some specific implementation measures are follows: strengthening the communication and coordination with a scheduling trading center, power grid enterprises and other electricity retailers to prevent vicious competition; establishing the strategic cooperative relations with Internet companies to build a platform operating mechanism using the virtual information technology; handling the relationship with the government to get the support to develop the business and divide electricity sale areas.

6 Conclusion

With China's electricity market reform deepen, bilateral electricity transactions, as the important breakthrough to liberalize an electricity market, has a bright future. Chinese governors encourage the development of bilateral electricity transactions to improve the operational efficiency of an electricity market. Supports for bilateral electricity transactions are getting greater and greater. Power generation enterprises should seize the opportunities to involve in bilateral electricity transactions. However, due to the lack of a capacity market and a spot market, there are many threats and weaknesses from the external and the internal for power generation enterprises. Aging power generation system, the monopoly of power grid enterprises, imperfect mechanisms of electricity transactions, altogether effect the performance of power generation enterprises in bilateral electricity transactions. According to a SWOT-PEST matrix, we listed a series of strategies choose by power generation enterprises: strength–opportunity (SO) strategies, weakness–opportunity (WO) strategies, strength–threat (ST) strategies and weakness–threat (WT) strategies. We also proposed some specific contents with respect to the corresponding strategies. An optimal strategy was chosen by employing a polar coordinate method. The calculation result showed that the ST strategies should be optimal. Some implementation measures of optimal strategy were proposed, including developing a differentiated service system, paying attention on benchmarking management, the expansion of customer resources and the strengthening for external cooperation's.

7.References

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