Factors Influencing New Energy Enterprises' Technology Innovation: Based on Dynamic Factor Market Framework

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Abstract: Resource depletion and environmental pollution are the serious problems which traditional energy faces; therefore the development of new energy is in urgent need to improve the dangerous situation. Developing new energy depends on the level of the development of new energy technology; while the enterprise with advanced technology and continuous innovation can develop faster. Technological innovation is affected by many factors, and the dynamic change of determinants also influences the process of technological progress. Therefore, this article selects 71 new energy listed companies in our country from 2006 to 2013 as the research object and examines the degree of technological personnel, intangible assets, enterprise property, growth rate, technology elements, scale, and capital structure influencing technology innovation. At the end, the article proposes suggestions on the development of new energy listed companies in China.

Keywords: technology innovation, influencing factor, new energy technology, new energy listed companies

1 Introduction

2015 China's domestic oil consumption is estimated at 543 million tons, consumption growth was 4.4%, net oil imports of 3.28 million tons, foreign dependence for the first time exceeded 60%. At the same time, China's coal consumption in 2015 decreased by 3.7%, coal consumption in 2014 by 2.9%, although China's coal consumption continued to decline, it still accounts for 64% of China's total energy consumption, and calculating in accordance with China's proven coal reserves, we find that the coal just can be used for one hundred at most after 2020. Because of the danger which non-renewable resources are depleted and security issues that increasing dependent on imported energy resources, promoting the development of new energy has become a most important way to solve these problems. As we all know, a large number of traditional energy consumption has brought some serious environmental problems, such as acid rain, global warming, ozone depletion, smog etc. These problems are so closely related to energy consumption [1], there is no doubt that these environmental problems have been a threat to human survival, development of clean green new energy has become an important issue faced by governments.

In recent years, there are many achievements in the development of solar, wind, nuclear, biomass and other new energy; in most countries, the new energy's proportion of total national energy production and consumption are both rising. In 2014, US renewable energy generating capacity has been on-line for 7663 MW, accounting for nearly half of all energy new generation capacity, the ratio is up to 49.81%. Compared to 2013, renewable energy accounts for 43.03%, building new generating capacity was 6837MW, and its size is equivalent to three times the growth rate of natural gas as much. In 2007, hydropower, wind power, nuclear power and other new energy consumption accounts for 7.3% of China's total energy consumption, which in 2015 the new energy consumption increased to 17.9%. New energy is an important alternative energy, and technological progress is an important driving force to promote the development of new energy [2].

Advances in new energy technologies contribute to promote a variety of new energy feasibility and convenience, enterprises as new energy applications and promoters play an important role on new energy technology innovation. Enterprises are not only adoption subjects and research and development subjects of the new technologies, but also the investment subjects and incubation subjects of the technological innovation. When the technical innovation rises to technological innovation, companies not only become adoption subjects of new technology, but also take the initiative to participate in the cooperative innovation system to become a high-tech incubator body [3]. New energy companies as typical high-tech enterprises have the feature which technology and knowledge are highly intensive. Technical innovation in new energy enterprises have extraordinary significance, asking them to continue to invest a lot of R & D funding and technical personnel to carry out technical research and development [4]. From 2001 to 2013, the technical personnel number growth rate of 71 new energy listed companies is up to 200%, in 2013, 71 new energy listed companies' total R & D

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investment is almost 21 times as total R & D investment in 2006, the data shows that in recent years, the number of new energy listed companies which disclose R & D investment increases, R & D investment's growth rate is also considerable. New energy listed companies have paid more and more attention to technological innovation, trying to get a head start in the fierce competition in the industry.

Companies have recognized the importance of technological innovation and increase investment in technological innovation, but the investment is constrained by its own constitution and elements, then what factors will affect corporate investment in technological innovation? Elements of the enterprises itself is not static; with changes in the market price and the flow direction of elements, how to impact Chinese new energy enterprises technology innovation investment? This article will focus on these issues.

2 Literature Review

At present, literature studying enterprise technology innovation mainly concentrate on culture, market, government policy system, technical ability, the ability of the network, and the study about influence factors on energy enterprises technology innovation is less, and mainly focus on the influence factors of the energy industry technology innovation, microscopic theoretical exploration that based on more reliable empirical data of the enterprise for new energy technologies innovation is relatively few.

Khazanchi et al.（2007）analyzed further the special effect of the organization value for realizing technological innovation from the perspective of innovation supportive culture, and he considered organization culture was the significant guarantee for the technological innovation[5]. Maranto-Vargas & Ran-gel （2007）found that the development and improvement on the ability of hard technology (equipment, craft and so on) and soft technology (the running program of organization) with the business performance and the competitive advantage were positively correlated[6]. Philip Shapira (2001) believed that commonality and private cooperator had formed a central organization mechanism to promote research and development and accelerate innovation diffusion in the contemporary technological policy [7]. Some scholars researched the driving effect of the institution for technological innovation from the view of property right system. Eric (2001) considered manufacturing enterprise wanted to obtain the knowledge which was created by other organizations from market approach, and yet purchasing knowledge may just satisfy this demand of these enterprises, and little enterprise relied on perfectly their own scientific research to improve the product and service in network economy [8]. Cohen et al. (2002) thought monopolizing innovative product would influence the driving of corporation continuous innovation[9]. Avlonitis & Salavou (2007) conducted empirical study on 149 small and medium-sized manufacturing enterprises, and he thought entrepreneurs were important factors which promoted the product innovation of small and medium-sized enterprises[10]. Wan et al. (2005) showed that the enterprises innovation were positively relevant to the risk preference, the exchanging will, innovational idea of staff and organization flexibility, the allocation of organization resources[11].

Domestic energy enterprises' technology innovation research started relatively late, it is not until the 1990s that the domestic scholars' researches on the impacting factors of energy enterprises' technology innovation were observed in all kinds of literature.

Aijun Fan and Yunying Liu (2006) mainly studied the foreign capital and technology spillover effect on enterprises' innovation ability [12]. According to the empirical analysis model of technology process Jiangsu province, Xichao DAI et al. came to the conclusion that the technology process is affected by factors like market competition, R&D, culture of the company, leader's spirit, demand, policy and so on[13]. ChunSen Ye (2008) found that the creation activity network, culture of the company, R&D, and the level of information technology are main factors which affected strongly the companies' technology innovation performance [14]. Wei Li(2009) believe that the labor with creative ability, leader's spirit, technical capacity, which are the internal core competences of companies, and the strategy of international enterprise, the global value chain, technical standard, national or regional innovation system, which are external environment factors, will make great influence to the way of becoming creation enterprise and the level of creation[15]. Jing Yang, Gongmin Bao (2009) found that R & D capabilities, high-level support, location, strategic technology alliances are the main factors which impact the technological innovation based on 125 private enterprises in Zhejiang[16]. Jun Su, HanWei Zhang (2012) based on the technology life cycle perspective, discussed the effect of technology demonstration and promotion on new energy enterprises technology innovation, thought that the government should consider the characteristics of each stage and formulate target public policy to promote the development of new energy technology innovation and industry[17]. These factors all influence the enterprises technological progress, these elements change with time and space, the most direct embodiment in its annual report is that the absolute value, variation of the new energy enterprises' technical elements are different. The effect of the elements is inter-temporal, this is also dynamic. Capital investment is a variable which cannot be ignored. Investment growth in the long run will expanse the production capacity and impacts the sustained economic growth (Zhang et al., 2004) [18]. In the short term, because of production capacity constraints, and relatively stable industrial structure, it need long time from fixed assets investment to the

formation of the production capacity, the investment function has a lagging effect on economic growth [19]. YuXin Zheng (2007) argued that evaluating the quality of economic growth does not take into account the long-term effects of factors，may produce larger deviation[20]. However, the dynamic effect of capital has not been considered by the researchers in the most time, most researchers only make capital stock as a common input factor to evaluate the efficiency [21]. In addition, whether other technical elements also have lag effect, will be the focus in this study. At the same time, what are the differences between major technology factors of manpower, financial resources and other elements for the contribution of technology innovation, also will be one of the research emphasis in this paper.

To sum up, scholars at home and abroad deeply analyzed the factors from internal factors, such as culture, entrepreneurial spirit, technical skills, organization; and external factors, such as policy, system, market, location. In particular, the influence of these factors on the technological innovation activity often varies with the industry, at the same time, the elements market is dynamic, pre-state factors will also affect the company's innovation investment decisions, and so the characteristics of the effect of the new energy companies' dynamic factors on technology innovative are needed to study.

Based on this, this article selects 71 new energy listed companies in the Shanghai and Shenzhen stock market in China, through dynamic elements configuration technology, using the theory of production function to create and extend new energy enterprises innovation influence factors model, and researches the various technical factors how to impact the technology innovation from 2006-2013. At the same time, the article compares systematically the science and technology input represented by the technical person, intangible assets with the corporate governance structure, firm size, growth, and capital structure to represent the influence degree of the characteristics of technological innovation of enterprise, tries to further explore the influence of China's new energy enterprises the real influence factors of technology innovation.

3 Theory and Model

3.1 The technical production function theory model

To check the effect of technology input on production of firms, they regards the input of R&D as a kind of technology input, as well as the capital and labors, all of which constituted the model of production function. Qunwei Wang (2013) suggested that the related research costs of new energy can serve as the input of new energy innovation in the study of the effect factors and relationship on new energy innovation [22]. Yahong Zhou (2012) pursued the effect factors and productivity of independent innovation within Chinese industrial companies, regarding R&D input as measurement index [23]. This paper considers operating income as index of output because the operating income is the final output performance of enterprise, as well as the final output results of all activities, when using the production function model of Cobb-Douglas; The input of R&D as well as labor and capital all consist of the enterprise inputs, we therefore let Y denote operating income, and the input factors include: capital K, labor L and input of R&D, so we construct the production function model based on panel data:

$$Y_{it} = A_i K_{it}^{\alpha} L_{it}^{\beta} T_{it}^{\gamma} e^{\varepsilon_{it}} \quad (1)$$

Where i is one of enterprises, t and e denote the year and error term. And A involves some possible heterogeneous elements which may lead to difference in production of enterprises, consisted of the characteristics of industry and enterprise itself; α, β, γ stand for the elasticity of production in capital K, labor L, and input of R&D.

We take the logarithm of formula1, we estimate the following specification:

$$LnY_{it} = \alpha_i + \alpha \ln K_{it} + \beta \ln L_{it} + \gamma LnT_{it} + \varepsilon_{it} \quad (2)$$

其中，$\alpha_i = \ln A_i$。

And in formula 2, α_i denotes the difference of enterprises, or some other factors like the characteristics of industry.

3.2 The building of General technical production function

In the estimation of linear model, to guarantee the consistency of parameter estimate, we must control the erogeneity of input factors, where the material capital input mainly includes the fixed assets investment like machinery equipment. In General, the capital stock in enterprises that has a certain size will stay stable in a short time. At the same time, the impact of external technology usually result in increased fixed assets or the technology innovation, enterprises will also change the number of employment for the reason of spillover of mature technology market and the competitive characteristics. So we suppose K and L only be affected by external factors such as market, thus dealing with which as exogenous variables. And enterprises consider the effect of their own characteristics when making decisions on input of R&D according to their production requirement relative to input of material capital and labors.

We expand the model 2 according to measurement in literature of Yahong Zhou (2012)[23], assuming $E\langle \alpha_i | K_i, L_i, T_i \rangle LnY_{it} = c + othercontrols_i$, where c is constant, other controls are control variables of each enterprise itself characteristics. We estimate the following general technical production function [24]:

$$LnY_{it} = c + \alpha \ln K_{it} + \beta \ln L_{it} + \gamma LnT_{it} + \eta othercontrols_{it} + \varepsilon_{it}$$

(3)

For the reason of studying the effect of material capital, employment and characteristics of enterprises on technology innovation, we transform model 3 as follows:

$$\gamma LnT_{it} = \ln Y_{it} - (c + \alpha \ln K_{it} + \beta \ln L_{it} + \eta othercontrols_i + \varepsilon_{it}) \tag{4}$$

And we transform model 4 further, as follows:

$$LnT_{it} = 1/\gamma \ln Y_{it} - (c/\gamma + \alpha/\gamma \ln K_{it} + \beta/\gamma \ln L_{it} + \eta/\gamma\, othercontrols_i + 1/\gamma\, \varepsilon_{it}) \tag{5}$$

This paper regards value, enterprise type, capital ratio and growth as control variables for the reason that enterprises can be affected by their value, enterprise type, capital ratio and growth. Moreover, the property of capital and employment, specially technicists and intangible assets can also have influence on technology innovation. We suppose K1 is intangible assets, K2 is other assets except intangible assets, L1 is technicists and L2 is other labors except technicists.

$$LnT_{it} = 1/\gamma \ln Y_{it} - (c/\gamma + \alpha_1/\gamma \ln K_{1,it} + \alpha_2/\gamma \ln K_{2,it} + \beta_1/\gamma \ln L_{1,it} + \beta_2/\gamma \ln L_{2,it} + \eta_1/\gamma\, Value_{it} + \eta_4/\gamma\, Growth + 1/\gamma\, \varepsilon_{it}) \tag{6}$$

We transform the model 6 as follows:

$$LnT_{it} = c' + \gamma' \ln Y_{it} + \alpha_1' \ln K_{1,it} + \alpha_2' \ln K_{2,it} + \beta_1' \ln L_{1,it} + \beta_2 \ln L_{2,it} + \eta_1' Value_{it} + \eta_2' Type_{it} + \eta_3' Ratio_{it} + \eta_4' Growth_{it} + \varepsilon_{it}' \tag{7}$$

Thus we estimate the specification.

3.3 The building of dynamic technology production function

The offset of neoclassical production function is obvious. For instance, capital K is capital stock at the end of the current which cannot reflect real capital input of current period, as well as the fundamental role of accumulation in the past on current production, on the contrary, it can also denote material basis and starting point of next issue, which can also be the precondition of production for next issue.

Due to dynamic change of technology elements, the input of technology factors in the early like intangible assets and technicists need some time to accumulate and digest in order to bigger effect. Moreover, the technological and innovative ability which is replaced by R&D input also has cumulative effect. Thus we take the lagged variables of technology elements into consideration to emphasize the dynamic of it. There is no standard of the selection of time lag. We regard one year as time lag, so the dynamic technology production function is as follows:

$$LnT_{it} = c' + \lambda' \ln T_{i,(t-1)} + \gamma' \ln Y_{i,(t-1)} + \alpha_1' \ln K_{1,i(t-1)} + \alpha_2' \ln K_{2,i(t-1)} + \beta_1' \ln L_{1,i(t-1)} + \beta_2 \ln L_{2,i(t-1)} + \eta_1' Value_{it} + \eta_2' Type_{it} + \eta_3' Ratio_{it} + \eta_4' Growth_{it} + \varepsilon_{it}' \tag{8}$$

Thus we estimate the specification.

4 Empirical Research

The data of this paper is based on 71 new energy listed companies from 2006 to 2013.We chose R&D as the main indicator of technical innovation; we also chose net intangible assets, non- net intangible assets and the number of technical personnel as the main indicators of capital factor and labor factor separately. Moreover, stock market capitalization, asset-liability ratio and operating income growth rate denote the indicators of company size, company structure and company`s development potential. Furthermore, we estimate the equation within dummy variable, whether the companies are state-owned or not. Besides, the model brings the effect of lag variables and the former R&D is the first-order lag variable. Table 1 shows the descriptive statistical analysis of relevant variables.

Table 1: The descriptive statistical analysis

Variable	Mean	Std.Dev.	Min	Max	Observations
lnT	8.6433	8.5802	0.0000	21.4789	568
lnY	21.3738	1.7006	0.0000	25.0954	569
$\ln K_1$	17.9617	3.3412	0.0000	23.4303	570
$\ln K_2$	22.0805	1.3365	19.0816	26.1958	571
$\ln L_1$	5.4407	1.5189	0.0000	8.9950	572
$\ln L_2$	7.4326	1.4649	0.0000	10.2672	573
lnvalue	15.3550	1.0568	13.0935	18.3343	574
Type	0.3944	0.4891	0.0000	1.0000	575
Ratio	0.5682	0.1723	0.0459	1.2008	576
Growth	0.2239	0.4793	-1.0000	4.2972	577

Table 1 shows that the standard deviation of technology innovation factors differ sharply. This suggests that the level of listed companies` technology innovation remain unbalance. At the same time, the standard deviation of the operating income growth rate and asset-liability ratio among the new energy listed companies remain low with the average value of operating income growth rate is about 22%. The conclusion shows clearly that the company`s performance is relatively good, and the assert-liability structure is consistent and reasonable.

Figure 1 shows that different companies have various time trend of technology innovation. Some listed companies' technological innovation elements change relatively flat; and the changes of some companies` innovation factors are even larger. However, the major trend is upwards.

Next, the paper would analysis the effect factors of

technology innovation across new energy listed companies, using panel data induced by 71 new energy listed companies from 2006 to 2013. We usually consider fixed effect model and random effect model during the regression. Inspection method would depend on Hausman test to alter which effect is more reasonable. The results of Hausman test are shown in Table 2.

As can be seen in Table2, P value is 0.000, Hausman test reject random effect model and accept fixed effect model. The paper therefore chose fixed effect model to estimate. Table 3 shows the estimation results.

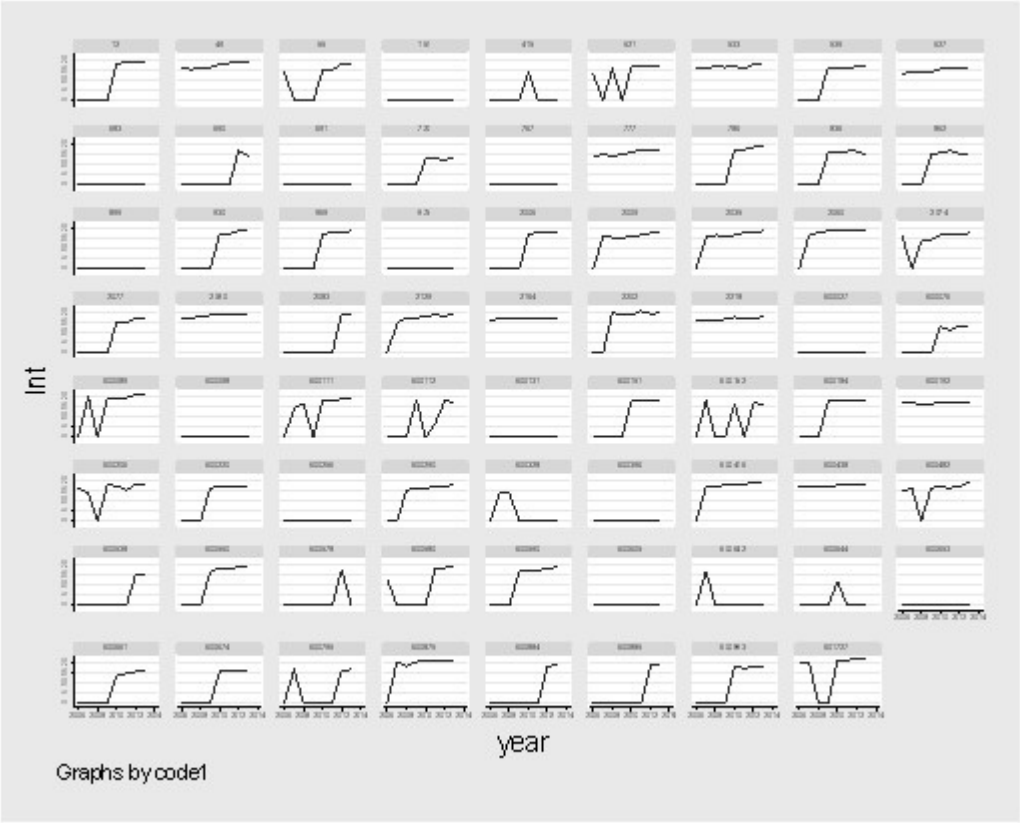

Figure 1: Time trend of technology innovation of new energy listed company

Table 2: Hausman test

	(b) FE	(B) RE	(b-B) Difference	Sqrt (diag(V_b-V_B)) S.E.
lnY	0.3057	0.2941	0.0115	0.1499
lnK1	2.1617	-0.0687	2.2304	0.1066
lnk2	1.2894	0.7365	3.5529	0.4091
lnK1	1.1059	1.9725	-0.8666	0.2850
lnK2	0.4163	-0.1059	0.5222	0.2812
lnvalue	0.9524	0.4468	0.5056	0.2429
Type	-0.2854	-0.8288	0.5434	1.0468
Ratio	-4.5894	-1.8972	-2.6921	1.7520
Growth	0.6472	-0.2786	0.9258	0.1226
_cons	-110.5682	-28.0098	-82.5585	9.4520

There are a total of four variables passed the significance testing, including technicists input, intangible asserts factors, stock market capitalization and the growth rate of companies, which all are significant at 5%.the between group R-square of fixed effect model approach 0.21 .all the variables, other than asset-liability ratio, remarkably improve the technology innovation, especially for the intangible assets with the coefficient up to 2.16. It`s worth nothing that technicists play a less important role in technology innovation. This conclusion suggests that the new energy listed companies depend more on traditional energy than new energy, thus making less innovation in new energy and inconspicuous effect in technology input.

The static panel model states the impact of technology factors in the technical innovation. While the factors are dynamic, technical innovation is also effected by technology factors input. We therefore check static panel data to disclose the effect of former technology factors input. The results are shown by Table 4.

Table 3: The estimation results of fixed effect model

lnT	lnY	lnK_1	LnK_2	lnL_1	lnL_2	lnvalue	Type	Ratio	Growth	cons
Coef.	0.3057	2.1617**	1.2894	1.1059**	0.4163	0.9524**	-0.2854	-2.9396	0.6472**	-110.5682

The results can be established without disturbance autocorrelation and excessive recognition. Meanwhile, the technical innovation of new energy listed companies clearly affected by the former technical innovation inputs with the elastic coefficient of 0.33, suggesting that the dynamic effect of innovation inputs is obviously. The effect of technists with respect to technical innovation is significant at 5% with the elastic coefficient up to 1.21. Moreover, company` scale with respect to technical innovation is significant at 10% which shows that the enlargement of company scale can improve the marginal efficiency. The dummy variable don`t has significant positive effect in technical innovation, suggesting that the state-own company should seize development opportunities to speed up technical innovation. The capital structure and growth rate of the companies didn`t show obvious impact on technical innovation with an specific industry characteristics. The debt asset ratio and growth rate can`t illustrate the impact because of the less difference and similar benchmark.

Table 4 empirical results of dynamic panel

lnT	Coef.	Std. Err.	z	P>|z|
lnT Lag1.	0.3367***	0.1061	3.1700	0.0020
lnY Lag1.	-0.0885***	0.1060	-0.8400	0.0040
$lnK1_{,lag1}$	2.2177***	0.8009	0.2700	0.0060
$lnK_{2,lag1}$	1.3816	2.1444	1.5800	0.1150
LnL_{1lag1}	1.2108 **	0.7188	-0.2900	0.0290
LnL_{2lag2}	-0.4969	0.5636	-0.8800	0.3780
lnvalue	1.5581*	0.8878	1.7600	0.0790
Type	0.3487	1.3586	0.2600	0.7970
Ratio	3.4858	6.9890	0.5000	0.6180
Growth	-0.1794	0.8384	-0.2100	0.8310
cons	-124.2500	38.5971	-3.2200	0.0010

5 Conclusion

Based on new energy technology innovation factors according to a study of listed companies in our country，we find that China's new energy listed companies dependence on traditional energy input mode is still very big, technical inputs need to be strengthen and expand the influence on technology innovation, new energy industry needs further optimize the industry structure and give full play to the technological advantage. At the same time, the significant hysteresis of technology also indicates that technical innovation is not a short-term, attention should be paid to its long-term benefit, avoiding appear decision-making errors in the development of new energy enterprises.

The study also finds that the company scale has an important influence on technology innovation ability, with the increase of company size, the new energy enterprise innovation ability is stronger, which fully reflects the actuality of our new energy industry, new energy industry needs further integration of the enterprise resources, bigger and stronger leading enterprises, to promote the development of new energy industry.

New energy industry at the same time should also pay attention to the cultivation of talents and the improvement of labor quality, the study finds that technical personnel for new energy technology innovation has a significant influence, only to improve the quality of the staff, the company will grasp opportunities in the process of the development of new energy technology and shorten the R&D cycle, bring power to the development of enterprise.

Paying attention to the intangible assets investment is an important guarantee for the future development of new energy in our country listed company, the research and development of the technical intangible assets, such as patent right, proprietary technology, can ensure that enterprises are in the industry advantage over a period of time. Therefore, enterprises need to continuously research and develop and innovate, so that to continuously consolidate and extend the advantages in the long time and to ensure the good performance of the enterprises, which can have more capital of technological innovation, eventually it will form the virtuous cycle that innovation drives performance, performance feedbacks.

To "innovation driven development strategy" as an opportunity can strengthen the independent innovation, master the core technology of new energy technology actively, and maintain China's energy security, realize the sustainable development of new energy industry.

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