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Social Self-Organization Evolution Path of Photovoltaic Industry Chain System

Lingjun WANG[1], Ying WANG[2], Jian CHEN[3]

Abstract

The photovoltaic industry chain system is a very large and complex system, influenced by external forces such as market demand, policy promotion and technological progress. At the same time, there is a complex competition and coordination mechanism in the industry. In order to explore the evolution path of the photovoltaic industry chain, the corresponding industrial growth and development mechanism, development strategy and policy are proposed. This paper introduces the Logistic improved model by social self-organization theory to empirically analyze the evolution path of China's PV industry chain. Studies have shown that the evolutionary path of the PV industry chain has gone through four periods: incubation period, growth period, maturity period and recession period. Each evolution path is accompanied by an innovation model of the industry chain, optimization of main functions and system structure. On this basis, the proposal of long-term development of photovoltaic industry is put forward from the perspective of social system of self-organization theory.

Keywords: photovoltaic industry, social self-organizing, evolution path, distribution of resources, development, leadership.

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Introduction

With the continuous increase of the world population and the rapid development of the global economy, global energy consumption has grown rapidly, traditional energy sources such as coal and oil have gradually dried up, and the energy crisis and the resulting global climate change have threatened the sustainable development of the global economy and society. The strategic fulcrum that can solve the energy crisis global climate change crisis at the same time is the research and development and popularization of new energy. Therefore, new energy has become the focus and hot spot of the new round of international competition.

The new energy industry is a strategic emerging industry in China. In recent years, China's new energy industry has achieved rapid development. Especially after the international financial crisis, the new energy industry has become one of the most important emerging industries. The central and local governments and related enterprises have a high enthusiasm for the development of new energy industries. . The "New Energy and Renewable Energy Development Program", "Renewable Energy Medium and Long-term Development Plan", "Renewable Energy Development "12th Five-Year Plan", "Renewable Energy Law of the People's Republic of China" and "National Energy" has been issued. Programmatic documents and regulations such as the Notice of the Bureau on Declaring Distributed Scale Photovoltaic Application Demonstration Zones have a great leading role in promoting the rapid development of China's new energy industry.

The solar photovoltaic industry is an important part of the new energy industry. It is an inexhaustible, non-polluting and freely usable energy source. It is the most important component of renewable energy. Solar power generation is currently the most used energy source in China, with the highest conversion rate, the most economical, most reliable and simplest energy source. Solar power generation has absolute safety, sufficient cleanliness, relatively wide distribution of resources, and maintenance-free and other advantages that other conventional energy sources do not have. The most important new energy source in the 21st century is photovoltaic energy. The development and benefits of solar energy mainly include the solar thermal utilization industry and the photovoltaic industry. Among them, the solar thermal utilization industry is relatively mature in China, and China has become the world's largest solar water heater supply market and demand market. In the field of photovoltaic technology, many multinational companies and high-tech enterprises have begun to deploy layer-level patents in key technologies, with the intention of mastering the future solar photovoltaic industry market by mastering core technologies.

Implementing industrial chain development in the solar photovoltaic industry can achieve optimal allocation of production factors, rational layout of space and rapid response to time, and improve the overall competitiveness of industry and industry. Correct understanding and grasp of the concept of the industrial chain and

its related theories are of great significance to the integrated cluster development of the photovoltaic industry, the improvement of the industry's own market competitiveness and China's economic development strategy. China's research on the competitiveness of the photovoltaic industry and the PV market is relatively rare. The research on the industrial chain as a research perspective is rare. In theory, there is a lack of adequate guidance for the rapidly developing photovoltaic industry. In this paper, through the research of self-organizing evolution path of photovoltaic industry chain system, it is of great practical significance for the development of China's photovoltaic industry to improve the optimization of industrial chain and enhance the competitiveness of photovoltaic industry.

Literature review

Guided by evolutionary economics, the domestic scholars have done a lot of research. Ye Jinguo et al (2005) used equation to describe the overall evolution process of the industrial system. The results of fitting the evolution process of China's energy industry system using China's energy production data show that the energy production time series of China's energy industry system is chaotic and systematically evolved. Has an irregular period. Zhao and Chen (2003) analyzed the reasons and evolution mechanism of high-tech park success by using the basic viewpoints and thinking modes of ecology and self-organization theory, and proposed a series of countermeasures for developing high-tech industrial ecosystem in China. Xiang (2005) used self-organization theory to construct a dynamic mechanism model of industrial growth, and believed that industrial growth is actually a process of industrial self-organization evolution. Wang & Zhang (2005) used the research methods of foreign industrial organizations to quantitatively analyze the relationship between the change speed of the number of enterprises in the green food industry and the stage of the industrial life cycle, and analyzed the characteristics of the formation period and growth period, and predicted the maturity period. The characteristics and trends of the recession period, proposed a green food marketing development strategy. Li, Dai, & Han (2005) used the empirical data of the steel industry in developed countries to empirically analyze the evolution process of China's steel industry using a growth-like curve model, and predicted the time of arrival of the Chinese steel industry at the inflection point and extreme point. In the research of photovoltaic industry, domestic and foreign scholars have done a lot of research and achieved rich results. The development of foreign photovoltaic industry is leading by Germany, Japan and the United States. Botzen Aerts, & van den Bergh (2009) believes that solar energy is an emerging renewable energy source, and the key driving force for the rapid growth of the photovoltaic industry is technological innovation. Powell et al., (2012) constructed a crystal silicon production cost assessment model, proposed a

large compression cost and increased technological innovation to increase market share.

Ashhab, Kaylani, & Abdallah (2013) analyzed the feasibility of photovoltaic systems and believed that the use of hybrid systems in the photovoltaic industry could increase the sale of the ultimate PV products. Badescu and Iacobescu (2013) pointed out that in order to promote the coordination of the photovoltaic industry chain, Romania should carry out technological reforms from the aspects of fixed optimal tilt angle, uniaxial azimuth orientation, uniaxial elevation angle and biaxial orientation in photovoltaic modules. Zhang (2013) found that under the impetus of the German federal government, the Technology Innovation Alliance, as an effective model to enhance the technological innovation capability of the German high-tech industry, has developed rapidly and formed a kind of industry-led, close integration of production, study and research.

The model solving key technologies for industrial development, increasing technology reserves, and cultivating high-quality innovative reserve talents. Chu and Long (2006) compiled the article "American Photovoltaic Industry Roadmap" that the United States has lost its leading position in the development of the solar industry. In order to reverse this trend, the US Photovoltaic Industry Association designed the US roadmap for the photovoltaic industry to 2030 and beyond. Whether the United States can restore its market leadership status depends on the actions of the government and industry. I Supply believes that despite the current challenging situation, the solar market will continue to grow in the next few years. During the financial crisis, the factors driving the growth of the overall PV market were not affected, and the public support for the industry in the major solar regions was not shaken. Long-term factors driving the growth of the photovoltaic market still exist. Wen (2009) also analyzed from a technical perspective in his "Thinking about the development trend of China's PV industry under the financial turmoil". Even in the financial turmoil, the big environment is still very beneficial to the photovoltaic industry.

For the development of China's photovoltaic industry, domestic experts and scholars generally believe that its development potential is relatively large, but there are still many constraints at this stage. For example, China's Optoelectronic Technology Development Center's Thursday Qing et al. concluded in 2007 that the era of renewable energy development has arrived, but we still face many problems, such as "two heads out" (more than 95% of domestic PV industry). Raw materials and more than 95% of the market rely on foreign countries. The key equipment

dependence import and renewable energy law are in the process of implementation and implementation, and the driving force for the current PV market is limited. Shen, Shu, & Wen (2009) pointed out that the renewable energy law has limited market drivers, mainly because of the lack of specific rules for photovoltaic power generation guidance. Wang (2008) believes that the development of China's entire solar photovoltaic industry is not satisfactory, and there are problems such as backward core technology, unbalanced development of industrial chain, and low added value of products. The development of the industrial chain is closely related to the industrial prospects. A correct understanding of the current status and problems of the development of China's solar photovoltaic industry chain is a condition for enhancing the competitiveness of China's solar photovoltaic industry market. In the 2009 study, Xiao (2009) believed that the demand encouragement policy drives the rapid industrialization of solar photovoltaic power generation technology and the government's support to start the market, the cost of photovoltaic modules can be rapidly reduced, and will eventually have the ability to compete with conventional energy sources. For the prospect of the development of the photovoltaic industry, Ma and Fu (2006) in their article "Analysis of the constraints of the development of China's photovoltaic industry", that the growth model of the entire industry is jointly promoted by the government and technology, namely: Policy support - demand expansion - supply increase - photovoltaic industry development, technological progress - cost reduction - photovoltaic market expansion - supply increase - photovoltaic industry development. Kang (2008) analyzed the current situation of China's photovoltaic industry and believed that with the official release of the China National Climate Change Program on June 4, 2007, the photovoltaic industry as a renewable energy ushered in a better opportunity. Zhao *et al.* (2008) believe that technological progress is an important factor in reducing the cost of photovoltaic power generation and promoting the development of the photovoltaic industry and the market.

In summary, few scholars at home and abroad have applied the theoretical system of the industrial chain to the research of the photovoltaic industry. The research on the foreign photovoltaic industry chain is scarce. The main reasons are: on the one hand, scholars who study the value chain and supply chain of the photovoltaic industry from the perspective of management fail to specialize in the special expression form of the value chain and supply chain in a specific cluster area. On the other hand, Potter et al. who proposed or valued "location competitiveness" focused their attention on industrial cluster research in countries and regions, and scholars using this theory have not yet applied to the photovoltaic industry. In view of this background, based on the previous research, this paper uses self-organization theory to study the evolution path of China's PV industry chain, and hopes to provide meaningful reference for the optimization and upgrading of China's PV industry chain.

Research on Evolution Path of Photovoltaic Industry Chain System

Self-organization theory Self-organizing Theory

Self-organization theory is a theory about the self-organizing phenomenon that each subsystem within the system can form a certain structure or function according to certain rules without external command. This theory mainly studies how the system evolves from chaotic disordered initial state to stable ordered final state. It is believed that there must be several basic conditions for disorderly and orderly evolution: (1) The system that generates self-organization must be an open system. The system can only produce and maintain stable order by exchanging substances, energy and information with the outside world. The possibility of structure; (2) The system develops from disorder to order, and must be in a state away from heat balance. Unbalance is an orderly source. Open systems must be in an unbalanced state; (3) There are nonlinear interactions between subsystems within the system. This interaction enables synergistic actions between subsystems, which can turn the system from chaotic to orderly. In addition to the above conditions, the self-organization theory also believes that the system can only make the order become a reality by leaving the original state or the fluctuation of the orbit, thus completing the self-organization process of the ordered new structure. Self-organization theory mainly includes the following contents:

Dissipative structure theory

It mainly studies the relationship between material and energy exchange between the system and the environment and its impact on the self-organizing system. A structure based on the relationship between substances and energy exchanges with the environment is a dissipative structure, such as a city or a life. Far from the equilibrium state, the openness of the system, the existence of nonlinear mechanisms between different elements in the system, and the fluctuation of the system are the four basic conditions for the emergence of the dissipative structure. Far from the equilibrium state, the material and energy distribution in each area of the system is extremely unbalanced, and the gap is very large.

Synergy

It mainly studies the synergy mechanism among various elements within the system. It is considered that the synergy between the various elements of the system is the basis of the self-organization process. The competition and synergy between the various order parameters in the system is the direct source of the new structure. Fluctuation is caused by the independent movement of system elements or the various coordinated movements generated locally and the random

interference of environmental factors. The actual state value of the system will always deviate from the average value. The magnitude of this deviation fluctuation is called fluctuation. When the system is in a steady state transition from one steady state to another, when the independent motion and the coordinated motion between the system elements enter the balance phase, any slight fluctuation will be quickly amplified into a large fluctuation that affects the entire system.

Mutation theory

It is based on the stability theory and considers that the mutation process is a process from a steady state transitioning from an unstable state to a new stable state. It is mathematically indicative of the various parameters of the system state and their function value changes. the process of. The catastrophe theory believes that even in the same process, corresponding to the same control factor threshold, the mutation will still produce different results, that is, several different new steady states may be achieved, and each state presents a certain probability.

Synergistic dynamics

There are three main points: First, within the existence of a large number of subsystems, on the basis of the input of the necessary substances, energy and information, the competition must stimulate the network to form an influence and interaction; second, promote cooperation, form and The necessary tension to compete against each other, and let some advantages of cooperation spontaneously and autonomously form a greater advantage without interference. Third, once the order parameters are formed, it is necessary to pay attention to the dominance of the order parameters. In order to carry out, the dynamic process of the system should be organized according to the self-organization process of the system under the rule of order parameters. This may result in two ordered movements, one that is the quantitative level of growth and the evolution of its degree of organization, and the other that is the evolution of the catastrophic organization.

Evolutionary path theory

It believes that the path of evolution is diverse, there are three paths, one is the evolution path through the critical point or the critical area, the evolutionary outcome is unpredictable, the small incentive is likely to lead to large fluctuations; the second is the intermittent road of evolution, There are large ups and downs, often sudden changes, most of which can be predicted, but some areas or structural points are unpredictable; third is a gradual evolutionary path, the path is basically predictable. The morphological evolution method (structured method) used by the catastrophe theory analyzes the mutation possibility of the self-organized evolution path on the overall background, providing a holistic view for the researchers.

Chaos theory

It makes a significant contribution to the nonlinear approach to the study of complexity. First of all, chaos can not only appear in simple systems, but often chaos can be generated by simple rules. Simple systems can produce complex behaviors, and complex systems can produce simple behavior. Layering, bifurcation, branching, locking, and amplification, the nonlinear development or evolution process is so magical and unpredictable; secondly, nonlinear dynamic chaos is intrinsic, inherent, rather than additive, exogenous. Especially the chaotic characteristics in management determine the non-optimization and uncertainty of the "chaotic management" method. Businesses do not pursue optimization and maximum efficiency - this is determined by stable management values; there is no direct relationship between management processes and outcomes. Based on the characteristics of the PV industry chain, this paper uses the evolutionary path theory to empirically analyze the self-organized evolution path of the PV industry chain system.

Empirical analysis on Evolution Path of Photovoltaic Industry Chain System

Model construction

The evolution of an industrial system is constrained by its own growth capabilities and resource environment, and its actual number cannot grow forever. Eventually one or more constraints will stop growth. The initial growth is usually exponential, but gradually slows down until the system state reaches equilibrium. The shape of the curve is like a stretched S-shape. The Logistic equation is most commonly used to represent the evolution path of this type of industrial system. The Logistic equation is given by R. Pearl first proposed and is now widely used in the study of population growth evolution. This paper is used to indicate the overall growth of the photovoltaic industry. Based on the above assumptions, based on the improvement of the Logistic standard original equation $Y_{x+1}= \beta Y_x (1- Y_x)$, the self-organizing evolution path model of the PV industry chain system is constructed as follows:

$$\frac{dQ_{(x)}}{d_x} = aQ_{(x)}\left(\frac{P-Q_{(x)}}{P}\right)+b \qquad (1)$$

Q_x indicates the overall scale parameter of the PV industry chain system during the x period, P indicates the limit value of the development scale of the PV industry chain system or the maximum load capacity of the market; a indicates the natural growth rate of the PV industry chain system, and a>0; b indicates PV Random

fluctuations in the industrial chain system. The practical significance of $\frac{dQ_{(x)}}{dx}$ can be explained by the rate of increase in industrial output. It is closely related to the level of industrial chain cooperation, technological innovation, market size, etc. at the time of x, and is also affected by industrial growth. Space restrictions.

Therefore, $\frac{dQ_{(x)}}{dx}$ is not only related to the output of the previous period, but also depends on the remaining degree of the industrial growth space. Equation (1) shows that the industrial system has positive and negative feedback loops, and its evolution is nonlinear.

Analysis of evolution path

In this paper, the Logistic evolution model (1) is firstly integrated. At this time, the initial value $Q_{(0)}= Q_0$ is substituted into the formula, and the initial solution of the evolution equation of the PV industry chain system is:

$$Q_{(x)}=\frac{P}{1+Ce^{ax}} \qquad (2)$$

$$C=(\frac{P}{Q_0}-1) \qquad (3)$$

Where: C is a constant, and its specific value is determined by the extreme value P and the initial size of the system Q_0. Equation (1) represents the self-organization evolution speed of the PV industry chain system. When a > 0, dQ(x)/ dx ＞ 0, the evolution velocity curve of the PV industry chain system presents an “N” type, and equations (2) and (3) indicate that the evolution curve of the system exhibits an “S” type.

$$\text{Let } Q_{(0)}=a\text{, then } e^{c}=\frac{a}{1-a}\text{, so } Q_{(x)}=\frac{P}{1+\left(\frac{P}{a}-1\right)e^{-aPx}} \qquad (4)$$

Equation (4) is the evolution equation of the output state of the photovoltaic industry chain system. Its graphical trajectory describes the change of the output of the photovoltaic industry system. The graph is S-shaped, as shown in the following *Figure1*:

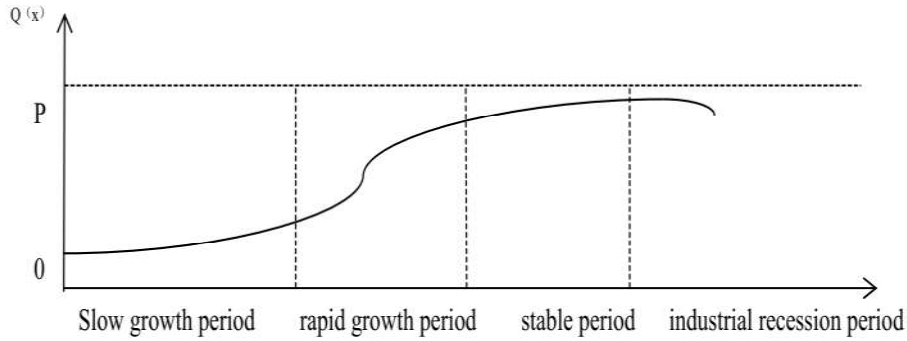

Figure 1. Growth law of industrial chain system

Analysis of the evolution path of Photovoltaic Industry Chain System

By finding the second-order guide for equation (4), we can gain a deeper understanding of the changes in its development speed and acceleration in industrial evolution.

$$\frac{d^2Q_{(x)}}{dx^2}=a^2Q_{(x)}\left(\frac{P-Q_{(x)}}{P}\right)\left(\frac{P-2Q_{(x)}}{P}\right) \quad (5)$$

Equation (5) is the growth rate equation of the PV industry chain system. It is a bell-shaped curve that describes the growth rate of the output variation of the industrial system at any time. If a>0, then $\frac{dQ_{(x)}}{d_x}$>0, the image is a bell curve, as shown below.

Let $\frac{d^2Q_{(x)}}{dx^2}$=0, because 0<$Q_{(x)}$ <Px ,The inflection point Q*(x)=P/2 of the evolution curve of the system can be obtained, and this point can be brought into equation (2), the result as shown below.

$$x_0=\frac{PlnC}{a}$$

At this point, the maximum evolution rate of the PV industry chain system is:

$$\frac{dQ_{(x_0}}{d_x} = \frac{aP}{4}$$ Â

Further deriving the formula (5) to obtain the third derivative:

$$\frac{d^3Q_{(x}}{d_{x^2}} = a^3Q_{(x)}(\frac{P-Q_{(x)}}{P})(\frac{P-(3-\sqrt{3})Q_{(x)}}{P})(\frac{P-(3-\sqrt{3})Q_{(x)}}{P})$$

Let $\frac{d^3Q_{(x}}{d_{x^2}}$=0, get $Q_{(x_1} = \frac{P}{3+\sqrt{3}}$, $Q_{(x_2} = \frac{P}{3-\sqrt{3}}$

Substituting the two solutions into equation (2) gives:

$$x_1 = \frac{lnC - \ln)(2+\sqrt{3}}{a/P}, \; x_2 = \frac{lnC + \ln\left(2+\sqrt{3}\right)}{a/P}$$

Therefore, the growth rate of the PV industry chain system can be obtained as follows:

$$\frac{dQ_{x_1}}{d_x} = \frac{dQ_{x_2}}{d_x} = \frac{aP}{6}$$

So two points on the speed curve $\left(x_1, \frac{aP}{6}\right), \left(x_2, \frac{aP}{6}\right)$

Corresponding to two points on the evolution curve of this output

$$(x_1, \frac{P}{3+\sqrt{3}})(\quad x_2, \frac{P}{3-\sqrt{3}})$$

When x→∞, there are Q→P, $\frac{dQ}{d_x} \to 0$. The above analysis can draw the growth rate curve and state evolution equation curve of the PV industry chain system:

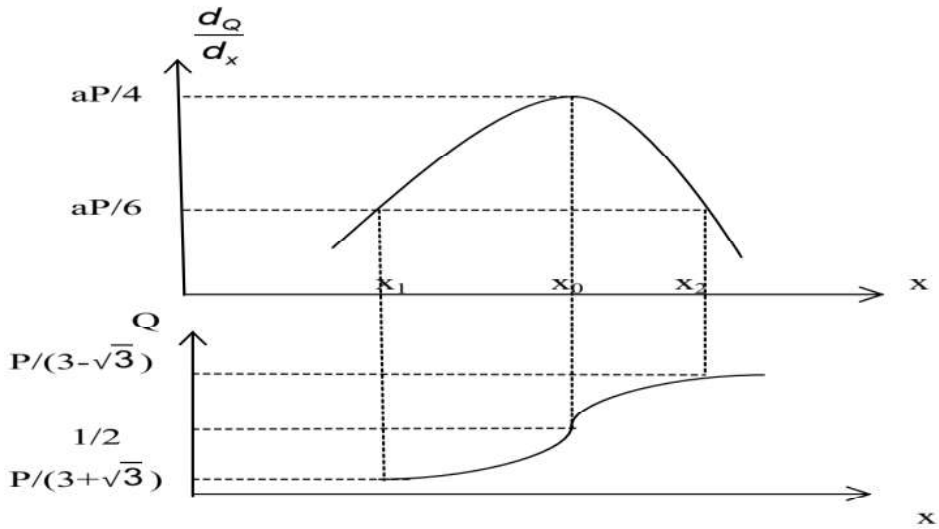

Figure 2. Industry chain system evolution curve and growth rate curve

It can be seen from *Figure 2* that the output of the PV industry chain system grows with time according to the S-shaped curve, and the evolution path can be divided into four stages:

(1) The first stage ($0<x<x_1$) is the incubation period, which indicates that the growth rate and acceleration of the PV industry chain system are increasing at this stage, and the industrial base is gradually accumulated. The industry growth acceleration reaches the maximum at $x=x_1$. This is called the "takeoff point" of system evolution. Therefore, in the gestation period formerly known as the industry,

(2) The second stage ($x_1<x<x_0$) is the take-off period, and the growth of the PV industry chain is still in an accelerated stage. The PV industry chain has evolved into a new era after the previous "pregnancy" stage. The "takeoff period" is a crucial moment for the development of the photovoltaic industry chain. When the PV industry chain system output reaches 1/2 of the limit value P, the industrial growth rate reaches the maximum value, and the acceleration is zero at this time, and the photovoltaic industry develops prosperously. The performance of the industrial chain system is usually the market demand continues to expand, the market prospect is broad, the enterprise benefits are high, and the entire photovoltaic industry chain is in a good cycle and high-yield state.

(3) The third stage ($x_0<x<x_2$) is the maturity stage. At this stage, the acceleration of the growth of the photovoltaic industry chain is less than

zero, and the growth rate begins to decrease, indicating that the development momentum of the photovoltaic industry chain is weakened. When the output reaches 10,000 hours of the limit value, the negative value of the acceleration reaches the maximum, which is called the "mature point" of evolution. Before the maturity point, the technology in the industry is getting better and better, and the market demand is becoming more stable. The effects of technological progress, policy stimulus, and industrial reforms have been fully demonstrated, making the industry scale and product production scale close to the maximum. With the further development of the maturity period, the market capacity tends to be saturated, the utilization of resources is close to the limit, and the growth rate of the industry begins to decline. At the same time, with the fierce competition within the industry, the release of core technology potential, the industry will simultaneously breed new industrial genes.

(4) The fourth stage ($x_2<x<\infty$) is a recession period. At this stage, the innovation technologies of the photovoltaic industry chain converge and the advantages complement each other. Disappeared, oversupply of products, processes and services. The loss situation of the existing photovoltaic industry began to emerge, the internal and external network of the system began to disintegrate, and the development space of the photovoltaic industry chain gradually narrowed, that is, the growth rate of production became increasingly slow, and the market demand reached its limit, until the growth almost completely stopped.

Conclusion

Research shows that the PV industry chain system has undergone self-organization and evolution, and the system structure, main functions, innovation models and cultural concepts have been subtly changed. The self-organizing characteristics of the system in the evolution process are conducive to understanding its evolutionary nature, facilitating the coordination of the competition relationship within the system, prolonging the development of the system's self-organizing evolution, and the mature period of action, avoiding or reducing the risk of system recession.

Suggestions

Improve policies to promote the development of the photovoltaic industry. Based on the current situation of the development of China's photovoltaic industry, the application of supply-oriented and demand-oriented policy tools should receive the attention of the government. In the application of supply-oriented policy tools, there are mainly joint ventures, scientific research institutions, institutions

of higher learning, building a technical service platform for photovoltaic industry; implementing tax incentives; providing financing guarantees, including photovoltaic industry projects as priority support projects, and providing government financing guarantees Support measures such as listing financing. In the application of demand policy tools, there are mainly procurement of photovoltaic power generation; encourage the ability to implement the "solar roof plan"; and promote the application of solar power system in the public infrastructure and basic industries to ensure the enterprise market.

Expand the extended industry chain. China's current PV industry chain is still in a two-headed mode, the scale of enterprises is small, the number of high-end enterprises is small, and the low-end market has fierce competition. Through horizontal integration, we should improve the production of supporting equipment for the photovoltaic industry, promote the localization of equipment, and introduce foreign equipment into the independent production capacity through independent digestion, absorption and transformation. At the same time, it extends the upstream and downstream of the industrial chain, especially to promote the installation and application market of photovoltaic power generation products. Through the two-way integration strategy to achieve high synergy within the industry chain, on the one hand to achieve optimal allocation of resources and technology within the industrial system, on the other hand to promote the emergence of scale effects.

Encourage innovation activities within the industrial system. The role of technological innovation is to effectively reduce the cost of photovoltaic power generation, and on the other hand, to effectively improve product performance. At present, the main technological advancement methods of the photovoltaic industry include the improvement of photoelectric conversion efficiency, the improvement of solar absorption rate, the improvement of polysilicon manufacturing methods, the reduction of silicon wafer thickness, and the improvement of photovoltaic power generation system integration technology. The advancement of technology is the main driving force for the photovoltaic industry to get rid of the government's financial subsidies and move toward the independent market mechanism. It is necessary to increase investment in technology research and development in the field of photovoltaic, while paying attention to the problem of technology diffusion within the industry. Give full play to the demonstration effect of technology-leading enterprises, the imitation effect of technology-stricken enterprises, and the flow of talents, so that the knowledge in the industry can be spread through competition and interaction of enterprises, thus becoming the driving force for the overall development of the industry.

Development of photovoltaic industry integration development. Conditional PV manufacturing enterprises can enter the domestic downstream PV power plant industry through vertical integration. In addition to large-scale ground power stations, they can also enter the field of distributed photovoltaic power plants, or combine photovoltaics with agriculture, fisheries and ecological management, especially photovoltaic power generation. Combined with poverty alleviation, it

opens up new models for integration with the photovoltaic industry. In addition to developing and operating photovoltaic power plants themselves, some PV companies have further developed their technology and service marketing, or gradually divested their manufacturing and power station construction businesses, providing customers with consulting, project design, engineering installation, grid connection support, monitoring and maintenance, One-stop service for all aspects of system upgrades, financing loans, etc., providing a full range of solar power solutions to help other companies develop and construct various forms of photovoltaic power plants.

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