

Inherent Analysis on Feature and Mechanism of Renewable Energy System in ST-3E System

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Abstract. Development of renewable energy is significant for energy security and also an important solution to cope with the climate change. Nowadays, due to its unique energy endowment, China's energy security and sustainable development becomes a big issue. In this paper, in the ST-3E renewable energy system, the five features and five inherent mechanism are analyzed. In the area of sustainable development, this work can further promote the ST-3E renewable energy system model to help governments and international agencies to make energy strategies and policies.

1. Introduction

For tackling energy security and climate change, the research and analyses for development and policy of renewable energy system have been done. Taichen and Jin-Li (2008) conducted an in-depth research on the stimulation of policy in realizing sustainable development [1]. Joanna (2007) studied the relationship between market-driven competition and renewable energy from the perspectives of China's electricity market reform and renewable energy policy changes [2]. Chunyan etc (2013) ST-3E system of renewable energy is such a system in which energy, economy and environment can sustainably develop with renewable energy-an effective component of the harmonious society and driven by technology progress [3]. This system comprised of S (Society), T (Technology), E (Energy), E(Economy) and E (Environment). This paper analyzed the five features and five inherent mechanism in the ST-3E renewable energy system, which further improved the connotation of ST-3E system. It further lays the foundation for energy strategies and policies making.

2. Features of ST-3E Renewable Energy System

2.1. Integrity

The five elements in the renewable energy system are closely related as integrity. The development of one system element is severely affected by the development of other system elements, supported and restricted by the others; The development of a system element depends on its former development path. It is accumulative and path-dependent, and derives the executive factors which directly affect the renewable energy system. Therefore, the integrity of the renewable energy system determines that the simple superposition of the optimal development mode of all subsystem elements cannot guarantee the optimal development of the whole renewable energy system. As a result, it is essential to study the development of the renewable energy system from the perspective of system theory.



2.2. Hierarchy

The renewable energy system is an ordered, multi-level-structured entity. Its diversity and unity is reflected through levels of hierarchy. Not only does the renewable energy system include five system elements of society, technology, energy, economy and environment, but there are many different levels of hierarchies in all system elements, which interrelate and interact with each other. The system element layer and the executive element layer can only abstractly describe the different levels of the renewable energy system. The sub levels could be further divided.

2.3. Dynamics

The renewable energy system and all their inner layers continue to improve with new emerging features all the time. Quantitative and qualitative changes reflect the dynamics of development of the renewable energy system. When the system is at a stable state, progressive quantitative changes make dynamic characteristics of the system's development predictable. However, when quantitative changes accumulate to a threshold, the original balance will be broken, and the dynamic characteristics are often uncertain. The most revolutionary element is technology. Technology shows great uncertainty during quantitative and qualitative change process of the renewable energy system and has the most direct impetus on human energy system. The changes of renewable energy system are an integral part of energy system changes.

2.4. Openness

The renewable energy system is a complex system with high openness. Its development is closely related to external environment. The national emission reduction responsibilities under the background of climate change, requires further development of the renewable energy system. Economic elements after the financial crisis changed the speed of renewable energy development. Energy resource endowments in different countries make renewable energy development strategies differ dramatically, however, in order to deal with the issue of climate change, different countries have to cooperate with each other in the development of renewable energy. Technology innovation of renewable energy and international energy cooperation affect the capacity of renewable energy development, greenhouse gas emission reduction conditions, knowledge innovation and property rights protection in different countries.

2.5. Complexity

The system elements and executive elements in the renewable energy system are all interdependent and interactive. And those relationships are in different forms, they can be linear or nonlinear, unidirectional or multi-directional, stable or unstable, etc. The complexity of the system structure and their interrelationships create the complexity of the system development process, making the system development in disorder, and inevitability in occasionally.

3. Inherent Mechanism of ST-3E Renewable Energy System

3.1. The Sustainable Development of Renewable Energy Aims at Benefiting Social System

With harmonious social development as its ultimate goal, the sustainable development of renewable energy shows a human-oriented thought since society consists of human beings. Various actions as taken by human beings aims to make living standards higher, environment better, energy supply more continuous, and relationships among human beings as well as between human beings and nature more harmonious.

One conflict between the development of renewable energy and social objectives is the cost of renewable energy. The cost of renewable energy is higher than conventional energy, and whether extra part of cost can be accepted by society is the decisive factor to its sustainable development. Using green price as the baseline to judge the level of social environmental awareness determines whether renewable energy can be developed on a large scale.

In the report delivered at the Seventeenth National Congress of the CPC, the Communist Party made a political commitment publicly to the world: in terms of environmental protection, China will

make efforts together with other countries to help each other, move forward in concert, and jointly take good care of the earth that human beings rely on. From the domestic point of view, the report proposed the idea and development goals of building an ecological civilization the first time. The report pointed out: “we will build an ecological civilization, basically form an industry structure, a growth pattern and a consuming model that save energy and resources and protect the environment. Meanwhile circular economy will achieve a considerable scale, and the proportion of renewable energy should be increased significantly. The emissions of main pollutants will be effectively under control, and the environment will be greatly improved. The concept of an ecological civilization should be firmly established in the society.” This is the first time that China developed the social development philosophy of human living in harmony with nature from a height of national strategy. The construction of an ecological civilization is an important cultural aspect of the scientific development concept put forward by the Communist Party of China. It is also an important ideological guarantee to achieve economic model transition and sustainable development, displaying the scientific development concept of “people-orientation”. This is the first time environment and human development are considered together, sublimating and expanding Taoists’ development concept of unity of mankind and nature proposed 2,500 years ago.

With China's rapid economic development, people's standard of living and way of life have undergone fundamental changes. In the course of China's economic take-off and building a moderately prosperous society, it has experienced the impact of environment deterioration on people's lives and the constraints resulting from economic and social progress. Among those impacts, the most fundamental are human health cost caused by environment deterioration, and the intensification of conflicts among social groups as well as social instability resulting from resource depletion. Environmental problem has become a huge challenge for sustainable development of economy. Various natural disasters caused by environmental problems gave profound lessons to the human society. Meanwhile, intensified group incidents have greatly affected social stability and national security.

In the new environmental situation, we should promptly adjust our development policies and environmental protection strategies. We should adopt an integrated policy to set up a sustainable social and economic system. Meanwhile, we should keep improving the governance structure and encourage participation through various cooperative partnerships and incentive policies. We should give more support to the civil environmental protection organizations and strengthen our environmental cooperation internationally to promote the sustainable development process.

A green and sustainable social development mode is the inevitable choice for China to create a harmonious society and a harmonious world. Renewable energy, as the primary means of optimizing energy structure, plays an important role in achieving this goal.

3.2. Economic System: the core of the sustainable development of renewable energy

The normal operation and development of economic system, the core of the development of the entire renewable energy system, provides support with other key system factors. Only the continuous and uninterrupted support can ensure more funds and materials being put into renewable energy and environmental protection to push the progress of the entire society. The harmonious development of economic system can be seen in the growth of economic aggregate, in the improvement of economic structure, and in its decrease of the enormous pressure on energy and environment system imposed by economic growth.

The inseparability between economy and society leads to the integration of economy and social ideology. The social responsibility of economic steering and social publicity is to form psychological preference over renewable energy, so that investment in renewable energy can be stimulated in economic system. The development speed of renewable energy and the industrialization of technologies can be achieved only if the investment is enlarged; and meanwhile, the state should support its development through finance and tax policies and attract sustainable investment to it by stabilizing electricity price.

As for the importance of the interdependence of China's economic development and energy supply, economic security and energy security have become the two most important issues of national security.

In the "Eleventh Five-Year" period, China's unit GDP energy consumption increased instead of decreasing, making energy-saving situation more pressing. The reason of the persistent rise of energy intensity in recent years is not the increase of unit product energy consumption, but the rapid expansion of energy-intensive heavy industry. In fact, the new round of high economic growth is driven by the accelerated development of heavy industry, which coincides with the middle stage of industrialization in developed countries, whose energy density also showed the "inverted U-type" curve of left-side effect.

China has proposed its national energy policy to ensure economic security. Recently, China started changing system factors such as adjusting energy price policies, taxation policies and energy government in order to inhibit the disordered development of high-energy-consumption industries as well as promoting adoption of advanced and applicable technology. In the medium and long term, China will adopt technology leapfrogging strategy, achieving technological innovation in major fields and improving the contribution rate of technical energy saving; meanwhile, the economic structure will be significantly optimized. Therefore, sustainable development of renewable energy is an inevitable choice to achieve the short-term and long-term national goals.

3.3. Environment System Motivates the Sustainable Development of Renewable Energy

The quality of environmental system affects directly the living conditions, the level of resource stock, economic development foundation and the speed of technology progress. The key to its healthy development is to make social and economic development compatible to the carrying capacity of environment, which requires society and economy develop at a speed not exceeding the carrying capacity of environment. Renewable energy is duty-bound to put energy supply in line with environmental constraint and to bring sustainable development into reality.

The development of renewable energy and environmental protection has been promoted to the height of national strategy, so the definition to the cost of renewable energy cannot be limited to the cost within the system. The comprehensive cost of environmental that combines externality and internality price must be considered. Consideration of the comprehensive cost of renewable energy and its development under corresponding policies can result in industrial structure optimization indirectly.

Climate change has become a common challenge for human beings. Apart from tackling climate change, China also has to face serious environmental pollution. Climate change and environmental issues will accompany China's society and economy transformation. The resource constraint and environmental pollution during the transformation period have appeared in the initial stage of economic development, and have endangered the foundation of the country's sustainable development. Energy production and consumption is the main source of China's environmental pollutants, approximately 90% emissions of sulfur dioxide and nitrogen oxides in waste gases are caused by energy production and consumption activities. From international experience of reducing greenhouse gases, enhancing energy efficiency and developing renewable energy are the two main measures.

Developing clean renewable energy can not only reduce local environmental pollution and economic loss caused by using fossil energy, but also decrease greenhouse gas emissions. This makes a contribution to mitigating global climate change as well as the greenhouse gas emission reduction pressure that China might face in the future. More importantly, determination and actions to develop renewable energy is one of the main symbols representing that China is a responsible country for reducing greenhouse gas emissions.

3.4. Energy System: foundation for sustainable development of renewable energy

Energy has become a kind of strategic material for the economic progress of modern society. Many aspects of human activities require energy, especially for modern economy. The development of modern economy has strong relevance and dependence on energy consumption, and only safe and secure energy supply can spur the consistent progress of economy. The harmonious development of energy system is represented in its quantity, but the consumption structure of energy also has great influence on economy and environment. The sustainable development of renewable energy can turn

the sustainable supply and optimal structure of energy system into reality, decreasing the emission of greenhouse gas and pollutants.

Renewable energy and renewable resource are closely connected. As a kind of energy, the large-scale application of renewable resource is an inevitable choice for human beings to develop sustainably. When reaching certain scale, it can reduce the consumption of non-renewable resources, giving dual protection to environment and resources. And also, renewable resource affects the output of renewable energy directly. It turns energy system from non-renewable to renewable through technical means for a sustainable development.

China is in a period of rapid economic growth. Nowadays, China is the world's largest coal producer and consumer, the second largest energy producer and consumer, and the largest oil importer after OECD. The dependence of China's economy on energy will continue to increase, and energy security has become a bottleneck restricting its economic and social development. The resource reserve of traditional energy that China's development relies on, its production capacity and the level of protection are in a serious situation. Estimated by the relevant state agencies, there will be a large gap between the conventional energy supply and demand, reaching 18%, 20% and 30% in 2020, 2030 and 2050 respectively, according to the constraints of production capacity that can be actually increased, the environmental capacity as well as the effect after the implementation of energy-saving policies. In that case, renewable energy will historically shoulder the responsibilities of filling energy supply gap, optimizing energy structure, and protecting the environment.

3.5. Technical System: backbone for the sustainable development of renewable energy

Renewable energy system directs the energy revolution. It serves as a substitution for conventional energy consisting of wood, coal and petroleum. And its sustainable development shall gradually make it from supplement to strategic energy. By means of ever-going technical progress, the use of renewable energy can improve the utilization efficiency and change mankind's energy consumption mode. To sum up, technological system shall affect the direction and speed of energy development of the entire world.

Technology is the most revolutionary factor. Its immediate action is to enhance the transformation efficiency of renewable energy. The enhancement of transformation efficiency not only shows that the level of renewable energy makes the large-scale application of renewable energy possible but also predicts that the completion of energy transformation will raise renewable energy to a strategic significance at the middle of this century.

Science and technology are primary productive forces, so the level of renewable energy technologies is often used to measure a country's overall strength. Major developed countries all devote lots of money in R&D, resulting in fast development of renewable energy technologies.

Therefore, when discussing sustainable economic development these days, we should make the level of renewable energy technologies the main indicator of China's energy structure adjustment. Improvements of technology can effectively decrease the cost of renewable energy and make it more economical. Meanwhile, the consensus of the world about the global climate change will generate huge demands for new energy technology. It will also greatly stimulate China's economy. Moreover, the development of renewable energy and the country's emission reduction commitments will benefit each other to win the initiative in the international political game of climate change.

4. Conclusion

The ST-3E renewable energy system is an integral, hierarchical, dynamic, open and complex system. Therefore, the study of the development and evolution pattern of the ST-3E system must be based on systematic and comprehensive study of its structure and their correlations. Further discussion of the inherent mechanism among all the ST-3E system elements, all executive elements and different levels in the system is crucial for the development of renewable energy, and also for the sustainable development.

The sustainable development of ST-3E renewable energy system, as the link and center of the five key factors of the system and the five key factors of operation, is directly related to the healthy development of system factors and operation factors. It is not a simple addition. It should be upgraded

to the height of national policy and strategy for optimization and also requires different stimulation policies and institutional guarantees in line with specific development situation.

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6. References

- [1] Taichen Chien & Jin-Li Hu. (2008). Renewable energy: An efficient mechanism to improve GDP. *Energy Policy*, Vol.36, pp 3045-3052
- [2] Joanna I. Lewis & Ryan H. Wiser. (2007). Fostering a renewable energy technology industry: An international comparison of wind industry policy support mechanisms. *Energy Policy*, Vol.35, pp 1844-1857
- [3] Chunyan Diao, Jianfeng Li, Research on Sustainable Development Mechanism of Renewable Energy using System Theory, *Advanced Material Research*, 2013, Volume 779-780, pp 1320-1323