Research on innovation management and innovation governance of power grid under low-carbon transition

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Abstract. Green development as the basic goal of the construction of modern society, at present our country strengthening the reform of energy production and consumption, actively building a clean low-carbon and safe and efficient energy system, this not only clarified the future direction of energy development, but also changed the traditional power industry development mode. Therefore, on the basis of understanding the development background of low-carbon transformation of power grid, this paper mainly explores the power grid planning model and application effect of adapting to the development of low-carbon energy in a certain region according to the response ideas and implementation suggestions of power grid enterprises under the background of low-carbon transformation, so as to provide reference for the innovative development of power grid enterprises in the new era.

Keywords: power grid; Low-carbon transition; Innovation management; Innovative governance; Smart grid.

1. Introduction

The development and construction of energy is an important symbol of human progress and plays an important role in urban construction and economic development. Since the 1760s, the first industrial revolution marked by the widespread use of steam engines officially began, which represents the replacement of traditional manual labor by machine production, the increasing demand for energy development in various fields, and coal has gradually become the main variety of energy consumption in the world; From the 1860s to the first half of the 20th century, the invention and promotion of two iconic science and technology, electricity and internal combustion engine, represented the official start of the second industrial revolution, and the emergence of electricity and oil further consolidated the important position of energy in the modern social and economic development of mankind. Especially after entering the 21st century, coal, oil and natural gas, as the three major fossil energy sources, accounted for more than 80% of the total energy consumption in the world. With the increasing dependence on energy for the construction and development of human society, a large number of fossil energy is over-consumed. Although this accelerates the pace of human society development, it also brings a series of security problems, such as haze and greenhouse effect. Nowadays, climate change, which is characterized by global warming, has been widely concerned by the international community, and global warming has become the main issue discussed by all countries in the world. According to the detection and analysis of relevant institutions, if there is no greenhouse effect on the earth, then the average temperature of the earth's surface should be about minus 18 ° C, and it is precisely because of the greenhouse effect that the average temperature of the Earth's surface is more suitable for human life. However, with the increasing concentration of greenhouse gases in the atmosphere, the intensification of the greenhouse effect will bring drastic changes to the living environment of human beings, such as the abnormal climate, the increase of diseases and pests, and the rise of sea level. ［1,2.3］

Faced with the environmental problems caused by the greenhouse effect, countries around the world began to rationally analyze the harmonious development relationship between human and nature, human and society, and human and human, and strive to achieve the expected construction goals while developing economic and social development and protecting resources and the environment. The concept of low-carbon economy first appeared in the British energy White paper released in 2003, and then it has been widely concerned around the world. The United States, Canada, Japan and other countries have carried out research on low-carbon economy, and successively put forward policy plans for the transformation and development of low-carbon economy. In essence, low-carbon economy refers to under the guidance of the concept of sustainable development, through technological innovation, institutional innovation, industrial adjustment and other diversified technical means, gradually control the consumption of high-carbon fossil energy, reduce excessive emissions of pollutants, and ensure the harmonious development of social economy and natural environment. Green and low-carbon development strategy is the inevitable choice of China's urban construction and development in the new era, and the electric power industry, as the current fossil energy consumption industry, is facing huge pressure of transformation under the background of green development. Compared with traditional power, green power has the characteristics of high efficiency, good benefit and high safety, and belongs to a new development mode of resource saving, ecological environmental protection and advanced technology. Domestic research on the green development of electricity is relatively late, the existing research content is not perfect, and the goal and standard of low-carbon transformation development of power grid are not uniform, until 2005, it gradually developed into a complete research system. As the country attaches great importance to the green development of electric power, power generation enterprises, power grid enterprises and scientific research institutes, while actively responding to national policies, have begun to study the innovative management and innovative governance of low-carbon transformation of electric power from the perspective of long-term development. Therefore, on the basis of understanding the development status of low-carbon transformation of electric power, this paper mainly explores the effective countermeasures of enterprise innovation management and innovation governance under the low-carbon transformation of electric power grid according to the strategic goals of low-carbon energy and electric power proposed by the state and the requirements of social and economic transformation and development, and finally combines practical cases to clarify the practical significance of low-carbon transformation and development of electric power grid. [4.5.6]

2. Method

2.1 Transformation and development goals

Nowadays, while vigorously developing the power industry, China will adjust its power energy structure according to the existing policy needs and gradually reduce the amount of fossil energy burned. As of 2020, the proportion of non-fossil energy generation and installed capacity in China's electricity energy composition has increased significantly, according to the carbon peak and carbon neutral action plan proposed by the National Grid, it is expected that China's electricity carbon emissions can reach the peak in 2023, and the development goal of carbon neutrality can be reached in 2060. Since power grid enterprises play an important role in the transmission, distribution and low-carbon transformation of electric energy, under the development trend of low-carbon transformation of power grid, power grid enterprises must not only ensure that electric energy meets

the comprehensive needs of national economic construction and development, but also achieve the ultimate goal of carbon neutrality within the scope of their responsibilities.［7.8.9］

2.2 Transformation Measures

In order to better cope with the global greenhouse effect and the requirements of power energy transformation and development, the power system began to focus on the development of wind, light, water and other clean energy, but because new energy power has a certain instability and volatility, large-scale access to the grid system will have a certain impact on the operation and management of power grid enterprises. Therefore, in the context of the low-carbon transformation of the power grid, it is necessary to ensure the safety and reliability of clean energy and new electrical equipment, and scientifically deal with the development relationship between clean energy and fossil energy. According to the analysis of low-carbon transformation strategies of power grid enterprises as shown in Figure 1 below, the specific work is reflected in the following points:

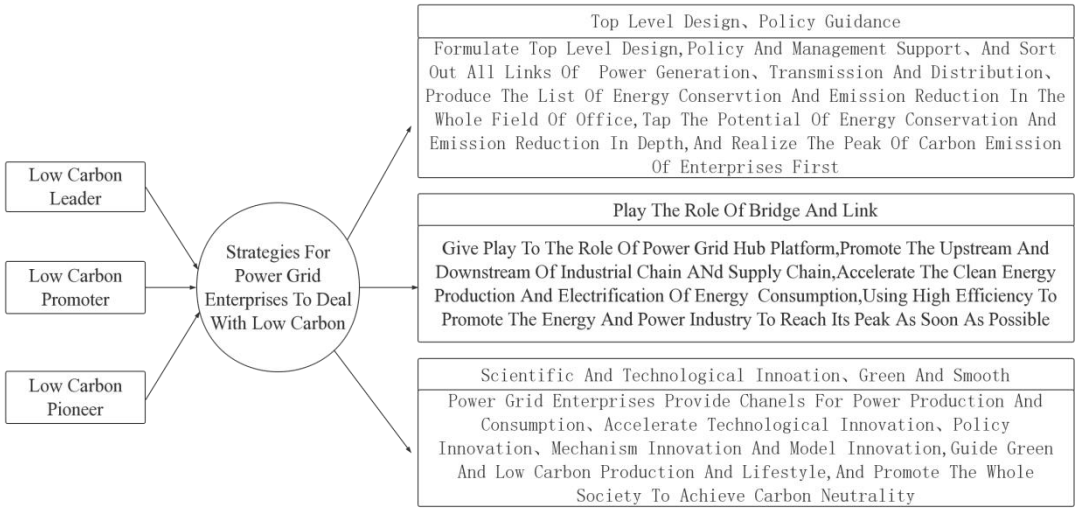

Figure 1 Strategy analysis of power grid enterprises in response to low-carbon transformation development

First of all, power grid enterprises should provide technical support for the access and application of clean energy, increase the proportion of new energy generation in dispatch, and gradually control the power generation output of traditional fossil energy; Secondly, improve the service level of the distribution network on the user side, truly meet the needs of new electrical equipment such as distributed power supplies, electric vehicles and mobile energy storage devices, and gradually replace traditional conventional energy consumption technology equipment, so that the power system always maintains the goal of low-carbon operation; Third, attach importance to the innovation and reform of science and technology, provide technical support for all aspects of low-carbon development of the power grid, truly achieve the development goals of accurate prediction and scientific control, and meet diversified electricity demand by adjusting the supply-side energy structure; Finally, the smart grid and smart distribution network system are gradually built to lay the foundation for the full implementation of electric energy replacement on the user side.

2.3 Implementation Suggestions

As the implementation basis of power production, power transportation and power consumption, power grid enterprises are the solid force leading the low-carbon operation of the power system. As low-carbon action of power system is a complex and challenging system project, it requires enterprise managers to propose scientific and standardized top-level design, create a smart grid platform of green economy, and always guarantee the access, production and consumption of clean energy, so as to create a low-carbon electric energy ecological chain consistent with the development of the new era according to the preferential policies proposed by national construction and development. The details are shown in Figure 2 below:［10.11.12］

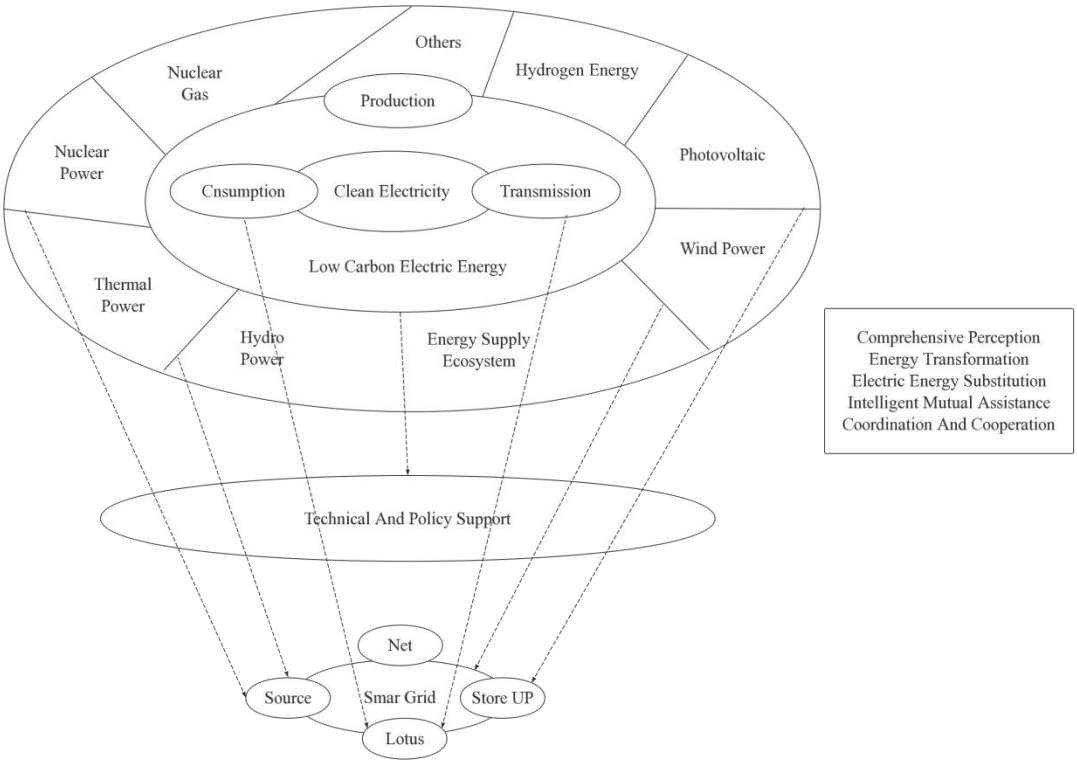

FIG. 2 Frame diagram of low-carbon operation of power grid enterprises

According to the above analysis, the low-carbon action implementation plan of power grid enterprises is mainly reflected in the following points: First, actively build a smart grid platform to ensure the two-way interconnection of source, network, load and storage. In this process, if power grid enterprises want to achieve the development goal of smart grid operation and provide technical support for the all-Russian consumption of clean energy, they need to use advanced technologies such as artificial intelligence and 5G communication to fully perceive the operation status of the power system, continuously improve the information transmission level within the system, and pay attention to laying the foundation for the realization of intelligent mutual assistance on the green power platform. Second, focus on providing technical support and preferential policies. Access to clean energy in the power grid system will inevitably have a great impact on the operation safety of the power grid system. Therefore, in the new era, power grid enterprises should integrate new technologies into the field of energy and power, ensure the coordinated development of various energy sources, and ultimately support the transformation and innovation of low-carbon energy. Thirdly, by demonstrating the regulatory role of the power market, we can promote social energy

conservation and emission reduction, introduce carbon emission costs during the production and consumption of electric energy, ensure the transition of power generation enterprises to low-carbon energy, and ultimately guide the whole society to achieve the transformation and development goals of energy conservation and emission reduction. Finally, establish a regulatory mechanism for electricity carbon emissions and implement low-carbon action plans in an orderly manner. Nowadays, China's power enterprises should scientifically design the power showdown supervision and regulation system in accordance with the national low-carbon emission reduction strategic goals to ensure that various energy sources can be used efficiently, thus forming green, low-carbon and environmentally friendly power consumption patterns and living habits.［13.14］

3. Result analysis

Taking the power grid industry planning scheme of a region as an example, the low-carbon power grid transformation development strategy proposed in this paper was applied for optimization and innovation. In a certain year, the local maximum load reached 102,500MW, the planned installed capacity was 120,400MW, and the line investment parameter information was shown in Table 1 below:

Table 1 Line information of power grid planning in a region

Line type	Transmission capacity /MW	Investment cost (ten thousand yuan /km)	Recovery period /a
220kv single circuit 2×LGJQ-400 wireway	262	196	25

The planned capacity, operating cost and carbon emission intensity of various units are shown in Table 2 below:

Table 2 Grid structure and parameter information

Unit type	Planned capacity /(MW-h)	Operating cost /(yuan /kW-h)	Carbon emission intensity /(t/MW-h)
nuclear power	2000	0.0840	0.000
Large coal-fired thermal power	30664	0.2856	0.746
Coal-fired small thermal power	21645	0.3171	0.905
thermoelectricity	520	0.3171	0.905
Gas (e grade)	2280	0.6584	0.462
Gas (class F)	3120	0.5933	0.431
hydropower	0	0.0000	0.000
Pumping storage	1100	0.1113	0.000
Wind power	6000	0.0000	0.000
Non-unified adjustment	8796	0.3171	0.905
110kvUnified dispatching unit	3621	0.3171	0.902
Off-site unit	7020	※	※
※-According to the actual type, it is determined by the values in the above table.			

By using the calculation software analysis, it is found that the power generation cost corresponding to the network loss is 0.3 yuan (kW.h), the carbon emission intensity of the whole system is 0.75t/ (MW.h), and the carbon price is 100 yuan /t. After considering the environmental benefits of wind power comprehensively, the cost is set to 0. The final statistical calculation results are shown in Table 3 below:

Table 3 Analysis of results of statistical indicators

index	definition	unit
New_Line	Number of new lines	strip
W_Curtail	Annual abandoned wind power	GW-h
B_Cost	Annual construction cost	hundred million yuan
G_Cost	Annual power generation cost	Yuan
B+G_Cost	build+Power generation cost	Yuan
B+G+C_Cost	build+generate electricity+Carbon emission cost	Yuan
C_Emission	Annual carbon emissions	Billion t

From the perspective of practical research, in the context of low-carbon power grid transformation and development, by integrating carbon emission cost into the optimization objective function and establishing the corresponding objective function, it can be found that there are great differences in system construction cost and carbon emission under different probe frames. From an economic point of view, although the cost of wind power generation is zero, in order to control the system operation cost, the system will absorb wind power through the construction of sufficient collection lines, which will inevitably increase the system construction cost. Therefore, the optimal planning result is a game between accepting wind power and reducing operation cost and increasing construction cost; From a low-carbon point of view, after the introduction of the magazine, the emission reduction benefits brought by the zero carbon emission intensity of wind power will improve the competition level of wind power. In the construction and development of modern society, creating a planning model and management model in line with the development of low-carbon power supply, comprehensively considering the low-carbon elements of every link of power grid operation, and truly realizing the sustainable development goals are the main issues in the power industry in the new era.［15］

Conclusion

In summary, in the context of rapid social and economic development, more than half of China's power system is fossil energy, of which the carbon dioxide emitted in the production of electric fire reaches more than 88%, so the low-carbon transformation of the power grid is imminent. Under the development trend of economic globalization, from the aspects of policy, technology, management and even supervision mechanism, it is very important to innovate management and innovation governance under the low-carbon transformation of power grid. Therefore, in the future, China's power industry should continue to explore the main goals and effective countermeasures of low-carbon power grid transformation and development, pay attention to continuous innovation from the perspective of sustainable development, only in this way can fully demonstrate the hub role of power grid enterprises, in order to provide technical support for achieving carbon neutrality.

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