Power System Planning and Thinking base on China's "Carbon peak and carbon neutrality" Policy

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Abstract. China's "dual-carbon" goal of "carbon peak and carbon neutrality" proposed in 2020 is a historical opportunity to promote the world's technological revolution. The key to constructing a new power system lies in the diversified development and integration of power supply entities, substantially increasing the proportion of non-fossil energy utilization, building a smart and strong power grid and playing the role of a resource dispatch platform, strengthening technological research and forming a positive cycle of industry, education, research and application. It's supposed to construct a carbon market system and mechanism for industry upgrading and elimination, while taking into account the issues of efficiency and fairness in the development process.

1. Introduction
Rising global average temperature and frequent extreme weather phenomena have now become non-traditional security challenges facing human development. In this regard, President Xi Jinping made a clear statement to the world on behalf of China: China will take the commitment of implementation of the peak carbon dioxide emissions by 2030, and strive to achieve the goal by 2060 [1]. The "green recovery" of the world economy has brought together a powerful force for sustainable development [2].

China's emission reduction was first proposed by the then President Hu Jintao in 2009 on behalf of China at the United Nations Climate Summit, which is to strive to reduce carbon dioxide emissions per unit of GDP by 40% to 45% compared with 2005 [3].

As of 2019, China's carbon dioxide emissions per unit of GDP have fallen by approximately 18.2% and 48.1% compared with 2015 and 2005, respectively, which has exceeded China's commitment to the international community to drop by 40% to 45% in 2020 [4].

2. The key development direction of the new power system
The key development direction of the new power system under the "dual-carbon" goal lies in the comprehensive utilization of diversified energy and the enhancement of power system regulation capabilities, optimizing and perfecting various network structures at all levels and focusing on building a resource dispatch platform, accelerating the research and promotion of new technologies to form Industry-education-research-application positive cycle.

2.1. Diversify energy supply and promote the transformation of renewable energy
Actively promote the transformation of coal power flexibility [5], give full play to the role of underpinning, make good use of the stock, and strictly control the increase. Coal power is still the most important flexible resource supply body of my country's power system. The cost of
transformation is relatively low, and it can release large-scale inventory adjustment capabilities. It is necessary to promote coal power to better play its role in emergency backup and regulation, to strictly control new coal power projects, and to actively promote technological transformation of existing generating units to improve utilization efficiency.

Vigorously develop pumped storage power stations. Pumped-storage power station is currently the most mature energy storage facility with good technical and economic efficiency, but the construction period is long. It is necessary to accelerate the construction of pumped storage power stations, and at the same time increase the planning and selection of sites and make arrangements in advance to prepare for the improvement of system regulation capabilities and the absorption of more renewable energy sources.

Actively develop the "renewable energy + regulated power supply" model [6]. Encourage existing and incremental renewable energy to be bundled with a certain scale of adjustable power sources such as coal power, hydropower, energy storage, etc., to stabilize the volatility of renewable energy output, and to improve the reliability and stability of power-side output.

Promote renewable energy to support the transformation of the grid [7]. It is necessary to adopt a series of measures such as technological transformation and configuration of energy storage to gradually enable the renewable energy to provide inertia, damping and other active support to the grid, with functions such as frequency modulation, peak regulation, voltage regulation, and black start, so that the renewable energy is close to the "conventional power source". Play a major role in assuming the role of system regulation and supporting the safe operation of the power grid.

2.2. Optimize the grid structure and build a resource dispatch platform

Build a strong smart grid and increase the delivery and consumption of clean power. Scientifically plan and arrange a batch of cross-regional DC transmission channels; timely optimize and upgrade the power grid in some areas to meet the demand for clean energy delivery[8]. Increase the proportion of clean energy in transmission channels. Strive to expand the scale of hydropower and renewable energy transmission power, promote the integrated development of DC transmission, solar and thermal storage, and increase the proportion of clean electricity in the transmission channel.

Support the development of distributed sources (DS) and microgrid. DS are important supplements to traditional power generation. Inspired by the "dual carbon" goal, DS will usher in a rapid growth stage. As a relatively independent system, microgrid can smooth the output fluctuation of DS through intelligent interaction of source network and load storage, which is conducive to the friendly access and local consumption. The construction of microgrid should closely integrate local resource characteristics and power supply and usage conditions, take into account technical indicators and investment benefits, and comprehensively consider the construction and operation methods to make it have stronger vitality and sustainable development capabilities.

Construct a new power system operation control system. Comprehensively improve the load dispatching capacity of the new power system. Build a two-way interactive support platform for source and load to help the system have stronger adjustment capabilities. Prosumers are very welcomed in the new power system. High digitization, automation and intelligence of power grid support the safe operation of large power grids, clean energy consumption, coordinated interaction between source, grid, load and power market operation.
Failure mechanism and the fault identification and processing ability will be important indicators judging new power system. Explore the mechanism of grid failure after high-proportion of renewable energy and high-proportion power electronic equipment is connected. Construct fast and high-reliability protection, and ensure the safe operation of the "double-high" power system. The new power system has fault defense system based on wide-area information and multi-time scale information coordination.

Power grid planning needs to consider the randomness brought about by renewable sources, transform from traditional deterministic planning to probabilistic planning. It is supposed to balance the relationship between safety and cost, and analyze and study the optimal power grid planning scheme. Vigorously promote power grid energy conservation and loss reduction.

3. Speed up key technology research and promotion of new technologies
By strengthening technological research in industry, education, research and application, accelerating the promotion of technology in source power, grid, load and storage, the two-wheel drive model promotes the "dual carbon" green revolution, showed in Figure 2.

On the power plant side, high-precision wind power and photovoltaic power prediction is an important technical means to improve the level of renewable energy consumption and utilization. Through the use of virtual synchronous machine technology, the renewable energy has external characteristics similar to that of the synchronous generator, providing frequency modulation and voltage support for the system, and gradually transforming the renewable energy into a controllable power source. Carbon Capture, Utilization and Storage Technology (CCUS) is vital for thermal power plants, achieving low-carbon or even zero-carbon emissions.

On the power grid side, the flexible DC transmission technology is suitable for large-scale centralized connection of renewable energy sources in weak systems at the transmitting end. The evacuation of power from the multi-drop DC network at the receiving end. Distributed phase modifiers are arranged in the vicinity of renewable energy access, which can effectively suppress the transient over-voltage level, improve the reactive voltage support ability, and avoid large-scale disconnection during the failure of renewable energy.

On the load side, the virtual power plant organically combines DS, controllable load and distributed storage, realizes the organic integration of various DS through information collection and coordinated control. It realizes the coordinated operation of multiple entities in a wide area of resources.
On the energy storage side, storage can be operated in conjunction with substations, renewable energy stations, new types of loads, etc., to improve the carrying capacity and regulation capabilities of the grid. It is necessary to actively explore the use of energy storage to promote the consumption of renewable energy, improve the operation state of the grid, reduce network losses and other application modes, improve the flexibility of energy storage operation. In the future, efforts should be made to focus on five aspects of cost, capacity, environmental protection, life, and safety. It’s also needed to accelerate the capture of high-performance materials, new electrolyte additives, battery recycling, and energy system integration and management.

4. The relationship between efficiency and fairness

"Efficiency" refers to the maximum output benefits of carbon emission (or carbon emission reduction) resource allocation. "Fairness" means that differences in development levels between different regions or groups must be taken into account. "dual carbon" has become a new kind of filtration mechanism, causing new "unfairness" in the allocation of carbon emission right and harming the development interests of backward regions (enterprises).

Take the construction of a carbon emission trading market, a necessary policy tool for achieving "dual carbon" as an example. In theory, carbon emission trading is a recognized "efficiency first" incentive policy tool, and high-efficiency subjects can obtain more emission allowances and resources through an effective carbon market, thereby improving the overall emission efficiency (that is, increasing the output level of unit carbon emissions). Then, in this "survival of the fittest" process, the problem of "fairness" will inevitably arise, which makes some low-efficiency emission subjects at an unfavorable competitive position in the market competition, and they are squeezed out of the market. Their interests are damaged, and ultimately their own development.

Therefore, in the process of "dual carbon", the essence of the dilemma of "efficiency first" and "fairness" is the balance and maintenance of the "right to development" among different emission subjects.

There are two key issues worth noting. One is that in the initial allocation, emission allowances must be allocated on a relatively fair basis. The second is in the secondary allocation, an allocation mechanism based on "efficiency" should be established. So that carbon emission rights can flow between regions, complementing the existing carbon emission rights trading market, and achieving joint performance of the positive effect of "dual carbon".
5. Conclusions
"Carbon Peak" and "Carbon Neutrality" are a broad and profound economic and social systemic change. To respond to the urgent requirements of this green industrial revolution, accelerate the construction of a new power system with renewable energy as the main body, promote clean power consumption, generate intelligence on the grid side, and stimulate source-load interaction on the load side. In the newly constructed carbon trading market, it is necessary to consider the history and future conditions of each participant in the market, and to put efficiency first and fairness as the most important principle to promote the overall development of electricity and achieve the goal of the green industrial revolution.

Acknowledgments
This article was inspired by the report by Pan Ersheng, Dean of the State Grid Economic and Technology Research Institute, thanking him for his contributions.

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