



Research on the Key Mechanism of Promoting the Construction of Southern Regional Power Market

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Abstract. In recent years, the construction of a unified power market in the southern region has been accelerating. In the context of the energy transition and dual-carbon goals, China has carried out relevant research work on the key mechanism of the unified power market in the southern region that meets the requirements of regional economic integration. Compared with the hot provincial market, the actual construction process of the regional market is slow and difficult. Therefore, based on China's actual national conditions, combined with relevant national policies, and borrowing from the experience of typical successful foreign power markets, this article analyzes and studies the southern regional power market from the aspects of market system, market mode, and transaction varieties, and puts forward relevant construction suggestions. Firstly, it analyzes the problems faced by the development of the power market in the southern region. Secondly, a set of trading varieties and market models suitable for the southern regional power market were designed. Finally, based on the proposed market model and the designed trading varieties, starting from the initial stage, the integration stage and the promotion stage, the corresponding path for the construction of the southern regional power market is proposed.

Keywords: carbon peak and carbon neutrality · market system · southern regional power market

1 Introduction

In recent years, the construction of a unified power market in the southern region has been accelerating. In order to adapt to the new situation and requirements of carbon peaking and carbon neutrality, it is necessary to carry out relevant research work on the key mechanism of the unified power market in the southern region that meets the requirements of regional economic integration as soon as possible. Therefore, this paper will focus on studying the key problems and systematic solutions faced by the construction of the unified power market in the southern region under the goal of carbon peak and carbon neutrality. Green and low-carbon development of energy is the key to achieving the

“double carbon” goal, and the power industry has the highest emissions in the energy industry, which is the main direction of carbon emission reduction in China in the future. All of the above put forward more in-depth requirements for the construction of the southern regional power market.

Document [1] considers and comprehensively describes the problems related to the construction of the southern regional power market, and points out that the current anti war of the unified market is still restricted by factors such as large differences in economic development levels between regions and limited market access. Document [2] studies the function design of the simulation operation system of the southern regional power market. Document [3] designs an independent settlement mode for the southern regional power market. Document [4] analyzes the experience of foreign regional power market construction, and document [5] studies the important aspects of market trading mechanisms such as trading varieties, trading cycle, measurement and settlement. However, there is still a lack of research on the trading mechanism compatible with the double carbon goal and the energy transformation policy. How to design new trading varieties and mechanisms to meet the new challenges under the new power system is still a big problem.

As mentioned above, the actual construction process of the regional market is slow and difficult. Therefore, it is urgent to analyze and study the southern regional power market from the aspects of market system, market model, trading varieties, etc., and put forward relevant construction suggestions, in accordance with China’s actual national conditions, in combination with relevant national policies, and drawing on the experience of foreign typical and successful power markets (including regional markets). By considering the needs of unified operation of multiple markets and rapid and flexible response, corresponding mechanisms to support and promote the unified development of market integration are designed. First of all, this paper analyzes the problems faced by the development of the southern regional power market. Secondly, it designs a set of trading varieties library and market model suitable for the southern regional power market. Finally, based on the proposed market model and the designed trading varieties, it proposes the corresponding construction path of the southern regional power market from the starting stage, the integration stage and the promotion stage.

2 The Development and Existing Problems of Power Market in Southern Region

2.1 The Development and Existing Problems of Power Market in Southern Region

During the “Thirteenth Five-Year Plan” period, based on the status quo of the province as an entity and the characteristics of the resource endowment in the southern region, the southern region has basically constructed a “two-tier market, coordinated operation” southern regional power market system, setting up a pilot reform model.

- (1) The market system continues to improve. A relatively complete system of medium and long-term market rules and systems has been established in the inter-regional

and inter-provincial markets in the southern region and the markets in the five provinces, with a total of 41 related systems. The rule system covers market access and exit, direct transactions on the power generation and consumption side, secondary transactions such as power generation rights transactions and mutual contractual guarantees, credit construction, settlement and information disclosure. It has formed transactions covering the entire cycle and the entire region. There are a total of 26 varieties, which can meet the transaction needs of various market entities at the annual, end of the month, temporary, and daily transactions.

- (2) The market operation mechanism is more mature. The inter-regional, inter-provincial, annual, monthly, and intra-monthly temporary full-period continuous trading mechanism operates smoothly. The market-oriented priority plan and the market incremental trading plan are closely linked, which fully meets the trading demands of market entities and guarantees the utilization rate of transmission channels.
- (3) Orderly advancement of power spot pilot projects. The Guangdong spot pilot project was the first to carry out a simulation trial run nationwide on August 31, 2018; a total of 3 rounds of spot settlement trial runs were organized throughout the year for a total of 13 days; a full monthly settlement trial run was launched in August 2020. Continue to improve the linkage mechanism between cross-regional and cross-provincial transactions in the southern region and the spot market, explore the continuous transaction working mechanism on a monthly, weekly, and multi-day cycle, and the idea of “dual settlement” for inter-provincial transactions.
- (4) The coordinated operation of trading institutions has become increasingly smooth. In the process of promoting the construction of the southern regional power market, the Guangzhou Power Exchange Center and the power trading agencies of various provinces and regions earnestly implemented the work requirements of the China Southern Power Grid Corporation “Notice on Printing and Distributing the Guiding Opinions on the Orderly Promotion of Power Market Transaction Business Work”, and continuously strengthened Business coordination and market connection have clarified that the Guangzhou Electric Power Exchange Center is the business contact and guidance relationship between the provincial and district trading centers, and has basically formed a unified management and collaborative operation work model.

2.2 The Key Issues Facing

- (1) The southern regional power market urgently needs to clarify the top-level market design. At present, there are various construction plans around the construction of a unified power market in the region and even the whole country, and they all have a certain degree of feasibility in terms of technical realization. However, from the practical experience of foreign countries, the choice of models for multinational/interstate unified markets such as Europe and the United States PJM are closely related to local political, historical, economic and social factors. The construction plan and clearing model of the southern regional power market must also be based on the actual situation of the southern regional power market, and analyze and demonstrate from the theoretical level. While maximizing the regional social

welfare, the balance of interests between regions should be properly balanced to ensure the market construction plan proceed steadily.

- (2) The inter-provincial transmission price mechanism of a single electricity system is not conducive to regional market integration. At present, the inter-provincial transmission price mechanism of a single power system has created more serious inter-provincial barriers, which has greatly weakened the market competitiveness of western power sources, and even caused the transmission price of provinces such as Guizhou to be inverted from the local market price. It is not conducive to the further development of inter-provincial transactions. After the market form in the southern region moves towards a regional unified market, the inter-provincial transmission price mechanism of a single electricity system will also distort the results of market clearing and cause social welfare losses. In addition, the inter-provincial transmission price mechanism of the single electricity system leads to a direct link between the recovery of inter-provincial transmission costs and the inter-provincial transmission power, which is also not conducive to the stable and reasonable recovery of the cost of special transmission projects by grid companies.
- (3) There is currently a lack of a price coordination mechanism that is compatible with the same-station bidding between different types of power supplies. The power generation costs of different types of power sources are highly differentiated, and the price coordination mechanism of bidding on the same power station is a key issue in the construction of the power market. At this stage, some provinces have adopted a certain price mechanism or market mechanism to solve this problem. For example, Guangdong has adopted a price difference model, allowing coal and gas power to bid on the same platform; Yunnan Fengqi only allows hydropower to enter the market and adopts thermal power The capacity compensation mechanism. After the regional unified market is completed, different types of units in different provinces will bid on the same trading platform, and a regional unified price coordination mechanism needs to be re-established to achieve effective competition and ensure relative fairness.

3 Research on the Coordinated Development Mechanism of Regional Complex Power Prices

3.1 The Basic Idea

In order to achieve the same-unit bidding of different provinces and different types of units in the regional power market, it is necessary to steadily promote the entry of relatively high-priced units into the market, but also to adapt to the large-scale grid connection of renewable energy. Some thermal power units will be used as backup power sources to ensure power generation capacity. The sufficiency situation requires that my country's capacity compensation mechanism is urgently improved to ensure the stable operation of the power system and the consumption of renewable energy, and effectively support the smooth realization of the dual-carbon goal.

3.2 Power Price Compensation Mechanism

In order to solve the problem of fixed cost recovery and sustainable operation of high-cost units in the environment of multi-category power supply bidding, typical foreign power markets solve the problem of unit capacity compensation through mechanisms such as scarcity pricing, capacity compensation, and capacity markets.

- (1) Electricity compensation mechanism. The mechanisms for compensating electricity include fixed electricity price subsidy mechanism, premium subsidy mechanism, scarce electricity price mechanism, etc. Among them, the fixed tariff subsidy mechanism is also called the “Fixed Feed-in Tariffs” (FITs) in foreign power cities such as the United Kingdom, which means a fixed subsidy for the power generation and on-grid power of renewable power sources that meet the requirements. Similar to the power generation subsidy mechanism policy represented by distributed photovoltaics currently adopted in my country. Premium subsidies (Feed-in premiums, FIPs) refer to the provision of certain price guarantees to these generators while encouraging power generation resources to participate in market competition, that is, to compensate on the basis of power market bidding to encourage renewable energy and other external sources. Sexual resources participate in market-oriented transactions. The scarcity pricing mechanism is a way to recover the cost of regulating resources and ensure the abundance of power generation resources by relying on a single electric energy market. It is widely used in the real-time market in the State of Texas (ERCOT) in the United States. The real-time reserve price increment is calculated according to the operational reserve demand curve, so as to provide certain economic incentives to the unit when the system reserve is low. The scarcity pricing mechanism makes it possible to increase the price of electric energy when the system’s electric energy and reserve are scarce, and to meet the needs of part of the cost of power recovery through short-term high prices. Some domestic provinces and pilot regions have also introduced some supporting mechanisms in response to practical problems such as low utilization hours of coal-fired units. As stipulated in the “Notice Concerning the Trial of Capacity Compensation Electricity Price for Coal-fired Units in the Spot Electricity Market” issued by the Shandong Provincial Development and Reform Commission, before the operation of the capacity market, coal-fired generating units participating in the electric spot market will test the capacity compensation price and the capacity compensation price standard. It is tentatively set at 0.0991 yuan per kilowatt hour, which is a typical fixed electricity price compensation mechanism for kilowatt-hours.
- (2) Capacity compensation mechanism The purpose of compensation for capacity is to encourage various types of power generation capacity investment, prevent excessive capacity decommissioning, etc., resulting in insufficient system capacity, lack of system adjustability, and insufficient low-carbon environmental protection. Capacity compensation mechanisms can include fixed capacity subsidies, capacity markets and other mechanisms. The capacity compensation mechanism is the capacity compensation price and compensable capacity set by the regulatory agency, and it is a power generation capacity cost recovery mechanism that is partial to administrative means. Generally, under the guidance of the government or regulatory

agencies, the unit capacity compensation standard and the compensable capacity of each unit are determined according to factors such as load forecasting, user power outage loss assessment, system reliability standards, and generator unit availability, so as to reasonably compensate the cost of generating capacity. The capacity market is a market mechanism that determines the price of capacity based on market competition, and is a new type of market outside the single electric energy market. The capacity market generally uses auctions, centralized competition, etc., to guide power investment through capacity price signals, and capacity fees are collected from the user side and paid to the winning power generation company.

- (3) Other market supporting mechanisms. The ancillary service market, green certificate market (Green Certificate, GCs) and other mechanisms can also compensate for the external benefits of power generation resources. The green certificate represents the environmental value of the electricity generated by a certain amount of renewable energy and other power generation resources. The essence of green certificate transactions is the process of confirming and realizing the environmental value of renewable energy through the electricity market. Currently, there are generally two types of transactions: “compulsory purchase” and “voluntary purchase”. Auxiliary service markets such as frequency modulation and reserve can also be one of the sources of compensation for externalities of generator sets. The ancillary service market enables power generation resources with good peak and frequency regulation performance such as gas and pumped storage to obtain income in addition to the income from spot electricity generation, and it also helps to promote the transformation of some generator sets from the main power generation to the provision of auxiliary services. Government-authorized CFDs can also achieve coordination between different types of generator sets participating in the market. For generators whose costs such as gas are relatively high and require safe operation of the system, but cannot recover the full cost in the market, the revenue can be increased by signing a government-authorized CFD that is higher than the market price; the cost of stock hydropower is relatively low, Units that are easy to obtain excess revenue in the market can return the excess revenue to users in the form of subsidies by introducing a government-authorized contract for difference mechanism.

4 Construction of an Electricity Spot Market Clearing Model Considering the Flexible Combination of Multiple Trading

According to the initial stage, the integration stage and the promotion stage, the construction of a unified power market in the southern region will be gradually promoted.

- (1) Initial stage In the initial stage of the regional market, the main focus is on the implementation of medium and long-term cross-provincial power market-oriented transaction requirements. Further improve the trans-provincial transaction mechanism, promote the formal operation of the Guangdong spot market, and promote the formal operation of the auxiliary service market in the southern region. In the initial stage, the inter-provincial and inter-regional government agreement electricity gradually transformed from “quantity guaranteed price” electricity to “quantity

guaranteed bidding” electricity. “Volume Guaranteed Bidding” adopts the mechanism of “base price + floating up and down”, and the landing price is based on the landing price of the “Volume Guaranteed Price” agreement and is comprehensively determined based on the range of market-oriented price changes in the sending and receiving end provinces. Organize market entities in the five provinces and regions to carry out annual and monthly transactions on the same platform that are not planned in cross-regional and cross-provincial agreements through listing or matchmaking. Market structure. When conditions are available, explore and carry out pilot projects for users and electricity sales companies to participate in cross-provincial transactions.

- (2) Integration stage in the stage of regional market integration, the primary key task is to promote the reform of the inter-provincial transmission price mechanism and pave the way for regional market construction. Promote the integration of the inter-provincial medium and long-term market and the provincial medium and long-term market. Expand the scope of the regional power spot market on the basis of the spot market in Guangdong Province, and establish a Yunnan-Guizhou-Guangdong spot market. Establish and improve the linkage mechanism between planning and market, medium and long-term and spot, regional and national. 1) Improve the mid- and long-term market in the southern region In the spot market environment, the medium and long-term market transactions in the southern region are mainly used to avoid spot risks, and the subject of the transaction is medium and long-term CFDs. The medium and long-term trading market no longer distinguishes the inter-provincial and intra-provincial markets. The users of the power receiving province can directly trade with the power transmission province power plants in the medium and long-term market. Medium- and long-term trading varieties with prices formed through negotiation, listing and delisting, or centralized bidding between the two parties. 2) Constructing the Yunnan-Guizhou-Guangdong spot market Expand the scope of the regional power spot market and build a unified spot market in Yunnan-Guizhou-Guangdong. The Yunnan-Guizhou-Guangdong spot market is based on the full power declaration and centralized optimization of the competition model. It organizes the market entities of the provinces (regions) within the market to carry out day-ahead and real-time spot electricity transactions that are cleared out uniformly, forming a day-ahead and real-time unit output plan, Inter-provincial power transmission plans and market prices. According to the degree of marketization, it will start from the mode of “quotation on the power generation side and non-quotation on the user side”, and gradually transition to the mode of “quotation on both the power generation side and the user side at the same time”.
- (3) Promotion stage Gradually expand the coverage of the regional market, and finally establish a regionally integrated southern region unified medium and long-term market and unified spot market. The regional mid- and long-term market is dominated by CFDs, and the spot market has established a centralized competitive trading mechanism for all electricity. Organized the market entities in the five provinces (regions) of Guangdong, Yunnan, Guangxi, Guizhou, and Hainan to simultaneously carry out the southern Regional day-ahead, real-time electricity trading and ancillary service trading, clearing out the unit output plan and inter-provincial tie-line plan, to achieve the optimal allocation of power resources in the southern region.

Establish and complete market supporting links such as regional capacity markets and financial markets to form a complete modern power market system.

5 Conclusion

This paper mainly studies the design of southern regional power market that takes into account multi-mode. Firstly, it studies and analyzes the successful experience of foreign typical power market. On this basis, combined with China's national conditions, national strategies, power grid business characteristics, and the problems faced by the development of the southern regional power market, a set of trading varieties library and market model suitable for the southern regional power market are designed. Finally, based on the proposed market model and the designed trading varieties, from the start-up stage, the integration stage and the promotion stage, the corresponding construction path of the southern regional power market is proposed to form the final southern regional power market system. It can be seen that building several trans provincial and open regional integrated power markets, then gradually expanding and integrating the market scope is an effective and feasible way to form a unified national power market.

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