Optimization Research on Production Organization Model of Power Grid Enterprises in the Context of New Electricity System

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Abstract. With the rapid development of renewable energy, the power system is undergoing a profound transformation. The traditional coal-dominated power generation structure is shifting towards a model characterized by strong uncertainty and weak controllability dominated by renewable energy sources. This transition has led to the diversification of renewable energy development modes, such as offshore wind power, large-scale wind and solar bases, and the scaling-up of distributed photovoltaics. Concurrently, the rapid application of new technologies and business models, such as load aggregators, virtual power plants, and microgrids in the distribution network, imposes higher demands on power grid enterprises to balance electricity supply and energy transition while ensuring the safe and stable operation of the grid. In light of these challenges, traditional production organization methods and business processes are becoming inadequate. Power grid enterprises must adjust their production organization models and management approaches, optimize business processes, and innovate the allocation of production factors, including technology, finance, talent, data, and information, to adapt to the profound changes in energy and electricity production structures. This study explores the new requirements for optimizing production organization models in power grid enterprises in the context of constructing a new electricity system, proposing ideas and directions for future optimization. The research indicates that power grid enterprises need to strengthen overall resource coordination, enhance internal organizational collaboration, build a platform-based organizational structure, and establish a collaborative and efficient operational system to improve the overall operational efficiency and responsiveness of the power grid.

Keywords: New electricity system; Power grid enterprises; Organizational model; Platformization

1 Introduction

In the context of rapid renewable energy development, the power system is undergoing significant changes. The power generation structure is shifting from coal-dominated, controllable continuous output to a model dominated by renewable energy sources

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characterized by strong uncertainty and weak controllability. The development modes for renewable energy are diversifying, with accelerated development of offshore wind power, large-scale wind and solar bases, and significant growth of distributed photovoltaics. New technologies and business models, such as load aggregators, virtual power plants, and microgrids, are rapidly being implemented in the distribution network.

Under the new circumstances, higher demands are placed on the power grid to balance electricity supply with energy transition, ensure safe and stable grid operation, enhance responsiveness and adjustment capabilities, and accelerate the digitization and intelligence of the grid. However, traditional production organization methods and business processes are increasingly unsuitable in the current context, necessitating adjustments in production organization models and management approaches by power grid enterprises. They must optimize business processes and promote innovative allocation of production factors, such as technology, finance, talent, data, and information, to adapt to the profound changes in energy and electricity production structures.

Therefore, this research delves into the new requirements for optimizing the production organization models of power grid enterprises in the context of constructing a new electricity system and proposes ideas and directions for future optimization.

2 Specific Impacts of New Electricity System Construction on Power Grid Business Organization Methods

2.1 Strengthening Overall Resource Coordination

To achieve large-scale and efficient allocation of energy and electricity resources, companies need to enhance overall coordination from the perspective of power grid production organization. This requires production organizations to be more integrated and open, with a strong capability to consolidate and utilize organizational resources. The development of energy and electricity in China faces dual challenges: ensuring sustained stable supply and accelerating the transition to clean and low-carbon energy. With the large-scale integration of distributed energy and renewable energy sources, as well as the significant influx of new energy utilization facilities, there is a need to optimize the allocation of energy and electricity resources nationwide[1]. On the functional front, it is necessary to further coordinate the effective connection between the main grid and the distribution network; in terms of market functions, coordination among multi-level markets is required, utilizing various market trading methods; in electricity resource allocation, effective operation of the main and distribution network scheduling systems must be ensured; and in workforce development, overall coordination of human resources across all business processes is essential.

2.2 Enhancing Internal Organizational Collaboration

The integrated development of source, network, load, and storage necessitates more lean and efficient operations across all professional links in power grid production. This demands that production organizations focus on internal collaboration among different specialties to enhance overall operational efficiency. The construction of a new electricity system profoundly impacts the entire chain of power production, transmission, and consumption, with the accuracy of grid planning further emphasized in high-renewable scenarios. Strengthening the connection between planning and scheduling is essential, ensuring comprehensive understanding of existing operational issues and proactively addressing potential challenges. The massive integration of equipment and diverse stakeholders in transactions raises the bar for the safe and stable operation of the grid and the orderly functioning of electricity markets[2]. From the perspective of electricity system operation, achieving instantaneous balance in electricity production, transmission, and use requires close collaboration and information sharing between grid scheduling and trading across organization, execution of results, and other aspects to ensure safe grid operation and improve resource allocation efficiency[3].

3 Platform-Based Organizational Structure of Power Grid Enterprises

3.1 Concept of Platform-Based Organizational Structure

This approach emphasizes a platform architecture, flexible organization, and end empowerment. Specifically, it forms a multi-center, distributed organizational model that highlights customer orientation, with operations driven quickly by the front end; emphasizes open collaboration and resource aggregation, integrating digital empowerment to achieve efficient decision-making, interaction between front, middle, and back offices, and self-driven organizational operations. The hierarchical construction of a platform-based organizational structure aims to achieve an overall framework of "headquarters overseeing, provincial levels solidifying, and city levels strengthening."

At the front office level, market entities play an agile role in efficiently serving the market. At the middle office level, platform operators connect the front and back offices for resource integration, providing support for general and specialized capabilities in front office business operations. At the back office level, resource construction entities serve the front and middle offices, fulfilling roles in shared services, governance, and empowerment.

3.2 Strengthening Top-Level Design Role of Headquarters

Leveraging the headquarters' back and middle offices, the top-level design role of headquarters is emphasized. The back office focuses on macro-level, strategic, and directional matters, overseeing development planning, policy research, rule-making, and

standard-setting across various fields. This includes functional departments such as human resources, finance, and compliance, as well as professional departments related to grid planning, construction, scheduling, operation, equipment, and safety.

The middle office of headquarters integrates the company's common business, technology, and resources, empowering front-end business operations. The technological middle office, supported by technology research institutions, undertakes strategic, forward-looking, and foundational research and system planning, providing underlying technical support for provincial and municipal middle offices. The data middle office, built around big data centers and industry units, extracts value from grid data to empower business functions.

3.3 Strengthening the Support Role of Provincial Grid Enterprises

At the provincial level, leveraging provincial back and middle offices and guided by headquarters' strategy, provincial companies formulate strategies for implementing the overarching plan. In alignment with the strategic guidance from headquarters, provincial companies must research operational strategies and pathways tailored to regional development characteristics and demands, strengthening resource integration and horizontal professional collaboration to empower the front and middle offices. Provincial functional back offices include human resources and financial departments. Provincial professional back offices consist of grid-related planning, construction, scheduling, operation, and equipment departments[4]. By integrating resources from headquarters' middle and back offices, provincial companies can offer personalized and precise business empowerment based on local grid development market demands and operational realities. Provincial research and development middle offices, established through provincial research institutions under the guidance of headquarters' technological middle office, will focus on technology solutions and integrated applications to meet the needs of the business front. Provincial business middle offices will leverage the advantages of provincial platform centralization to consolidate essential and common functions such as grid control and production management.

3.4 Strengthening Customer Service Capabilities of Grassroots Grid Organizations

At the grassroots level, the front end of grid production operations relies on district and county front and middle offices to enhance strategy execution, solidifying foundational work, market services, and team development. A robust back office primarily refers to integrated departments managing human resources, finance, safety, compliance, and party-building activities. By enhancing professional management capabilities, a clear and efficient functional management system can be established to provide effective support for district and city front and middle offices, ensuring effective implementation of provincial grid operational strategies and offering resource support for agile market responses.

The integrated support of a broad middle office primarily refers to the business functions related to planning, construction, operation, maintenance, and marketing services

at the district and county levels, forming a specialized business middle office. Management directives across various business lines will be implemented and allocated to the business front, ensuring strong overall coordination, vertical integration, and horizontal collaboration, enabling centralized production operations and collaborative management throughout the process.

Efficient service from a broad front office refers to entities such as county power supply companies, service centers, and teams. By leveraging local advantages, these entities can comprehensively promote electricity supply assurance, quality service, and integrated energy services, establishing a flexible business front characterized by proximity to customers, strong backend support, integration of management and operations, and intelligent execution.

4 Collaborative Operation Management System of Power Grid Enterprises

4.1 Establishing a Collaborative and Efficient Operation System

Drawing on matrix management concepts, a management system that emphasizes horizontal professional collaboration and vertical business integration is constructed, establishing an efficient and flexible operational mechanism to meet the demands for coordinated and efficient operations of power grid production organizations in the new electricity system.

Strengthening horizontal collaborative operations is essential. Collaborative planning and operations must address issues that have already emerged during operations comprehensively and proactively. The coordination between scheduling, operations, and market trading should be enhanced, with professional departments integrated according to business scenarios, customer types, and process links. Strengthening vertical integration involves coordinating the main and distribution grids, cross-regional projects, and regional grids in power planning. In operational management, a seamless connection between headquarters, provincial, and district/county operational controls must be established. In electricity trading, effective connections between intra-provincial and inter-provincial markets should be prioritized, promoting gradual coupling among markets at different levels to facilitate joint operations[5]. In electricity dispatching, integrated operations must be strengthened at the national and provincial levels, with enhanced coordination between provincial and district-level distribution.

4.2 Enhancing Management Coordination and Optimization of Distribution Networks

Improved vertical coordination and interaction are necessary to enhance market responsiveness. Based on unified planning and coordinated development, the specific responsibilities of professional regulatory functions at provincial, municipal, and county levels should be clarified. The interfaces of distribution network business management

responsibilities among headquarters, provincial, municipal, and county supply departments must be delineated. The duties of district-level scheduling, supply services, and load management centers regarding new elements should be clarified, along with investment interfaces involving grid core businesses, industrial units, and users with respect to new business models, enhancing planning coordination, professional collaboration, and management integration.

A differentiated management model for integrating distribution network professionals is essential to improve horizontal collaborative efficiency. Adapting to the large-scale development of distributed energy sources and the rapid emergence of new elements and models necessitates further clarification of responsibilities among horizontal development, infrastructure, equipment, marketing, scheduling, and material departments regarding distribution network management[6]. Exploring professional integration management, combining local grid development foundations and the degree of electricity marketization, encourages regions to devise localized, proactive, and prudent planning, construction, maintenance, scheduling, and marketing management models to enhance efficiency and meet development needs.

5 Conclusions

This paper concludes that power grid enterprises must adapt to the transformative changes in energy and electricity production structures to meet the new requirements posed by the rapid development of renewable energy. The study emphasizes the importance of overall resource coordination and internal organizational collaboration, proposing the construction of a platform-based organizational structure, which includes top-level design from headquarters, the support role of provincial grid enterprises, and strengthening grassroots customer service capabilities. Additionally, the study highlights the necessity of establishing a collaborative and efficient operation system to enable power grid enterprises to operate efficiently within the context of the new electricity system. Ultimately, power grid enterprises must implement these optimization measures to enhance responsiveness to market changes, improve resource allocation efficiency, ensure the safe and stable operation of the grid, and drive the innovative allocation of production factors such as technology, finance, talent, data, and information to adapt to profound transformations in energy and electricity production structures. These research findings are of significant theoretical and practical importance for guiding power grid enterprises in organizational optimization under the new circumstances.

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