Research on collaborative planning strategy of source network load and storage based on deep learning

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Abstract. In the construction and development of modern cities, creating a new power system with new energy as the main body combined with the dual-carbon strategic goal is the main topic of comprehensive exploration by government departments and power enterprises in the new era. Especially after entering the era of big data, how to meet the proportion of new energy that has risen significantly has brought new opportunities and challenges to the power system. At present, some scholars have carried out relevant research on renewable energy access to power system, and mainly put forward the collaborative planning strategy of source and network load and storage. On the basis of understanding the current situation of power grid system construction and development in the new era, this paper mainly explores the main direction of the future construction and development of the power industry according to the deep learning-centered collaborative planning strategy of source and network load and storage, in order to solve the problems existing in the current power system construction planning.

Keywords: artificial intelligence; Source network load storage; Collaborative planning; tactics.

1. Introduction

In the construction and development of modern society, the urban electricity supply is tight, and the traditional flexible adjustment ability of the power supply side and the optimization of the operation characteristics of the power grid side can no longer meet the operation needs of the system. The integrated energy system with the coordination and optimization of all aspects of the source and network load and storage has become the focus of attention of the power industry construction. The National Development and Reform Commission and the Energy Administration have clearly pointed out in the Guiding Opinions on Promoting the integration of Charge and storage and multi-energy Complementary Development of Power Source and network that the integration of charge and storage and multi-energy complementary development have important practical significance. Nowadays, there is an emerging technology in energy technology known as the source network load storage system, its biggest feature is the source network linkage and load storage collaboration, its purpose is to improve the application efficiency of power energy, improve the power energy structure, and truly achieve the sustainable development goals.

In the operation of this system, "source" refers to the aspect of energy supply, including natural gas, oil, coal and other traditional energy core energy; "Network" means an energy transmission network, which includes power system equipment and transmission lines; "Load" refers to the end users of energy, including public facilities, enterprises, urban residents, etc. "Storage" refers to the storage technology of energy, including energy storage technology and energy storage equipment. The core of the overall system operation is that in the case of sufficient energy supply, excess energy will be stored in the energy storage equipment, so as to achieve efficient use and flexible adjustment of energy, and further improve the reliability and stability of energy. (1—6)
Nowadays, the source grid charge storage system has a wide range of application scenarios, which can effectively combine energy storage equipment and renewable energy power generation equipment, comprehensively improve the proportion of renewable energy, reduce the dependence on traditional energy, and guide the power system to develop steadily in the direction of clean energy. With the rapid development of information and communication technologies such as cloud edge collaboration and 5G communication, the collaborative optimization of source network load and storage has generated new development momentum. Some scholars have found in their research that it is necessary and feasible to apply 5G technology in the power system with the collaborative optimization of source and network load and storage; Some scholars combined the technical concept of cloud edge coordination in their research, and proposed the scheduling optimization technology of cloud-group-terminal coordination for virtual power plant, which realized the optimal control of the new main body of virtual power plant. When studying the technical concepts of edge intelligence, poop collaboration, and cloud edge collaboration, six scholars applied them to the operation of the power system, focusing on exploring the application prospects of circular networks and various links, so as to accelerate the innovation pace of China's power system. From the perspective of overall development, at present, there is no clear plan for the system technical architecture and collaborative mechanism under the power system, especially in the context of the development of new power systems, the cooperation relationship between source-net-charge-storage needs to be further clarified. [7-9]

After understanding the current situation of power system construction and development in the new era and the content of source network charge and storage collaborative planning, this paper mainly explores the strategy and development direction of source network charge and storage collaborative planning with deep learning as the core from the perspective of development in the era of artificial intelligence.

2. Method

2.1 Collaborative Design

The use of 5G technology features to make the intelligent devices and system platforms in all aspects of the source network load and storage interconnect, and finally establish an organic whole with terminal perception, optimization analysis, deep learning and comprehensive intelligent decision-making, which can be oriented to multi-level analysis and decision-making, and truly meet the service needs in different scenarios. Based on the structural analysis of the source network load and storage collaborative planning and collaborative design shown in Figure 1 below, it can be seen that the logical structure is divided into the following levels: First, perception layer. This layer design is mainly used to collect information such as sensing device environment, regional characteristics, and system panorama. Second, the transport layer. This level is mainly to use the 5G extension of the terminal and the optical fiber support of the main network to achieve extensive access and high-speed interactive communication environment, meeting the goal of multi-level real-time mobilization and wide-area information interoperability at the cloud side. Third, the computing layer. This level will carry out data mining and feature extraction on multiple levels according to analysis needs and platform computing capabilities, and finally create a set with user device personality characteristics and regional characteristics as the core. Fourth, the decision-making level. This level is an important basis for collaborative optimization, which can
realize local optimization and global optimization according to different scheduling requirements on the basis of efficient information interaction and multi-layer feature sets. [10-12]

Figure 1. Structure diagram of collaborative design

2.2 Technical Architecture

In addition to the environment, the main influencing factors are the technical limitations of the traditional mode, such as the mismatch between the network load interaction rock and the operation demand of the power grid, the high terminal access cost, the overall control accuracy is not up to standard, and the difficulty of management decision-making. Based on the technical architecture analysis shown in Figure 2 below, it can be seen that the cloud platform includes source terminal element, network terminal cloud and charge terminal element, which can make use of wide-area demand response resource mobilization strategy on the basis of mastering power grid operation information. The regional power grid cooperation platform includes power grid disease control, substation disease control and load aggregation. On the one hand, it will optimize and adjust the regional power grid mode through unit joint optimization, and on the other hand, it will actively respond to the demand through local section constraints. The independent optimization of the user micro-network includes the unit, transmission and transformation equipment and load equipment, and truly realizes the distribution network reconstruction and load control.
2.3 Key Technologies

First, the service mechanism. In the process of system operation, it is necessary to ensure the diversity of technical means of auxiliary services, and the coordination and timing between various levels and isolation modes can be coordinated, only in this way can the foundation be laid for the operation of the power system. Generally speaking, the time period required for completion of different closed-loop control actions can be matched according to the actual control needs of power grid auxiliary services. At the same time, in order to meet the multiple control modes required by the same time sequence, the cooperation mechanism of multi-factor comprehensive decision-making can be fully considered, such as environmental protection, economy, operation constraints and power and electricity balance. Finally, the realization of multi-mode combination optimal scheduling is also one of the key aspects of the power system in the new era. Second, run the strategy. Compared with the scheduling control of source and network, the callability of the load side is still in the initial stage, and the demand responder in a broad sense includes specific forms such as auxiliary service, load control and price guidance. Due to the obvious differences in the degree of influence, participants and implementation difficulty of different forms, the new power system needs to understand many factors, such as operation subjects, power grids and users, when proposing the collaborative planning strategy of source and network load and storage, so as to ensure the effectiveness of the collaborative planning strategy of source and network load and storage. Based on the analysis of the operation architecture of the power grid system with the charge and storage of the source network as the core shown in Figure 3, it can be seen that it is mainly divided into four parts, including the central station, the main station, the sub-station and the
terminal control system, while the terminal control system is further divided into the energy storage power station control and the user side control, which have a very close relationship with each other.

FIG. 3 Operation architecture of power grid system based on load and storage of source network

Finally, data driven. The operation structure of the new power system is relatively complex, and the technical support requirements for periodic operation are high. Especially after the collaborative planning strategy of source and network load and storage is proposed, the data collection and access capabilities of each link are significantly improved, and the perception data dimension will be oriented to the storage requirements of massive, generalized and heterogeneous high-end data, while the traditional data mining and analysis technology has certain limitations. At present, there is no cooperative operation mode of each link. In the future, we should continue to use the research results in the field of computer science to optimize and innovate, so as to improve the intelligent level of system operation. [14-15]

3. Result analysis

Based on the analysis of the development relationship between the power system and the charge and storage integration of the source network as shown in Figure 4 below, it can be seen that the basic configuration of the current energy storage is reflected in the "source" side and the "network" side, and individual users invest in self-built energy storage on the "load" side, and the total scale is basically negligible. This kind of "storage", which is attached to the "source", or to the "network", or to the "load", can only serve others and cannot exist independently. From the perspective of overall development, the current power system is essentially a strengthened version of the "source network load" power system, "storage" does not grasp the right to speak, and the new power grid is a four-dimensional interactive relationship, so in the future, we should pay attention to improving the status of "storage", and eventually form a four-dimensional integration of "source network load and storage" interactive power system architecture for the whole society.
FIG. 4 Application direction of load storage in source network

From the perspective of the long-term development of the power industry, the purpose of the source and network load and storage collaborative planning strategy is to aggregate all the application resources that can be adjusted, and provide technical support for the safe and stable operation of the power grid in the optimization and matching. Nowadays, the security and stability of power grid is one of the key problems to be solved in the construction of new power systems. Especially in the face of dynamic fluctuations of the source load, whether it is large-scale cross-regional power balance or real-time scheduling in a short time, the system operation is faced with many challenges and opportunities. The collaborative planning strategy will break through the constraints between various elements, aggregate, coordinate and optimize the matching of power resources that can be regulated, fully demonstrate the interaction potential of source and load, and comprehensively promote the balanced development of wide-area power generation in the power grid. At the same time, ensuring the efficient operation of the power grid system is also the focus of attention of the power system operation in the new era. It is necessary to focus on thinking about the energy supply demand under the influence of extreme climate, internal and external environment and other factors, correctly handle the complex interaction relationship and the autonomous behavior of users, so as to protect the rights and interests of various main operators, and constantly improve the existing market mechanism and price policy. Give full play to the important role of the electricity market in the optimal allocation of energy resources.

Nowadays, when creating and promoting a new type of power system, it is necessary to integrate and use artificial intelligence technology to help the source, network, load and storage elements collaborate and interact, so as to promote the development of China's energy transformation and truly realize the national dual-carbon development goal. Combined with the online service mode of power system in the era of artificial intelligence as shown in FIG. 5 below, the analysis shows that as the core technology to achieve collaborative planning, artificial intelligence's biggest advantage is that it corresponds to source, network, load and storage elements one by one, improves the fitting and representation ability of uncertain optimization construction, and ensures that the system has multiple skills such as optimal scheduling calculation and risk identification and response. Truly serve the power industry and social residents, improve the safety and stability of system operation.
Figure 5 Development direction of power system based on artificial intelligence

Conclusion

To sum up, in the face of the rising demand for power energy development, the optimization and innovation combined with the theory of artificial intelligence technology and the continuous improvement of the development strategy of the source and network load and storage collaborative planning can not only meet the demand for electricity of social residents, but also improve the efficiency and quality of the operation of the new power system. Therefore, future scholars should continue to explore the deep learning as the core of the source network load storage collaborative planning strategy, focus on mastering the key technologies of the system architecture, and then from the perspective of long-term development, determine the collaborative planning strategy and implementation direction, in order to ensure the safety and stability of China's new power system.

Reference


