Introduction and prospect of integrated energy service platform in industrial parks

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Abstract. As a modern industrial division of labor and production area that adapts to market competition and industrial upgrading, the industrial park is a generation model for the country to actively plan and promote development. The integrated energy system of industrial parks is of great significance for improving energy efficiency, promoting large-scale development of renewable energy, improving the utilization of social infrastructure and energy supply, and achieving energy conservation and emission reduction targets. The combination of industrial parks and integrated energy service platform technologies can realize the coordinated operation and resource sharing of various energy systems, meet the individual needs of campus users, and provide diversified services for system maintainers, park managers, enterprises, and households. Based on the summary of the characteristics of the campus-type energy Internet, the paper studies the key technologies of its integrated energy service platform. The key technologies of information collection, source-charge prediction, multi-energy coordination scheduling and advanced application services of the company's latest integrated energy service platform are introduced, and suggestions for the development of integrated energy service platform in the park are put forward.

1. Introduction
Energy is the basic driving force for the development of the whole world economic growth, and the basis for human survival. The current energy security issues facing the world present new features and new changes that are significantly different from previous oil crises. It is not just a matter of energy supply security, but includes energy supply, energy demand, energy prices, energy transportation, energy use, etc. Comprehensive risks and threats, including security issues. [1] Improving energy efficiency, developing new energy sources, and strengthening the comprehensive utilization of renewable energy have become inevitable choices for solving the contradiction between energy demand growth and energy shortage in social and economic development projects. The integrated energy service under the energy Internet will promote the interconnection, intercommunication and mutual transfer of primary and secondary energy, realize the rational optimization and allocation of energy resources, promote the energy generation and consumption revolution, and promote the development of the real economy with good social and economic benefits. [2]

In recent years, the construction of industrial parks has become an important part of urban development, but there are also some problems in the construction of parks. [3] Due to the differences in the development of different energy systems, energy supply is often planned separately, designed separately, and operated independently. Lack of coordination has resulted in problems such as low energy utilization, weak overall security and self-healing capabilities of the energy supply system, resulting in difficulties in service management in the park and effective coordination between systems. The integrated energy service platform is a new energy system. [4] Through the deep integration of
Internet technology and energy technology, it provides effective support for the construction of smart parks. In order to enhance the core competitiveness of China's industrial parks, promote structural reforms in the energy sector, and develop based on the energy-based Internet thinking model and the development of new industrial parks, this paper mainly introduces the company's newly developed industrial park integrated energy service platform. [5]

With electricity as the core link of energy development, the energy strategy is mainly determined by various factors of production, the law of energy development and the unique characteristics of the power industry. [6] The energy supply of industrial parks will also be depended on electricity, and the realization of energy balance depends to some extent on the balance of power supply and demand. [7] Through the substitution of electric energy to realize the transformation of energy structure, the power generation is the focus of primary energy conversion and utilization. It can flexibly accept distributed power sources with multiple access points and other forms of energy, fully integrate distributed energy, integrate energy information widely, and promote primary energy. Clean and efficient development of resources and rational layout. [8] It introduces clean energy such as solar energy and wind energy, and replaces fossil energy by non-fossil energy through electricity, and adjusts with traditional municipal electric energy, gas, heat network and energy storage devices. [9] Its strategic transformation should include multiple aspects, namely, the transition from high-carbon energy structure to low-carbon type, extensive energy utilization to intensive and efficient, and energy service from one-way supply mode to intelligent interaction mode. [10]

In the rapid development stage of energy Internet and integrated energy services, our company has launched an integrated energy service platform for industrial parks in a timely manner and successfully put into operation in Wuxi Xingzhou Industrial Park. This paper focuses on the integrated energy service platform, combined with the actual project implementation, to show the latest development of the integrated energy service platform. Our company's latest industrial park integrated energy service platform has the following characteristics:

(1) Integrated design, system integration design, embody different connotations in different application scenarios, system realizes integrated architecture design of platform and application, establish integrated data center by using power grid panoramic view, and comply with relevant international standards Integrated design of the application. In the dispatch center, this integrated design is embodied in the integration of maintenance, data and models, and can realize the vertical integration of related applications.

(2) Standardization, each functional subsystem or functional module of the system is implemented in a modularized, standardized manner. The system platform follows the hardware equipment independence, grid model standardization, data communication standardization unified standards and norm construction, and facilitates the expansion of functions.

(3) Reliability, the platform provides a variety of system management services to support the application system to ensure its continuous, uninterrupted operation. In the case of no hardware failure and manual intervention on the duty equipment, automatic switching does not occur between the primary and backup applications. In the limit accident state of "single-machine single network", the data acquisition and processing functions ensure its integrity and correctness, and ensure that the basic functions of the system are not affected.

(4) Openness, the platform architecture has been fully considered in all aspects of design and function implementation to ensure system portability, scalability, interoperability and network connectivity, thus ensuring the openness of the system. The system is designed to comply with relevant international and industry standards and adhere to the principle of portability, which ensures that the system keeps up with the latest technology. Openness makes application integration in power system IT environments easier.

(5) Scalability, platform architecture design can ensure its continuous expansion and update, and constantly follow up the development of new technologies to meet the needs of users tomorrow. With standard features and tool sets, you can continuously upgrade and extend existing systems without affecting system uptime.
(6) Full support of C/S and B/S, the system not only realizes model and data integration and service, but also realizes integration and service of various application functions, and realizes sharing of various functions of the system. Implementation forms include C/S mode and B/S mode.

2. The overall structure of the park’s integrated energy service platform

The integrated energy service platform of the industrial park needs to comprehensively control the energy flow, load flow, business flow and information flow in the industrial park in accordance with the characteristics of the integrated energy service platform, maximize the development and utilization of renewable energy, and improve the comprehensive utilization efficiency of energy. Provide users with economical, safe, reliable, convenient and efficient energy services to achieve grid-friendly, user-friendly construction of the park's energy interconnection system. The integrated energy service platform can create an open software and hardware platform and comprehensively optimize the management of energy, power grid and load according to the needs of different levels of users, taking into account various factors such as energy supply end characteristics, load type, energy-using equipment and operational personnel quality. Provide diversified services for the main body of the grid and the users on the user side, leading the trend of the construction of integrated energy service platforms. The overall architecture of the system is shown in Figure 1. The overall architecture of the integrated energy service platform includes: information collection and control terminal subsystem, communication and storage system, function and application software system.

The information collection and control terminal subsystem is mainly responsible for the data collection and processing of the grid, natural gas network, thermal network, power station, energy storage station and load information of each enterprise in the industrial park, and is uploaded to the central data collection server through the communication network. The intelligent user terminal can access various energy-consuming equipment, smart meters and sensor data in target buildings such as...
residents, businesses, and industries, and interact with the integrated energy service platform in real time. At the same time, the device can also switch and control the energy-consuming equipment in the target building.

The data collected by the underlying device is uploaded to the local subsystem server through fiber, wireless, etc., and the data is pre-processed, and the subsystem data can be viewed through the subsystem. The integrated energy service platform control center communicates with each subsystem through the communication network and collects all data to the control center server. Realize system status real-time monitoring, energy and load forecasting, energy-optimized scheduling, demand-side management, and advanced energy efficiency analysis.

The capabilities of the integrated energy services platform include device information collection and intelligent information processing, intelligent applications, advanced services, and intelligent decision making and control. Equipment information collection is effective measurement of power supply system, heating network, gas system, power generation, energy storage, users and other information and uploads to the data processing center through fiber or wireless communication channels for pre-processing and further analysis. Firstly, based on the measured data and historical data, the multi-time scale prediction of photovoltaic power generation, electric/heat/gas load is carried out, and the energy demand-scheduled model is established based on the integrated demand side response technology to carry out high-efficiency energy distribution. As one of the key means of market competition, service is the lifeline that determines whether the park can operate for a long time. Therefore, it is necessary to define the effective service content of the integrated energy service platform, including the core contents of energy efficiency, energy saving income and auxiliary income.

3. Key technologies of the park’s integrated energy service platform

3.1. Platform software architecture

A large number of distributed new energy photovoltaic, wind power and controllable load access requirements must be highly scalable. Different from the wide-area communication demand of the global energy Internet, the main characteristics of the communication of the integrated energy service platform of the industrial park are characterized by short communication distance, many interfaces and frequent interaction. Therefore, targeted solutions such as Ethernet, GPRS, LTE, Wifi, Zigbee and 4G/5G are more advantageous than fiber-optic communications suitable for long-distance information transmission.

The software architecture of the integrated energy service platform is shown in Figure 2. In the software architecture of the integrated energy service platform, there are five layers, which are bottom-up:

1) Hardware platform layer: It can be various hardware platforms popular today, such as a computer that can be a RISC architecture or a computer with a CISC architecture; it can be a 32-bit machine or a 64-bit machine.

2) Operating system platform layer: The operating system can use a variety of popular operating systems, such as several mainstream UNIX, LINUX and Microsoft Windows.

3) Universal middleware layer: It enables the system to run on a variety of operating systems and hardware platforms, and has good portability. At the same time, it has scalability, heterogeneous systems, interoperability and so on.

4) Unified support platform layer: Provide a powerful and universal service, provide unified data management, high-performance real-time data access, coordinated human-computer interaction interface, network messaging, inter-process communication, system management, alarm and Events, data forwarding and other services. The various applications of the system are built on a unified data platform, an Internet/Intranet-based communication management subsystem, a fully graphical WEB-based user interface subsystem, a system management subsystem, and an alarm subsystem.

5) Application layer: On the unified support platform layer, realize the operation monitoring of power supply system, heating network, gas system, power generation system, energy storage system, user energy use; energy operation management; energy efficiency analysis management; optimization analysis and scheduling A series of software for training simulation with dispatchers. Each application
of the system adopts a modular design, and the user selects the required module to build the operating system according to the needs.

| Monitoring control | power generation control | Automatic voltage control | Power generation plan | Power generation optimization | Transmission network analysis | Distribution network analysis | Training simulation |
|--------------------|--------------------------|---------------------------|----------------------|-------------------------------|-------------------------------|-------------------------------|---------------------|
| Graphic integration | database management | Visual human interface | System resource management | Safety management | Model data management | Cluster Calculation |
| Model service | Graphics service | Task management | event | Email | Log | Workflow |

**SOA unified application data model service**

**Figure 2.** System software architecture

3.2. Data acquisition and monitoring SCADA

SCADA (Supervisory Control and Data Acquisition) is the basic application of the integrated energy service platform of the industrial park. It consists of front-end data acquisition devices and I/O nodes, SCADA nodes, network communication nodes, and historical nodes. SCADA functions include: data acquisition and processing, accident recall (PDR), alarm processing, and event sequence recording (SOE).

The system's data collection function supports information packet collection, wireless network mode information collection, and automatic data channel port-based duty function to achieve data collection for plant stations and soft handover to the active and standby channels. The pre-data collection server makes full use of the data network resources to reduce the dedicated line communication, and the network is the main one. The network and the dedicated line coexist and are mutually active, and comprehensively consider the lightning protection measures of the communication system. The system shall be capable of acquiring and processing the following types of data: analog, electrical, state (including dual position), time sequential recording, protection device setting parameters and action signals, RTU reset signals. In order to ensure the reliability of information transmission, an error check code is used. The system can collect information of various RTUs and subsystems, receive forwarding data of monitoring systems such as EMS and centralized control stations of power supply companies, and data transmitted by GPS clocks, frequencies, UPS power supplies and other computer systems, and manually set data. The system can receive RTUs with different transmission protocols and different communication methods (synchronous, asynchronous, etc.), and there should be a specification library, such as the ministerial CDT protocol (new/old protocol and variant version), DNP3.0, IEC 60870-5-101, IEC 60870-5-103, IEC 60870-5-104, TASE2, 1801, S5, DISA, POLLING, MODBUS and other common domestic regulations can explain various specifications in more detail. The system not only supports basic serial port standards such as RS232, but also fully supports various serial port protocols; the supported protocols are: TCP/IP, PPP, SLIP, etc., to ensure the advancement of communication component technology.

3.3. Multi-optimal scheduling

Multi-energy optimization scheduling is responsible for comprehensive optimization and scheduling of multiple energy sources in the integrated energy service platform, which is an important means to achieve “multi-energy complementarity”. Fully analysis the utilization characteristics of various energy sources and evaluate the energy utilization efficiency under specific utilization forms. With the
energy supply and load forecasting information and equipment operating status as input data, construct the corresponding objective function according to the user's needs or the system optimization purpose of integrated energy. Select the appropriate optimization algorithm to solve the problem, generate multi-energy optimization operation strategy, and realize the multi-energy complementation of energy supply, energy storage and load in the network. According to the network topology and specific needs, the scheduling decision variables include: photovoltaic power generation, natural gas network gas supply; battery charge and discharge time and power; exchange with external electricity, gas, water and other energy; controllable load. The amount of energy used, etc.

Different from traditional power system scheduling, the scheduling of integrated energy involves the interests of multiple entities and the mutual transformation of multiple energy sources. How to get the maximum comprehensive benefits is a problem that needs attention. At the same time, the energy Internet is the product of smart grid and energy structure reforms, and its operations must fully consider energy, environmental and social benefits. Therefore, the optimal scheduling of the integrated energy service platform must be a multi-objective optimization problem involving complex constraints.

3.4. Operational analysis application service

(1) Comprehensive decision analysis of electricity reliability. For the large-scale industrial enterprises accessing the integrated energy service platform (the highest voltage level is 110kV and above), the comprehensive decision analysis of power reliability can be analyzed by the following analysis methods, including power loss load statistics, power risk online analysis, and dispatch operation assistance. Decision-making, orderly electricity management, emergency plans and accident decision support. It can analyze the statistical loss caused by power outages, power outages and expected power outages, and provide a visual data display method. The power risk online analysis function module performs relevant analysis and judgment through network topology and real-time data, and comprehensively identifies, judges, analyzes, and classifies according to the characteristics of some common risks and custom risks, as well as risk triggering conditions and requirements. Present possible risks and provide accurate and comprehensive tips. This function can provide necessary reminders and auxiliary basis for scheduling related personnel to operate, troubleshoot, etc. Online risk analysis includes: important user monitoring, special operation mode monitoring, heavy equipment monitoring, accident risk analysis, and maintenance risk analysis.

(2) Power quality analysis and optimization. Power quality analysis and optimization functions should include voltage tolerance, voltage allowable fluctuations and flicker, three-phase voltage allowable imbalance, grid harmonics, etc., by comparing harmonics, voltage analysis and industry standard limits. This reveals existing and potential power quality issues, as well as safety issues associated with harmonics. Support standard value management such as harmonic voltage, harmonic current, harmonic content, harmonic content rate, harmonic order, total harmonic distortion rate, etc., can maintain and manage standard limits, including new indicators and their limits. Add, delete, modify, view, etc. Support statistical queries for transient events, and query results can be used for transient event curve analysis and event statistics. Support standard deviation management such as voltage deviation, three-phase voltage unbalance, voltage fluctuation, voltage pass rate, over-voltage, etc., can maintain and manage standard limits, including adding, deleting, modifying, and viewing indicators and their limits. Wait.

(3) Analysis of energy efficiency evaluation. The electricity consumption KPI index should be based on the economic and security perspectives for the enterprise electricity consumption, and the KPI indicators should be used to find out the problems existing in the enterprise electricity, and provide data support for the enterprise to optimize energy. In combination with the company's electricity bills, the economic indicators have been developed with indicators such as power factor assessment indicators, demand assessment indicators, and peak-to-valley electricity costs. From the aspect of affecting the daily safety production of enterprises, the three-phase unbalance rate assessment indicators are mainly formulated. The user's energy consumption ranking in the district provides a list of users' electricity consumption and rankings in the district, which is convenient for understanding the electricity consumption of the whole district, real-time information of the major customers, and providing effective data support for the later grading services, providing large customers with
Personalized quality service to improve the satisfaction of large customers. The user energy consumption ranking in the district provides a list of users' electricity consumption and rankings in the district. It is easy to understand the distribution analysis of the industry's electricity consumption in the whole district. The enterprises are classified according to their industry categories, and the total electricity consumption of each industry is counted. Analysis the electricity structure in the district from an industry perspective. Through the industry's output value power consumption, it can assess the power consumption of output value of various industries, and provide horizontal benchmarking for various industries, providing vertical benchmarking functions for enterprises and industries. Monthly, the enterprise users will be provided with a monthly electricity analysis report to calculate the power consumption of the company last month and provide data evaluation basis from the perspectives of economy and safety. The analysis report describes in detail the daily electricity tariff for the previous month, the total electricity tariff for the month, the distribution of electricity consumption, the distribution of electricity tariffs, the economic and safe operation status of each transmission line of the enterprise, the economic operation status of the internal transformer of the enterprise, and the economic operation status of the whole company. In addition, the analysis report provides a preliminary diagnosis recommendation for the company based on historical experience.

3.5. Integrated services
Value-added services are an important manifestation of creating value for users. They are big data, cloud computing, and mobile Internet. They are important tools for energy demand side users on the basis of data panoramic display and application services. Services, user energy conservation and customized services, big data information value-added services, energy optimization management services, etc.

The comprehensive energy service platform of the industrial park should make full use of the power system reform and improve the business model of energy management, and continuously improve its competitiveness in a fully competitive energy market. On the one hand, it is necessary to meet the basic diversified energy needs of users; on the other hand, it is necessary to guide users to change their inherent consumption habits, provide innovative energy services and interactions, and provide professional services, management and operation and maintenance platforms based on online services. Information, streamlined, intelligent, and closed-loop interactive service models provide customers with comprehensive energy services throughout their life cycle.

4. Conclusion
The integrated energy service platform of the industrial park realizes multi-energy complementarity through the application of advanced new energy power generation management technology and multi-energy flexible conversion network such as electric-gas-heat/cold, and coordinates and optimizes the source network-charge by using advanced energy-efficiency analysis technology and communication network. - Energy flow and information flow between the stores. The industrial park-level energy service platform can provide support and auxiliary services to the grid, and can guide users to actively participate in energy regulation. Establishing an industrial park-type integrated energy service platform to realize the joint optimization of the public energy network-park energy network-user cluster/individual multi-level level is of great significance to promote the absorption of new energy and the efficient and safe operation of the network.

This paper analysis the characteristics of the integrated energy grid and the generalized energy Internet under the premise of clearly defining the scope of the integrated energy service platform of the industrial park. It points out the basic structure and key technical content of its energy efficiency management, which is existing and under construction. The demonstration project energy management model provides an effective reference and a clear construction direction. Our company's later research will focus on the realization of multi-functional platform construction and business model innovation, as well as energy conversion efficiency, energy router optimization and so on. We will continue to develop regional, building, hospital, school, industrial and mining enterprise sub-platforms based on customer needs, and enhance customer energy self-management capabilities. At the same time, it will continue to innovate the platform service model, segment the target customer groups, provide industry
analysis for the industry, assist in the formulation of energy and industry policies, provide market potential analysis for energy service providers, and promote project cooperation; for equipment manufacturing enterprises and research units. Provide equipment energy efficiency analysis and promote technological innovation.

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