Research and Practice on the Integrated System of Power Management and Control

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Abstract. This paper describes the power management and control system from the business architecture, technical architecture, application architecture, system integration four parts, and studies each component respectively. Through the current advanced information technology and Internet technology, the platform, covering “acquisition, simulation, early-warn, analysis, and response”, is constructed to effectively improve the level of data management and utilization, which can further improve the intelligent and lean power management and control in cigarette industrial enterprises.

1. Introduction
Power energy is an important part of cigarette industrial enterprises. Most cigarette factories have built a relatively complete power energy data acquisition and centralized control system [1], and also established the power energy management system in the process of technical transformation [2]. Through the system, the effective control of energy equipment can be realized, and a relatively perfect energy data acquisition and analysis system has been formed. Energy management has become an important part of the digitalized factories [3], many factories have also explored and analysed the intelligent energy system [4], and constructed the energy balance scheduling model and application of cigarette enterprises [5]. However, the construction of integrated system on power management and control is lack of systematic elaboration. Through the research and practice of this platform, this paper analyses the four parts which contains business architecture, technical architecture, application architecture and system integration.

2. Business Architecture
The integrated system of power management and control in cigarette industrial enterprises, mainly includes data exchange, four functional modules, unified command platform and mobile application platform. Among them, the data exchange completes the comprehensive pre-processing of the data, carries out unified management of the pre-processed data, and carries out unified authority control by the platform. Starting from the four aspects of energy operation, equipment operation strategy, decision support, and modeling simulation. Finally, a business architecture contains four core modules and two platforms is formed, as shown in figure 1.
The energy operation module mainly deals with the whole process of energy supply and equipment inspection, emergency treatment, daily operation and approval of overtime energy supply. The dynamic model of "early warning, analysis and response" involved in the whole process of energy supply is provided by modeling simulation module.

The equipment operation strategy module realizes the optimal parameter configuration, fault diagnosis, data quick check and dynamic state tracking. The parameter configuration before the equipment is turned on and the dynamic parameter correction during operation is output by modeling simulation module.

The decision support module mainly provides support for strategy formulation, correlation analysis and performance evaluation, and modifies the simulation model according to the actual energy supply situation, and adds the diagnosis results into the knowledge base to enrich the experience for emergency response and equipment intelligent troubleshooting.

The modeling simulation module establishes simulation models related to equipment, energy and process integration around "beforehand, during and after" respectively, and continuously obtains simulation modeling evaluation results from energy decision support module, so as to continuously optimize simulation model.

Unified command platform realizes intelligent management and control integrated job monitoring and scheduling, mobile application platform realizes remote sensing monitoring of energy supply. The relationship between the functional modules is shown as figure 2:
The modeling simulation module is the basis of this system. Its main purpose is to provide support for the other three modules through the establishment of mathematical model and simulation. The data transmission among four modules is as follows:

1) The simulation of energy consumption and energy flow is transferred to energy operation management module;
2) The device startup initialization strategy is transmitted to the device strategy and operation module;
3) The real-time status is transmitted back to simulation module as the initialization tracking standard in energy supply. With the equipment running and energy supply continuously, the modeling simulation module constantly adjusts the model output;
4) In the decision analysis module, the energy (equipment) warning information is pushed to the corresponding module to analyze the abnormal problems in the simulation;
5) Simulation module uses the analysis results provided by energy decision analysis center to establish new models and optimize existing models.

3. Technical Architecture
Data persistence layer provides a data storage solution suitable for business applications by integrating the current mature framework of big data and stream computing.
The service layer is the coordinator in the microservice architecture. It completes the sharing and interaction of various resources and services, which is the guarantee of the safe, smooth and efficient operation of the system.
The application layer is composed of business middle platform and data middle platform. The business middle platform runs the control and whole process monitoring of business process, and the data middle platform integrates data collection, cleaning and processing services to complete the real-time processing of various monitoring data and analysis data.
The role of the perception layer is to show data information, business processes and other clear and intuitive to users through a series of front-end technologies, so as to give users a good human-computer interaction experience, as shown in figure 3.
4. Application Architecture

The application architecture of the system can be divided into data source, data processing layer, data storage layer, analysis and modeling layer, data service layer and application presentation layer, as shown in Figure 4.

**Figure 3.** Technical architecture.

**Figure 4.** Application architecture.

Data source: the data sources of power management and control integration system come from many aspects, such as MES system, energy management system, etc., and external data such as weather service,
data acquisition information obtained from OPC server and sampling information extracted from real-time database.

Data processing layer: according to different processing methods, some data, such as weather information and work order status information, are directly saved to relational database, while the data to be processed, especially the data for flow calculation, are sent to Kafka. After data processing, some data such as alarm data are stored in Oracle, which requires a large amount of modeling. The data is stored in Hadoop, and the data used for historical monitoring information query is saved to InfluxDB, and the data for real-time monitoring is still sent to Kafka.

Data storage layer: data storage layer, mainly including relational database Oracle, big data storage Hadoop, temporal database InfluxDB, and memory database Redis. Oracle database mainly stores system related basic information, configuration information, model parameters, etc.; Hadoop is used to store a large number of processed data for analysis and modeling, and InfluxDB is used for historical query data; Redis is used to cache data that needs to be read and written repeatedly, such as pre alarm rules.

Analysis and modeling layer: it provides model support for energy consumption, energy flow operation trend and power equipment operation strategy, continuously optimizes the model according to the simulation effect, and stores the modeling and optimized parameters in Oracle.

Data service layer: it mainly provides data for microservices, which are deployed in this layer. Microservices obtain relevant data from the data storage layer and provide data services for applications. In addition, through the data service layer and related microservices, the optimization rules of the equipment can be transferred to the device control layer to reserve the interface for the subsequent guidance of equipment operation.

Application presentation layer: the application layer provides display services for front-end PC, mobile terminal, etc.

Energy control layer: after continuous optimization and improvement, the model can control the operation of the equipment by sending instructions to the equipment control layer on the premise that the prediction accuracy is relatively accurate.

5. System Integration

The integrated system of power management and control can integrate energy related systems, such as control system, MES, equipment management system, and energy management system etc, in order to realize the whole process management of "acquisition, simulation, early-warn, analysis, and response". At the same time, the integrated system can transmit the energy management related information to the data center by using a unified data format to provide support for the data center.

Through the relative interface development, it can realize the synchronization of production plan, work order information, process related information, product and other basic data information of MES system, it can also realize the integration of OPC data, cigarette factory real-time database data, energy management system data and external meteorological information, so as to provide comprehensive and complete data for unified monitoring, prediction, early warning and optimization of the platform, as shown in figure 5.
6. **Summarize**

Through the construction of this system, Ningbo cigarette factory has realized the whole process management of power energy, and has constructed a relatively perfect Integrated System of Power Management and Control, which has made a beneficial exploration for the practice of energy management and control in cigarette industrial enterprises.

**References**

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