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Energy Management Business in the Context of Big Data

Jin Zhao*

Lyceum of the Philippines University, Philippines

zhaojin20072010@126.com

**corresponding author*

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Abstract: The average temperature of the earth's surface has become higher and higher over the years, and carbon emissions are an important driving force. Many countries around the world, especially the western developed countries, pay more and more attention to this. After China's entry into industrialization, energy consumption such as coal and electricity has increased year by year, and carbon emissions have also increased. In terms of carbon emissions, China is facing a very severe international situation. With the rapid development of information technology, people realize that the informatization of energy management is an important way to reduce carbon emissions. Building carbon emissions account for a large proportion of China's total carbon emissions. As a traditional high energy consuming enterprise, the steel industry has a large amount of carbon emissions, coupled with fierce market competition. Therefore, energy conservation and emission reduction, and the construction of energy management system are very important topics for steel enterprises. Based on the actual production data of steel enterprises, the energy management system unifies the energy-saving performance measurement methods. Through the joint efforts of all departments, the closed-loop management of energy can be achieved, which has a very significant effect on the energy conservation and consumption reduction of steel enterprises and the improvement of energy management level. By studying the energy consumption composition and main energy consumption indicators of steel enterprises, this paper establishes an energy management system suitable for steel enterprises based on big data(BD), Internet of things and cloud computing technology. Finally, the huge benefits obtained after the implementation of the energy management system are analyzed, combined with the current development of BD analysis technology and intelligent optimization control technology and the possible future development direction of the energy management system.

1. Introduction

In terms of total emissions, China is currently the largest country in the world in terms of carbon

emissions, accounting for more than 25% of the world. To achieve the goal of carbon neutrality, China's total emission reduction is much higher than that of other countries. In 2017, China's building energy consumption was about 900 million tons of standard coal, accounting for more than 20% of the national energy consumption; The construction carbon emission is more than 2 billion tons, accounting for about 20% of the national energy carbon emission. The so-called building energy consumption refers to the energy consumed to ensure the normal use of buildings, including the consumption of heating, cooling, electrical appliances, lighting, elevator pumps and other power equipment [1].

As one of the traditional high energy consuming industries in China, the steel industry is also an important sub industry of carbon emissions in the building materials industry. Its total carbon emissions are second only to the steel and electrolytic aluminum industries. In the face of the current severe international situation of energy conservation and emission reduction, and in order to successfully complete the goals set on carbon emissions, government departments at all levels attach great importance to the energy conservation and emission reduction work of steel enterprises. The key to energy conservation and emission reduction is to save energy, improve energy efficiency, and strengthen energy management, especially for high-energy consumption industries [2]. Most steel production lines still use the traditional management system, with low energy efficiency and widespread energy waste [3]. In order to speed up the pace of promoting made in China 2025 and the integration of industrialization and industrialization, further strengthen the energy-saving technological transformation of steel enterprises, and improve the intensive and refined management of energy consumption of steel enterprises, the Ministry of industry and information technology of the people's Republic of China issued (Ministry of industry and information technology [2010] No. 582) and (Department of industry and information technology [2016] No. 586) documents in 2010 and 2016, respectively, on the guidance on the construction of green manufacturing system and energy conservation and emission reduction in steel enterprises, As the guiding outline for the implementation of energy management and lean manufacturing projects in steel enterprises, vigorously promote the construction of energy management centers in steel enterprises [4].

With the increasing competitive pressure among steel enterprises in recent years, steel enterprises have been forced by the increasingly stringent energy-saving and emission reduction policies issued by relevant national departments, as well as the actual needs of enterprises to reduce costs and increase efficiency. More and more steel enterprises have begun to pay attention to energy conservation and consumption reduction. Energy management technology has been widely used in domestic steel enterprises and achieved certain results, However, due to various factors and conditions, the energy management level of some enterprises is still relatively backward. This topic mainly studies how to set up a cloud computing platform based on the Internet of things technology from the perspective of the actual needs of steel enterprise management, establish a flat energy management system suitable for steel enterprises to realize the centralized collection, management and analysis of various key data, and unify energy-saving performance measurement methods, so that steel enterprises can rely on the energy management system, through the joint efforts of various departments, Realize closed-loop management of energy, improve energy efficiency, reduce energy consumption, optimize production costs, and achieve green development.

2. Theoretical Basis of Energy Management Business Research in the Context of BD

2.1. Energy Management System

Energy management system (EMS) is an energy management platform and tool developed on the basis of information technology. The energy management system collects the energy consumption and operation information of each energy consumption monitoring point (lighting equipment, motor equipment, central air conditioning system, boiler heating system, heat pump system, power transformation and distribution and other key energy consuming equipment), forms the classification, sub item, time-sharing and sub regional statistical analysis of energy consumption, and carries out unified scheduling of energy, optimization of energy allocation, reduction of carbon emissions, improvement of environmental protection level Reduce the comprehensive energy consumption of enterprises and improve labor productivity, help users use energy more effectively, and then combine multi energy complementarity, intelligent microgrid and other technologies to achieve zero carbon emissions in enterprises or regions, that is, "carbon neutrality" [5].

Generally speaking, building energy management can be divided into internal management and external management. The content of internal management is mainly to effectively manage the daily maintenance of energy consuming equipment in the building and the energy consumption process of users, as well as to realize energy conservation through the transformation of energy-saving equipment and energy efficiency improvement. External management mainly refers to the industrial policies and energy-saving regulations formulated by the government, which stipulate the implementation of energy-saving concepts and standards in architectural design, construction and operation. In terms of specific operability and intuition, the internal management is more specific and clear, which has a good energy-saving effect.

The functions of the energy management system mainly include:

(1) Data collection

Through intelligent metering equipment, the energy consumption data is collected in real time through the communication technology network (GPRS, Lora, Nb, etc.) and the data is stored. Provide data interface and basic energy consumption data for other enterprise information management systems (such as EAS), so as to help relevant technicians accurately evaluate and analyze the energy consumption of project equipment, and give early warning of emergencies [6].

(2) Energy consuming equipment supervision

The energy management system (EMS) can monitor energy consuming equipment, monitor the operation of energy consuming equipment in real time, and carry out accident early warning and analysis at the same time, so as to ensure the normal use of the project energy consumption system. In case of emergency, it can realize rapid alarm, so as to ensure that the project energy consumption will not be interfered too much. In addition, the energy management system (EMS) can also realize the unmanned management of energy using equipment [7]. Through the monitoring interface of the energy management center, managers can directly obtain the energy consumption information of each project, including consumption, peak and valley data, ambient temperature and other information, and analyze and display the early warning information with the BI data visualization technology of pie chart and histogram [8]. Therefore, the monitoring platform of the energy management system (EMS) can not only realize the daily operation monitoring of the energy consumption system, but also make the system give a timely warning in case of failure and remind relevant personnel to rush to repair the system [9].

(3) Basic data management

Collecting and collecting the data of the main energy consuming equipment of the system is the basis of energy management [10]. After this condition is met, the energy management system can provide the management of basic data, such as energy consumption analysis, energy consumption prediction, energy quality analysis, energy scheduling, energy performance, etc.

(4) Environmental monitoring

The energy consumption of the project is closely related to the indoor and outdoor environment of the building. In order to achieve the efficient utilization of energy, the energy management system (EMS) also has the function of monitoring the indoor and outdoor environment [11]. In short, energy management system (EMS) is an effective method to continuously improve the energy management level of enterprises and continuously improve the energy efficiency of enterprises. It allows property enterprises to have a fuller and deeper understanding of the energy use and energy-saving space of each project; The system provides a professional and accurate energy information transmission mechanism for the enterprises using it. Through this mechanism, the implementation plan of energy conservation and consumption reduction can be accurately formulated. Enterprises can accurately and quickly collect equipment energy consumption data, conduct scientific analysis and early warning according to the data, and provide enterprises with visual and multi-directional data information storage and decision support services, so as to achieve the goals of scientific energy use and efficient management [12].

The implementation significance of energy management system (EMS) can be embodied in the following points: first, EMS accumulates equipment operation data for enterprises: the operation data of energy consuming equipment is the basis for energy management [13]. At present, many property companies have not participated in the development of the early stage of the project, and the development company has not fully considered the later operation of the project in the development process. Therefore, a considerable number of projects have not installed meters in the secondary energy network, and it is a minority to achieve the coverage of the tertiary energy network. EMS improves the accuracy of enterprise energy consumption data: energy reports are an indispensable part of the daily management of energy consuming enterprises, and the accuracy of data determines the effectiveness of this work [14].

3. Demand Analysis of Energy Management Business in the Context of BD

3.1. Process Energy Consumption Index

Let the raw meal output in a statistical period be Q_{sl},Raw material crushing power consumption is E_{ps},The electricity consumption of raw material pre homogenization is E_{yjh},Electricity consumption for raw meal grinding is E_{fm},The process power consumption of raw meal preparation process is calculated by adding the three and dividing by the total output. The calculation formula is as follows:

$$e_{slzb} = \frac{E_{ps}+E_{yjh}+E_{fm}}{Q_{sl}} \quad (1)$$

3.2. Converted Standard Coal Index

Due to differences in electricity prices across regions, the quality of coal is also different. In order to conduct benchmarking analysis with national standard energy consumption indicators or international advanced energy consumption indicators, the actual energy consumption is generally

converted according to the calorific value of standard coal. The converted energy consumption indicators are the converted standard coal indicators, and the unit is kgec/t.

$$e_{cl1} = \frac{b*e_{ar1}}{7000} \quad (2)$$

$$e_{cl2} = \frac{b*e_{ar2}}{7000} \quad (3)$$

Ear1 - actual calorific value per kg of raw coal entering the plant (kcal)

Ear2 -- actual calorific value of pulverized coal per kg (kcal)

7000 -- calorific value per kg of standard coal (kcal)

Moisture is a key factor affecting heat consumption. The moisture content of raw coal entering the plant is large, while the moisture content of pulverized coal out of the mill is generally low due to the evaporation of moisture in the production engineering of pulverized coal. Therefore, the results calculated by the above two formulas are quite different. As for the selection of that formula for calculation, it should be determined according to the actual situation of the enterprise [15].

3.3. Comprehensive Energy Consumption Index

The comprehensive energy consumption index per ton of clinker reflects the comprehensive energy consumption of clinker production, mainly electric energy and coal. Since the measurement units of coal and electric energy are different, it is necessary to convert the electric energy consumption into standard coal consumption, and the coal consumption should also be converted into standard coal consumption. In a calculation cycle, these two kinds of energy consumption are converted into standard coal consumption, and the ratio of the sum of the two to the tonnage of clinker out of the kiln is the comprehensive energy consumption per ton of clinker [16].

$$e_{slz} = \frac{E_{coal}+0.1229*E_{slE}}{Q_{sl}} \quad (4)$$

When the steel production line is equipped with waste heat power generation system, the electric energy generated by waste heat power generation is only consumed by the steel enterprise. When it is not connected to the grid and sold out, it is only necessary to count the consumption of coal and actual electric energy, so the total electricity consumption should be deducted from the electricity generated by waste heat power generation [17].

4. Analysis of Energy Management Business System in the Context of BD

4.1. System Design

The whole energy management system is divided into three layers: real-time data layer, functional application layer and upper application layer. The system architecture is as follows:

1. Real time data layer. This layer is mainly used for data acquisition. It is composed of various intelligent instruments and existing functional systems of the enterprise, such as DCS system. It adopts the IOT data acquisition terminal with high reliability and 4G network connection. This layer of data transmission is mainly composed of 4G network, gateway and Ethernet equipment. This layer is the basis of the energy management system and is responsible for the data collection, classification and transmission of field equipment and related functional systems [18].

2. Function application layer. This layer mainly aims at the needs of steel enterprises and provides various services to meet the needs of enterprise energy management according to the

actual production status of the production line. The data in the data acquisition system is stored in the database according to the established rules, and various energy consumption data such as power consumption and coal consumption are calculated and stored in the database. Finally, based on these key data, All business functions that should be included in the energy management system are realized through various ways such as graphics and charts. The application layer is for the users of the energy management system to access the energy management system through the office computer or mobile app terminal connected to the Internet to master the operation of the production line.

3. Upper application layer. The energy management system shall have standard interfaces with other existing upper functional systems in the plant, such as ERP, MES, etc., to receive or transmit the data of the upper functional system and realize the effective interaction between systems at all levels.

4.2. System Analysis

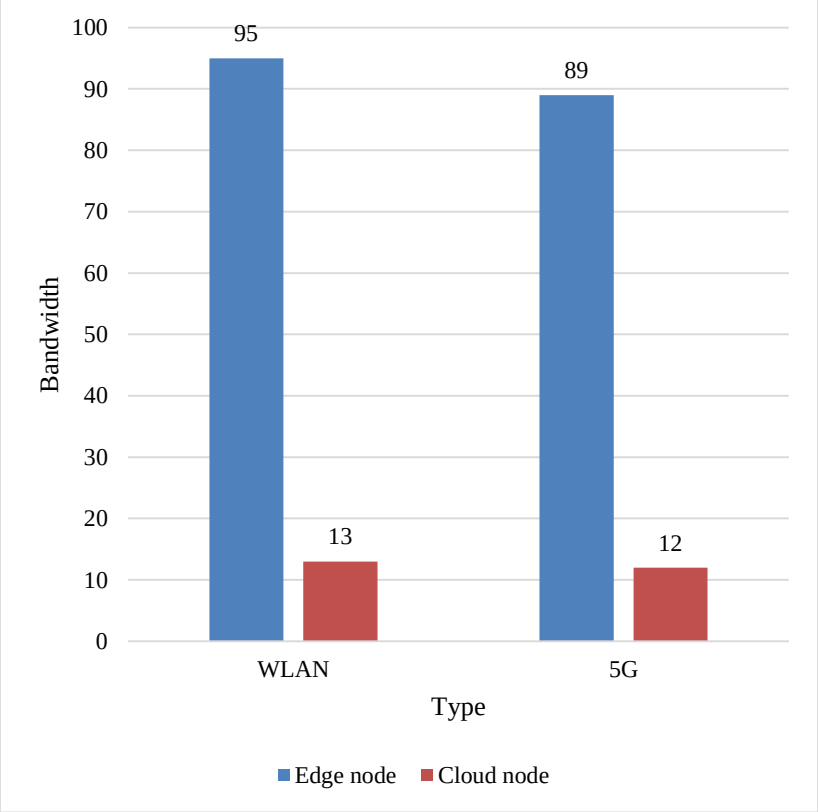

Figure 1. Response speed test

Figure 1 shows the bandwidth comparison. Select the number of nodes in different networks to compare the network bandwidth in the case of cloud computing only and cloud computing combined with edge computing. It is obvious that the bandwidth performance of the smart energy management system with edge computing is better than that of the original cloud computing smart energy management system.

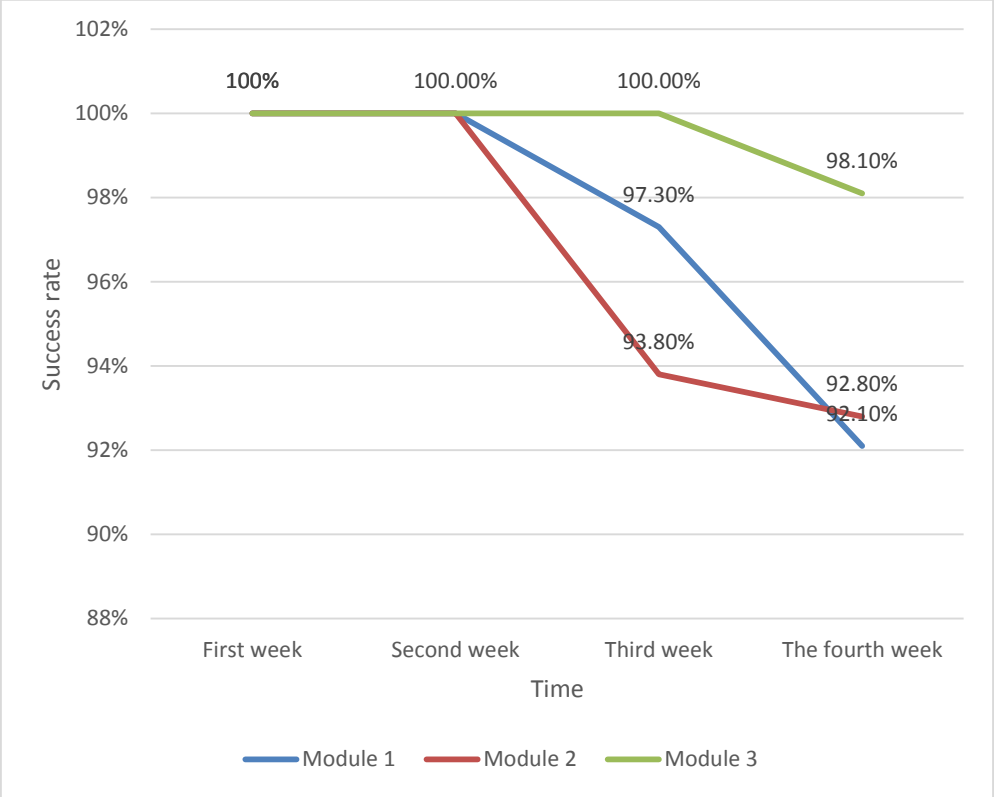

Figure 2. Module running test

As shown in Figure 2 above, after a one month reliability test of the system, the operation success rate of various functions of the system can still reach more than 90%, but according to the figure, the operation success rate will continue to decline with the passage of time, which may be caused by the long-term operation of hardware facilities. But the system is still very reliable in reliability.

Table 1. Comprehensive electricity consumption of clinker

	Week 1	Week 2	Week 3	Week 4
Electricity consumption	57kWh/t	54kWh/t	55kWh/t	53kWh/t

Table 2. Comprehensive coal consumption of clinker

	Week 1	Week 2	Week 3	Week 4
Electricity consumption	107kWh/t	106kWh/t	103kWh/t	101kWh/t

Table 3. Comprehensive power consumption of cement

	Week 1	Week 2	Week 3	Week 4
Electricity consumption	86kWh/t	82kWh/t	79kWh/t	77kWh/t

According to table 1, 2 and 3, the steel enterprise has not only generated economic benefits, but also generated huge social benefits after establishing the energy management system. It is mainly reflected in the following aspects:

1. Reduce the loss rate of power supply. After the energy management system went online, through the strengthening management of the metering system, the power loss rate was reduced by more than 0.5% compared with that before the system went online.

2. Demonstration and leading role. Through the successful application of the energy management system, the enterprise has established an energy management business data system, which has laid a solid technical foundation for the refined operation of the energy management of the steel group company where the enterprise is located. At the same time, it has also played a demonstration and leading role in the application of the energy management system to other surrounding steel enterprises.

3. Improve management efficiency. Through the application of the energy management system, the group company can fully understand the production and operation parameters and energy consumption indicators of all subordinate steel enterprises, and can obtain the required data at the first time. The graphical data display method makes the statistical analysis results clear at a glance, which provides great convenience for the group company to guide the production of subordinate enterprises and organize the energy consumption benchmarking between subordinate enterprises.

4. Reduce carbon emissions. The good effect of the enterprise's application of the energy management system has promoted the optimization of the overall energy management system of the steel enterprises affiliated to the group headquarters, reduced energy waste and reduced carbon dioxide emissions.

5. The reaction speed of power grid accident handling is improved. In the past, when the power supply system failed, the dispatcher could only know the accident situation by the attendant level by level. Not only the speed of obtaining the accident power outage was slow, but also the frequent reporting at all levels was easy to expand the accident situation that might not be too big. After the energy management system goes online, the dispatching administrator and managers at all levels can timely understand the accident situation, respond at the first time, and give emergency plans to avoid the expansion of the accident, ensure production, and reduce economic losses.

5. Conclusion

This paper introduces BD and Internet of things technology. Smart meters, smart gas meters and other metering equipment terminals all adopt smart devices with Internet of things protocol, which avoids the trouble of cable laying and wiring. Data acquisition and debugging of all metering equipment are carried out in a wireless manner, which greatly improves efficiency and enables rapid deployment. At the same time, these intelligent devices can be intelligently identified, located and tracked, which improves the efficiency of device management and reduces the cost of device maintenance. With the rapid development of BD analysis technology and intelligent optimization control technology of cement production line, as well as the increasing application of these

technologies in cement enterprises, in the future, we can use BD technology to analyze how to reduce production energy consumption more effectively, and feed the analyzed results back to the intelligent optimization control system, which will give the control scheme and implement the corresponding control strategy, The energy consumption of cement production can be effectively reduced without manual control. In the future, the energy management system can also be deeply integrated with the machine self-learning technology. The energy management system can analyze the working conditions with the highest energy efficiency under various conditions, then carry out mathematical modeling, and input the energy-efficient production model into the automatic control system, so that the automatic control can refer to the model for corresponding control, so that the system can always operate automatically under the state of high energy efficiency.

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Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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