

Research Article

Research on Food Power Distribution Network's Energy Efficiency Management and Energy Saving Technology

Jijun Liu

Taiyuan Institute of Technology, Taiyuan, China

Abstract: In this study, it takes the energy management system of food power distribution network as the breakthrough point, with the comprehensive the interpretation and evaluation on energy management system and distribution network efficiency in food power distribution network, combined with the application of networking technology in the distribution network's energy efficiency management, discussing the technical measures of energy saving and loss reduction of the food power distribution network. Therefore, developing energy efficiency management and energy saving technology of the distribution network can make contribution to achieving the purpose of saving energy and reducing emission both for our country and food power grid company.

Keywords: Energy efficiency, food power distribution network

INTRODUCTION

Food power distribution network is an important part for the operation of food power system, with the characteristics of wide management regions, scattered customers, many kinds of equipment, etc. The establishment of energy efficiency management system in distribution network is an important measure to improve the "three rate" of the food power distribution network (Ha *et al.*, 2013). In view of the present situation of food power distribution network, in accordance with the relevant technical standards, according to the related technical standard of China State Grid Corp and the reforming plan of the food power Grid Corp, we can carry out the transformation work of the food power distribution network, which can help us to improve the efficiency of food power grid, so that we can realize the monitoring of energy efficiency, the analysis of energy efficiency, the management of saving energy equipment as well as some other functions from the comprehensive dimensions, so as to make contribution to the implementation of energy saving and emission reduction.

MATERIALS AND METHODS

The overview of energy efficiency management system of food power distribution network:

The interpretation of energy efficiency management system of food power distribution network: The energy efficiency management system of food power distribution network can be divided into two parts in the logical system, namely, the terminal equipment and the main layer. Terminal equipment such as: the integrated energy saving distribution area (reactive food power

optimization coordination control device), which can achieve the side of distribution reactive food power balance on the spot, get real time acquisition of the electrical data with the public distribution transformer that is in working state. As for the frontal machine of energy efficiency management system is shown in Fig. 1 and can get data acquisition from the energy management data center in a wireless way.

The function of food power distribution network's energy efficiency management system:

- It can make the whole food power distribution network's energy efficiency data transparent and networked. It also can get the real-time data both from the status of running devices and the status of the food power energy saving devices.
- It can realize the visualization and intelligence of energy regulation in the whole food power distribution network. It also can centralized the processing and get real-time data about efficiency calculation of the scattered data, which can have visualization control over the food power supply from the food power supply company, both in the province and around the city, namely, displaying the operating status of all the ranges and areas with real-time data about energy saving. At the same time, it can be combined with the energy saving device, according to the relevant provisions of the state as well as the relevant standards for intelligent control of China State Grid Corp.
- It also can realize the evaluation of food power on energy saving timely. Schematic Diagram of the Function is shown in Fig. 2.

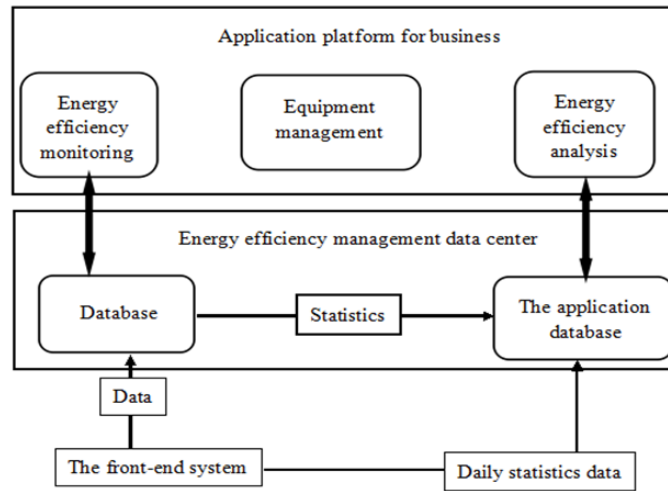


Fig. 1: The composition of food power distribution network's energy efficiency management system

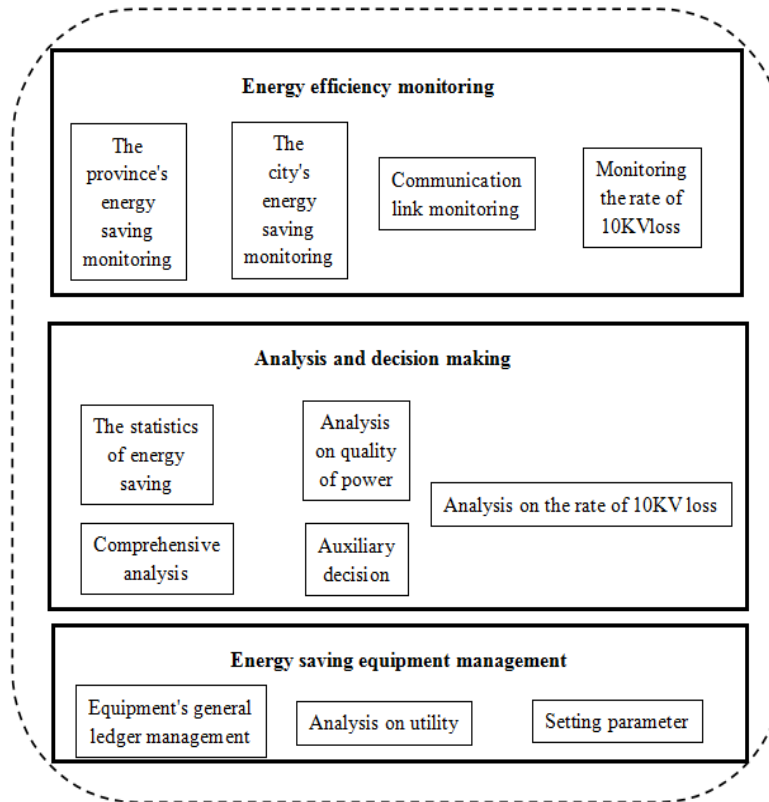


Fig. 2: Schematic diagram of the function of food power distribution network's energy efficiency management system

Comprehensive evaluation on food power distribution network's energy efficiency:

Energy efficiency index of food power distribution network's transformer: The energy efficiency indicator of transformer can mainly be including: the loss rate of food power distribution network's transformer, the qualified rate of food power distribution network's transformer, high energy consumption ratio of food power distribution network's transformer, the reactive food power compensation

capacity rate of food power distribution network's transformer, as well as the economic operational proportion of food power distribution network's transformer. The calculation formula for the loss rate of food power distribution network's transformer is as follows:

$$\Delta P_z \% = \frac{P_{0z} + \beta^2 P_{kz}}{\beta^2 S_N \cos \phi + P_{0z} + \beta^2 P_{kz}} \times 100\%$$

The food power factor of distribution transformer:

The qualified rate of food power distribution network's transformer: It means the ration of food power distribution transformer factors that accounted for the total number of the qualified transformer. This regulated food power factor that is more than 0.8 can be regarded as the lower values of the qualified food power factor. High energy consumption distribution ratio: it refers to the larger quantity of energy consumption in the proportion, which mainly refers to the S7 series and the beneath transformer.

The index of line energy efficiency:

- The rate of the number of economical operating line: The economical operation of food power distribution network refers to the reasonable operation of the delivery of the load under the current structure and layout of the existing conditions, by adjusting the load of food power, within the lines and equipment during the period of operation (Pitis and Zeller, 2008). When the circuit's current load I_{pj} can achieve the economical current load I_{jj} or the load rate of food power distribution network's transformer can reach the economical load range, then the line is in the state of the economical operation.
- The qualified rate of the food power factor in the line: The qualified rate of the food power factor is a very important technical parameter in food power system. As a parameter, it can measure the efficiency of transmission food power and the food power factor of the line. If the food power factor is low, it means that the consumption of transmission food power in the process is too large, which will make the end of the line have low voltage, at the same time, it can increase the loss.

Index of food power quality:

- The index of food power quality is also called as the electric energy efficiency indicator, which can be including the cumulative time rate of unqualified voltage, the unbalanced degree of three-phase load, the harmonic content and the fate of daily load. The three-phase unbalanced degree: ai is used to characterize the three-phase unbalance degree of the system. Assuming the maximum load of line's phase current is I_{max} and the average current is I_{pj} , since the range of I_{max} is $0-3I_{pj}$, so its value is in the range of $-1-2$.
- The amount of harmonic content: the investment of a large number of non-linear components of the enterprise will cause a large number of harmonics content, harmonic content will make current and voltage wave formed, which will cause serious impact on the normal operation of the production of gird enterprises, resulting in a large number of economic losses (Wang, 2008).

Application of IOT technology in food power distribution network's energy efficiency management:

The overview of IOT technology: The essence of Internet of Things (IOT) is to use RFID (radio frequency identification), wireless data communications and some other technologies to realize the automatic identification and information sharing of the things through the Internet (Gabbar, 2007). The architecture system of the Internet of things is known to have three levels, from the bottom to the top, they are perception layer, transport layer and application layer. The radio frequency identification technology, sensor and sensor network belongs to the perception layer, which can mainly solve the information perception and

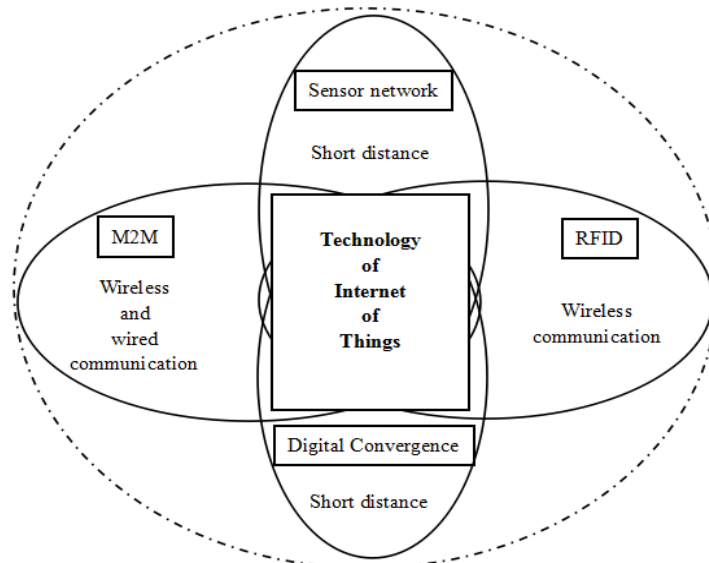


Fig. 3: Technology of internet of things

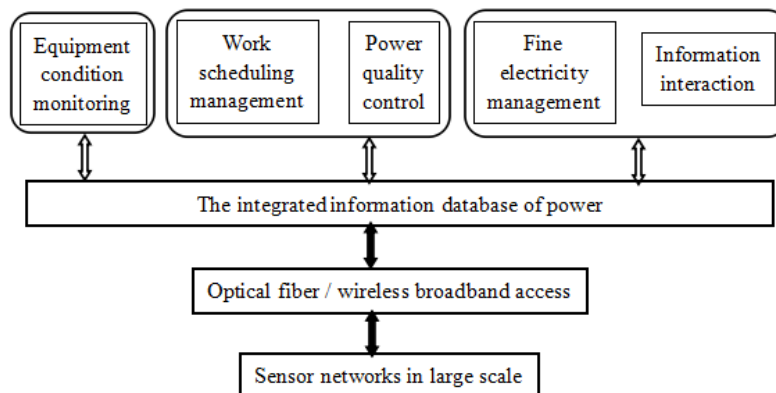


Fig. 4: Schematic diagram of the application of IOT in distribution and electrical link

acquisition; it is the core infrastructure of the Internet of things.

The application of IOT technology in food power distribution network: Among the food power distribution network, as for one equipment condition monitoring, there are a lot of monitoring instruments or devices that are used alone. Such as: the current monitoring device, GIS gas leakage alarm device, partial discharge detector, partial discharge acoustic wave detector, ultrasonic detection of partial discharge detector, etc. These devices have been successfully developed and put into practical use. At the same time, these devices can effectively detect the switch of the cabinet, the ring of network cabinet, cable branch box in the bus, circuit breaker, current transformer, cable casing, as well as the partial discharge. If these devices can be combined with wireless sensor network technology, it can be easily connected with other devices or monitoring center, so as to realize monitoring the condition of the equipment, which also can avoid laying a large number of cables. Technology of Internet of Things is shown in Fig. 3.

Parameter measurement technology: This kind of technology is the basic part of smart grid. The advanced parameter measurement technology can convert the acquired data into data information, which can provide parameter measurement technology to all the aspects of the usage of smart grid with the application of the Internet of things sensing technology (Lee *et al.*, 2003).

Communication technology of food power distribution network: In the implementation process of IOT, wireless sensor network is composed by a large number of different sensor nodes, which can form autonomous wireless network. It can obtain the real-time and dynamic sensing information from the physical world, which also can combine the fusion of information with the communication network, so as to improve the depth of perception with comprehensive information in each link of the smart grid.

The access technology of distributed energy: The core of the smart grid is the intelligent network system with intelligent judgment and the adaptive adjustment of various energy unified network and distributed management, which can be used for real-time monitoring and acquisition of food power grid as well as the user's electricity information, in the most economical and safest way to deliver the transmission and distribution of electricity to the user's terminal. The Application of IOT is shown in Fig. 4. In this way, it can realize the utilization of electricity with optimal allocation of energy, so as to improve the operation reliability and the efficiency of energy utilization.

RESULTS AND DISCUSSION

Technical measures for saving energy and reducing loss of food power distribution network:

The transformation of metering devices: Because there are a huge number of electric metering devices, the replacement of these devices will bring huge economic benefits. We can replace the mechanical electric energy meter into electronic watt hour meter.

Balanced three-phase load: Unbalanced load not only can affect the safe operation of the transformer, but also can increase the loss of the line and transformer. For the three-phase unbalanced load, load adjustment is the main method to deal with this kind of problem.

Shorten the radius of food power supply: The line of the food power supply is too long, which is more than the reasonable radius of food power supply, it will cause the increase of the resistance as well as the losses, which should adopt the reforming method namely, using the straight instead of the bended.

Harmonic wave control: The harmonic pollution can also increase the loss of food power distribution network. Some large chemical plants, railways and steel plants are the main harmonic sources in food power system, which need harmonic wave control.

Table 1: Dispersion compensation

In accordance with the main trunk distribution	The length of the installation position to the head of circuit	The number of the installed capacitors	The reactive food power ratio of the installed capacity to circuit
Even distribution	2/3	1	2/3
	2/5	2	4/5
Uneven distribution	The branch line is 600	1	4/5
	The branch line is 900	2	4/5

The transformation of circuit: The loss of circuit can be accounted for a large proportion in the whole loss of food power distribution. When the circuit of food power distribution is designed, the traditional method is according to the allowable voltage, the mechanical strength and the allowable load of the wire with the safe carrying capacity and so on. Starting from the perspective of saving energy, it should regard "the loss of food power energy" as one the basis to select the section of the wire for the circuit. In the principle of economy and rationality, it can properly increase the conductor wire's cross-sectional area, so as to reduce the food power loss of food power distribution circuit.

Reactive food power compensation: Reactive food power compensation should be in accordance with the following principle "unified planning, rational layout, classified compensation, law of balance", so far, it can be divided into three types, namely, central compensation, dispersion compensation and transformer compensation.

Central compensation: It is mainly installed in the low-voltage side of transformer substation, which is used for the compensation of reactive food power loss of the main transformer itself. At the same time, it can reduce the reactive food power substation above the transmission line, so as to reduce the loss of reactive food power of the food power supply network. In the transformer substation, it is mainly used capacitor group for compensation, its investment is generally larger, the specific requirement of it is to keep the range of the second food power factor of substation within 0.9~1.

Dispersion compensation: Dispersion compensation for 10 KV transmission line. This method of compensation and compensation of the energy saving effect of location and compensation capacity. The installed capacity and the installation position as shown in Table 1.

Transformer compensation: Transformer compensation is mainly installed in the low-voltage side of 10 KV distribution transformer, which is used to compensate the loss of non-load and the reactive food power compensation of the inductive electric equipment. According to the on-the-spot investigation, transformer compensation can be commonly existed in many areas, which is the principal means for the local reactive food power compensation.

CONCLUSION

Since 2000, China State Grid Corp had attached great importance, organizing the strength from all sides, putting focus on solving the weak link, making full use of self control, communication, information and other advanced technology, so as to increase the intensity of the transformation of food power distribution network. It has got a lot of achievements in the following aspects: fast fault diagnosis, isolation and automatic restoration of food power supply network, the data of reactive food power/voltage control, food power flow calculation, network topology analysis and distribution network reconfiguration, the application and development of GIS/AM/FM network, DMS and EMS and MIS sharing and so on. These achievements can play an important role in the realization of the food power distribution network's optimal operation, the improvement of the food power supply's reliability, the improvement of management and service level, as well as the improvement of economic benefits and some other aspects.

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