

Research of Energy Management System and its Applications at the Consumer Side Based on Converged Communication

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Abstract—The construction of smart grid brings opportunities to the development of technologies at the consumer side, which also appeals for the research of energy management. This paper introduced the architecture design and functions of energy management system, and also analyzed the applications in family, building, community and other scenes. According to the constructions of the network and platform, which used the converged communication technologies to provide a basic environment to the interactions between users and the grid, the energy management system, which has been used in many pilot projects, can provide analysis, guidance and management service to the consumers.

Keywords—Smart Grid, energy management, converged communication, interaction, Optical Power Low-voltage Cable (OPLC) .

I. INTRODUCTION

Smart Grid is an important practice in the sustainable development strategy of the grid. Intelligent power consumption is the key part of the smart grid, and is also the only part which contact the grid and users, energy management system is not only an important content of the smart energy service but also the important means of sustainable, low-carbon development for the grid. Therefore, it is necessary to have an energy management system, not only for consumers, but also for the grid. According to the interactions between users and the grid, it is able to save electricity consumption, the grid would be more stable, efficient and safe. This paper introduced an energy management system, which has been used in many pilot projects, its architecture and function were also be contained ^[1].

II. ANALYSIS ON THE ARCHITECTURE OF THE ENERGY MANAGEMENT SYSTEM^{[2][3]}

Communication network is the traditional carrier to support the information transmission for

energy management business system, and the basic transmission medium for the interaction between users and the grid. According to the local conditions of the construction principle and the using of converged communication technology, energy management communications network, with complex structure and wide distribution, takes advantage of reliability, low latency, high network capacity and low cost to meet the needs of the business request for efficient energy management, and implements the converge of the transmission on network and database.

Through technical analysis combined with user demand-side energy management network, the user side is to form the environment for the integration of different communication network architecture.

Through the analysis of the network demand at the user side, the demand side communication architecture for different environments was formed.

A. Network Analysis

Energy Management System is the core of intelligent power utilization. The following part is to analyze the convergent communication technologies for Energy Management System, by comparing the features and costs of optical fiber communication, wireless communication, power line communication and other communication technologies, which are showed in Table 1.

(1)Stability--To ensure the transmission of application data while the network is running, it must be good anti-jamming, or can restore quickly to the original condition when it was disturbed.

(2) Real time—The user-side network is required to provide a good real-time environment to guarantee the data transfer rate to meet the needs of business applications.

(3) Cost. Cost of the basic construction of communication network at consumer side.

TABLE 1. COMPARISON OF COMMUNICATION TECHNOLOGIES

Communication technology	Stability	Real time	Cost
Optical Fibre	High	High	Middle
Short-range Wireless	Middle	Middle	High
Power line	Middle	Middle	Low

B. Network Architecture^[4]

Based on the analysis of the network requirements and communication technologies, the communication network architecture of energy management system at the user side can be shown in Figure 1; the communication network structure is like a tree that, the service master stations and user-side terminals for the energy management in all communities are connected through the platform of the energy management service, to implement the bidirectional interaction between the consumers and the grid.

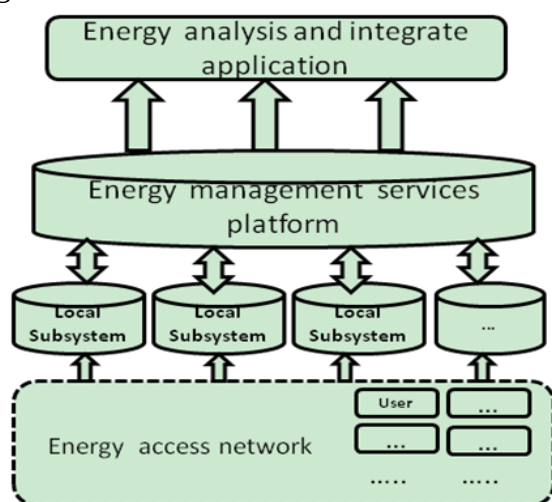


Figure 1. Energy Management System Architecture

III. CONVERGED COMMUNICATION NETWORK ARCHITECTURE AT CUSTOMER SIDE^[5]

Power consumers are divided into two parts by Energy Management System, one of which is residential customer and the other is industrial park customer. Based on the analysis of services,

network demands and the environmental characteristics of customer side, the architecture and converged communication network of the Energy Management System at customer side was designed respectively. It would be introduced in the following passage in detail.

A. Residential customer

This energy management system mainly provides service to residential customers, such as energy consumption collecting and analyzing, energy saving controlling and other related service functions. Information inquiring, energy consumption monitoring, distributed energy resource monitoring, energy storage device monitoring and other functional modules are consisted in this system, which could achieve query of power quality factors, energy consumption information and real-time pricing, energy consumption calculation and predict service, and detection of energy consumption of high power consumption appliance, sensitive loads and distributed energy generations.

Based on communication system architecture of intelligent power consumption at the consumer side, combined with electrical network, communication network at consumer side could be designed for family and community customers. The district distribution room network linked community service master station upward and district corridor network downward, which consists the access network. Network technologies are taken together with power line communication, traditional wired and wireless communication, and information access network and electrical power supply access network are converged in the system. The communication network of family customers is shown in Fig. 2.

In the consumer side network, collective and controlling device is the essential part of energy management system, which is connected with background management system through energy manage terminal upward, and with kinds of household appliances, equipments, new energy generations and energy storage devices by RF433, Zigbee, Wifi and so on. At the same time, the network connection between traditional controlling device and energy consumption device is

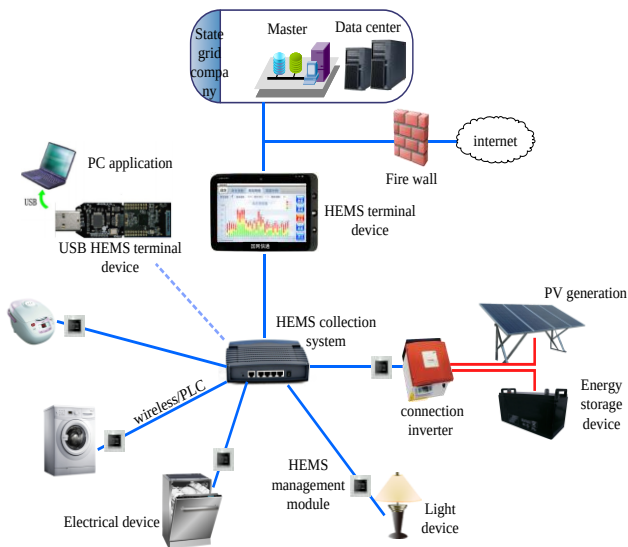


Figure 2. residential consumer side communications network

implemented in PLC way, while the information interaction is implemented by energy management module. Energy management system could collect, analyze and deal energy consumption information of household appliances. This system could also provide service at PC terminal by a kind of switching equipments.

B. industrial park customer^[6]

Through the deep analysis and excavation on enterprise information of energy consumption collecting and energy consumption characteristics, industrial park energy management system could provide services like energy consumption characteristics analysis, benchmarking management, energy consumption analysis and other services, which could display information of electrical power quality monitoring, energy consumption load and power consumption distribution of equipment, which makes analysis of energy consumption situation and structure of enterprises, and improve energy consumption efficiency.

The energy management system could achieve installing communication access network and electrical power supply circuit together for industrial customer by OPPC and OPLC. Converged communication network which include wired and wireless communication is used at internal customer side. The industrial consumer is equipped with electrical communication ONU which is connected with communication

management device and wireless router downward by Ethernet line. The smart terminal device interacted with energy management control centre by wireless communication, and various information was collected with collection devices by RS485 bus to achieve information collecting, transmitting and processing. The communication network of industrial park customers is shown as Fig. 3.

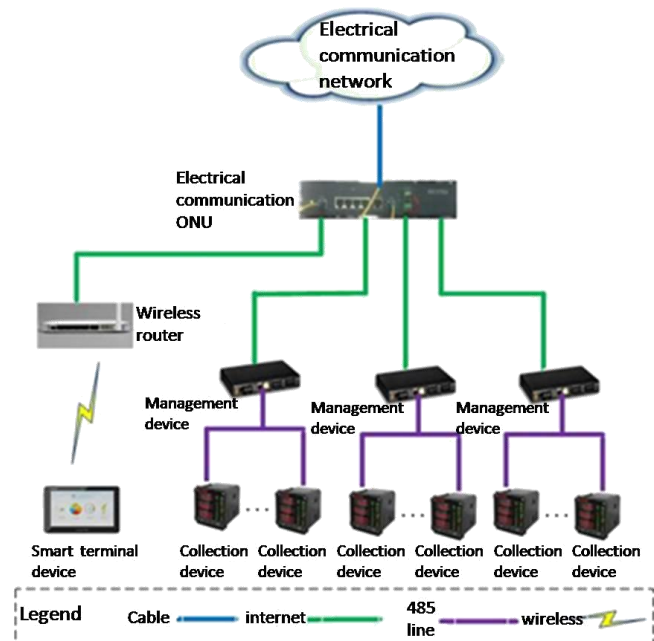


Figure 3. industrial park consumer side communications network

IV. CONVERGED COMMUNICATION NETWORK ARCHITECTURE AT CUSTOMER SIDE

This paper introduced an energy management system, which can conduct a comprehensive collection, further analysis and processing. It also can provide the energy strategies, guidance, electricity equipment control, remote control and so on, and this system considered about the integration and control of energy power generation, which can improve energy consumer efficiency. The main features of this system will be introduced below.

Through the consumer side communication network, the system can provide energy consumption analysis of different equipments (including the traditional appliances and intelligent home appliances) at anytime, and the intelligent interactions between users and the grid, which is based on the collection devices and management module.

According to the consumption analysis of household electrical appliances, the energy management system can find the law and remind the user to change its power consumption time to save cost, which was based on the time-sharing electricity price and other factors. Through the energy consumption analysis and guidance, it can bring intuitive experience to the consumers.

According to the monitoring data of distributed energy or energy storage and the electricity price information, the system can make full use of distributed energy effectively, and adjust and strategy of distributed energy generation and storage simultaneously.

The system and its architecture is appropriate for all types of families and intelligent park users, and accord with engineering construction requirement, which can also reduce the cost of the project implementation by the convergence of the communication network and power supply network.

V. CONCLUSIONS

This paper has deeply analysed the consumer side demands and application characteristics in the energy management system. Based on the integration of the technologies of OPLC, power line communication, micro communication and other technologies, it has implemented the energy management's important application in the communication network system framework by the user side.

The high integration of information between the users and the grid leads to an effective improvement in energy efficiency at the user side, helps to save energy, protect the environment and live a green life, and makes the safe, reliable utilization of energy come true. This system has got satisfactory verification results in a number of pilot applications. How to make the energy management system be more convenient and efficient is an important manifestation of the overall information technology of the electric power industry, and also an important symbol of the green grid's development. It meets the needs of basic and sustainable development for the electricity grid and smart grid. It is significant to carry out the user-side energy management research and construction work, not only to satisfy the development needs of the power industry, but also to promote the new energy use and the energy saving development in our society.

REFERENCES

- [1] Liu ZhenYa, 《 *Smart Grid Technologies* 》, China Electrical Press, Beijing, April.2010, pp160-183.
- [2] Li Ke, "The discussion about communication and information technologies in Smart Grid", 《 *Electric Power Automation Equipment* 》. NanJing, vol. 30, May2010, pp. 87-91.
- [3] "transformer of energy system in intelligent building," *Intelligent Building & City Information*, vol.7, pp. 6-7, 2006.
- [4] HuangQiang, "Energy Efficiency Management Information System and Application", 《 *Distribution & Utilization* 》 vol. 2, pp.78-80, 2010
- [5] LiuQin.SongLiJun. Study on Zigbee wireless sensor net. 《 *Computer Development&Application* 》. Tai Yuan, June 2008, pp.44-46.
- [6] Li Wei, "Study and Application of Energy Efficiency Management System for Intelligent Buildings", 《 *Distribution & Utilization* 》 vol. 3, pp.15-17, 2011.