

Design of Interactive Intelligent Family Utilization System in Smart Grid

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Abstract—Intelligent power utilization is an important part in the construction of smart grid, its outstanding characteristic is interaction between power grid and demand side. Based on the demand of family intelligent power utilization, this paper analyzes the significance of bilateral interaction system construction, proposes the design scheme of interactive family intelligent power utilization system to satisfy the user's various and individual demands, designs intelligent display client software. The system integrating power flow, information flow and business flow is established in order to support new power supply and demand relationship between grid and users and ensure the QoE (Quality of Experience) and optimize the configuration of assets of power grid.

Keywords—intelligent power utilization; bilateral interaction; client software

I. INTRODUCTION

Smart grid is based on the strong grid, supported by information and communication platform, and characterized by information, interactive and automation. It covers the following six aspects: generation, transmission, transformation, distribution, power utilization and scheduling. Intelligent power utilization directly faces the power consumers. It is an important way for users to perceive and experience smart grid's achievements. Family intelligent power utilization is developed through the use of new technologies such as advanced measurement, communication, controlling and management. It can meet the diversity needs of users because it can support new interactive intelligent power utilization business. The intelligent power utilization can change terminal users' pattern of power consumption and improve the efficiency of electricity consumption. It constitutes the new power supply relations between the grid and users and achieves real-time interaction of power flow, information flow and business flow^[1].

The development of interactive intelligent power utilization is driven by price^[2], electricity quality, power safety, value-added business and so on. It focuses on realizing the new power supply relationship and energy conservation. Based on the framework of smart grid, this paper analyzes special service and function requirements of family interactive intelligent power utilization, and proposes an interactive family intelligent power utilization system^[3-6] in which the smart grid and family users can exchange information in an interactive, real-time way. The system's terminal layer is made up of smart appliances, smart meters

and other intelligent devices and it mainly communication through optical fiber. This system provides high-speed, secure and reliable bilateral interaction network and information channel for intelligent power utilization business. At the same time, the intelligent client is also designed to make users effectively participate the response of demand side. A more efficient, transparent and convenient utilization will achieved by building the system. As expected, it will optimize grid operation mode, comprehensively improve the interact ability between the supply side and user side, improve power supply reliability, and ensure the reliable operation.

II. THE INTERACTIVE FAMILY INTELLIGENT POWER UTILIZATION DEMANDS ANALYSIS

The development of the smart grid has brought great changes to energy and information technology and it will also bring huge changes to power utilization service. The traditional power utilization service^[7] is cabinet artificial mean. The development of intelligent power utilization service makes it change to network self-service. These changes will generate great amounts of electricity data, so it requires corresponding intelligent service background and business supports. Intelligent power utilization's development will expend demand-side services, increase the scope and means of user's interaction, in which interactive family intelligent power utilization service's demands will also change.

(1) Update traditional power utilization service. In traditional electricity service, users get basic services such as electricity information inquiries, payment and fault repair through the power supply business hall. With the further development of intelligent power utilization, intelligent home systems, marketing systems, 95598 website and other professional power applications, a lot of business is operated in network self-service way. Users can query information details and conduct business through websites, mobile phones and other virtual way.

(2) Add new intelligent power utilization service. The smart grid produced novel forms of power utilization, such as distributed power systems, energy storage device access, electric vehicle charging services and smart home system. These new electricity business management models are different with traditional electricity service. This will generate new electricity service, such as energy efficiency analysis and management, power quality monitoring, energy bilateral metering and user demand response.

(3) Increase the value-added services. Through the development of intelligent power utilization, ISP can provide security, community news, payment, health care, triple play and other third-party services on the intelligent power utilization service platform. The grid completes value-added services through cooperating with banks and other third-party organizations and expands service area.

III. INTERACTIVE INTELLIGENT FAMILY POWER UTILIZATION SYSTEM

A. The Framework of Interactive Intelligent Family Power Utilization System

Three parts (home side^[7,8], grid side and network) should be considered in the designing of interactive intelligent family utilization system. As shown in figure 1. The power utility information gathered by the collector will be transmitted to interactive master station via telnet. The integrated information application platform in the interactive master station will realize information storage, classification and filtration. Then, the power side will provide the users optimal power scheme through web or cellphone. It will realize the interaction between the grid and users through the process.

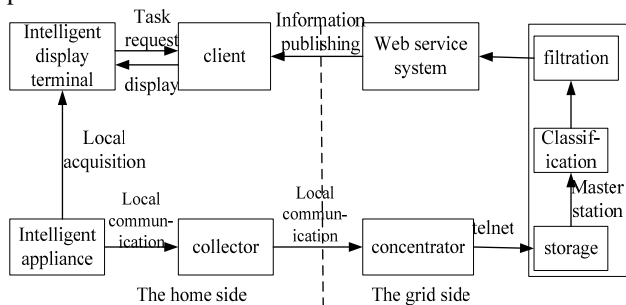


Figure 1. The framework of Interactive intelligent family utilization system

As the interactive demand side, the home side will realize two functions: power utility information acquisition inside the family and receiving information from the grid. In the home side, the smart meter and other intelligent terminals will collect all kinds of power utility information including basic power information, smart home information and distributed generation information. The sensor network is used to realize the interconnection of family internal equipment. At the same time, users can receive information through the Web service system, the Web application software can provide a variety of services such as energy consumption analysis, internet electricity purchasing, fault information (including owe, grid blackouts, repair information) and alarm information. At the same time, users can buy a third party application through intelligent interactive terminals.

The grid side mainly includes the interaction master station and Web service system. Interactive data in the user side will be collected, monitored and transmitted to the interactive master station. And the information which can be open to the public will be filtered, encrypted by the station

and then will be released to the users via the Web service system. Users can check the detail by using intelligent interactive terminals or mobile phones, also can adjust the power utility mode reasonably. In the designing of intelligent user terminal, a security module should be set up to ensure information security.

Communication network is an interaction bridge between the grid and users, it can provide a high speed, large capacity transmission channel for power data. Communication network is divided into power private network and public network. The key of power private network construction is the sensor network and broadband access network. The broadband access network construction mainly use optical fiber communication technology, it will realize the massive information accessing through fiber entering household. Sensor^[9,10] is mainly used for intelligent electric equipment interconnection in home. It has many advantages, such as flexibility in deployment.

B. Interactive Intelligent Family Power Utilization System

In this paper, we put forward an interactive family intelligent power utilization system which consists of three levels: application service layer, network layer, perception layer. The purpose of designing the system is to realize information collection all-round in perception layer, information transmission through network layer and information process in application layer. The information will be released to users after be processed in application layer. By this way, it will realize a good relationship between supplying and using electric power. The system is shown in figure 2.

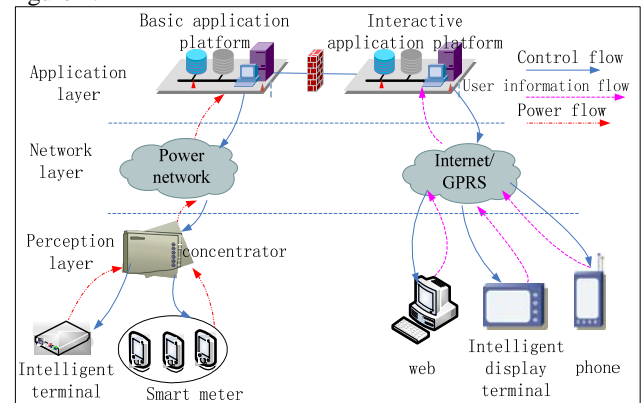


Figure 2. Interactive intelligent family utilization system

The perception layer is the terminal layer of interactive family intelligent power utilization system. It includes intelligent household appliances, smart meter and concentrator. The monitored objects this layer faced include smart home, three meters and security equipment. The environmental information, equipment information and user electricity information generated by these objects will be accessed to higher layer through the sensor network. Users receive the news released by the master station by means of Web or cellphone.

The main function of network layer is transmission. Kinds of information will be transmitted to the basic

application platform through the network layer. The network layer includes backbone network and access network. At present, the optical fiber communication is the first choice of the construction of backbone network. There is no unified standard for the construction of access network. For new village, fiber to home can satisfy the needs of bandwidth and high speed. At the same time, it can also support other service, such as community service, three networks convergence and so on.

The construction of application layer is to realize information analysis and process. This layer includes inside and outside system. The inside network receives the information transmitted by network layer and processes it. Then, the users can check news and control equipment through interactive software running in outside system. The bilateral interaction system can also support the realization and extension of new service.

IV. DESIGN OF INTELLIGENT DISPLAY CLIENT BASED ON WEB

A. Structure of Web-based Bilateral Interaction System

The web-based intelligent display client software system, developed with Java and other techniques, is an application client, which is developed to provide smart electricity services for family consumers. An intelligent interaction client is developed to support the services based on the survey of application mode of interactive smart electricity services of domestic family consumers, and the requirement analysis of different types of consumers. It is based on C/S mode and can realize interaction of electricity information and business applications. Its structure is shown in fig.3.

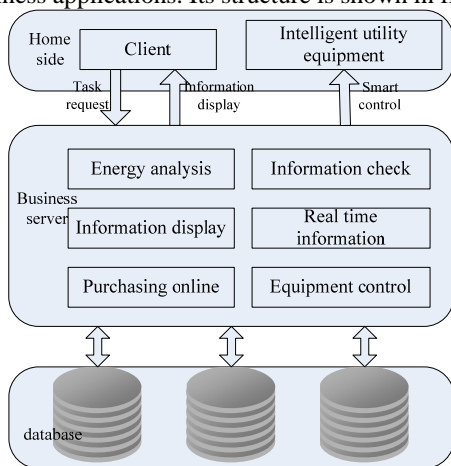


Figure 3. The structure of web-based bilateral interaction system

The web-based bilateral interaction soft of the design is operated on the external network of electricity information network. It is composed of web server, application server, database server and etc. The browser is used as the client because of its advantage of simple operation. Consumers can request the services by click the URL. The business service system is composed of several business modules with different functions. It can accept the requests and request to

the database, and send the processed information to the consumer. It has the ability of function extension for other services.

B. Intelligent Display Client Design

As a visualization terminal of interaction between power companies and consumers, the intelligent interaction terminal is installed indoor. On the one hand, it can receive guidance of electricity consumption from power companies, inquiry the status of household appliances and control the household appliances. On the other hand, it can connect to other smart devices and show the electricity information of the devices. Intelligent display client is installed in intelligent interaction terminal; it has several functions, shown in fig.4, such as information display, energy consumption analysis, etc.

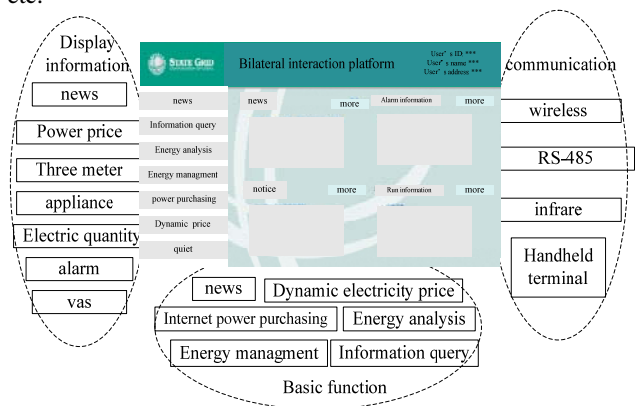


Figure 4. Intelligent Display Client

(1) Function module design

1) Energy consumption analysis. The implement of energy consumption analysis is based on intelligent interaction terminal and intelligent collection terminal. Electricity information is real-time collected using intelligent collection terminal such as smart meters. The web-based interaction system, as a portal, displays electricity consumption, electricity information, power consumption mode, historical electricity consumption records, household load curve, etc.

2) Electricity information inquiry. Consumers can inquiry electricity information by the web-based interaction system.

3) Energy consumption information publish. The interaction master station can publish the electricity information to consumers after data processing and provide services such as electricity information inquiry and energy consumption analysis to consumers.

4) Alarm information publish. The alarm information, like overload, low remain electricity, power outage, power grid overhaul and so on, is published to consumers by inquiry mode or push mode.

5) TOU power price. Consumers can inquiry TOU power price, month price, prepaid electricity, remaining electricity charge and other electricity information.

6) Electricity purchase online. Consumers can purchase electricity online by the web-based interaction system like shopping online.

(2) Information display

The displayed information include published information by grid, data of meters, electricity consumption information of smart appliances, payment information, alarm information, dynamic electricity price information and VAS information. Consumers can understand electricity consumption information and adjust electricity mode to meet the demand of grid. Smart interaction client, as a visualization terminal of interaction between power companies and consumers, can show load information published by the grid. Consumers can control home applications according to the load information.

(3) Communication

The smart interaction terminal, as a portal of grid and consumers, can connect to smart meters, smart phone and smart socket by short distance wireless communication or RS485. Grid can get electricity information of consumers from smart gateway, understand the electricity demand. Otherwise, Consumers can monitor and control the smart applications by the smart home system consisted of intelligent display terminal and smart applications. Consumers also can control the smart applications and realize reasonable electricity consumption by smart mobile terminals with the support of intelligent display terminal.

V. CONCLUSION

The research and design of family interaction intelligent power utilization system is an important way to realize the two-way interaction between power grid and demand side. For one thing, through this system the control center can real-time hold the all-round running aspects of power grid and optimize the use mode of power assets. Finally it can respond the demand side in time and flexibly. For another thing, users can change their electricity consumption behavior according to the guidance from power grid in order to reduce the cost of electricity use. In a word, it has great significance to balance power supply and use, prove the use efficiency of energy and realize the win-win among Grid Company, users and society.

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