

Design and Implementation of Demand Response Information Interactive Service Platform Based on “Internet Plus” Smart Energy

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Abstract. In order to promote the effective use of demand response load side resources, promote the interaction between supply and demand, enhance the level of customer service and achieve the overall utilization of energy, this paper briefly explain the background significance of design demand response information platform and current situation of domestic and foreign development; Analyse the new demand of electricity demand response combined with the application of Internet and big data technology; Design demand response information platform architecture, construct demand responsive system, analyse process of demand response strategy formulate and intelligent execution implement ; study application which combined with the big data, Internet and demand response technology; Finally, from information interaction architecture, control architecture and function design perspective design implementation of demand response information platform, illustrate the feasibility of the proposed platform design scheme implemented in a certain extent.

1. Introduction

Demand response is a means of power demand side management. At present, it is developing rapidly in the standard setting and technical application. The pilot work at home and abroad is fruitful, and gradually realize the development from passive to active. However, with the increasing awareness of the power users, the simple passive demand response cannot meet the needs of power users' electricity cost and comfort. The traditional power supply and demand model is in urgent need of transformation, and the idea of clean alternative and electric energy substitution is urgent to change the traditional energy system.

The rapid development of Internet technology brings an opportunity for the transformation of power supply and demand model. The concept of intelligent energy promotes the transformation of traditional energy system. The development of traditional industrial economy by Internet thinking is the inevitable trend of the development of the times. In 2016, the national development and Reform Commission issued "on the" Internet plus wisdom "energy development guidance", which provides guidance for the integration of Internet information technology and energy industry.



This paper is based on "Internet plus" smart energy technology application on demand response information platform design and implementation. In this paper, we fully consider the application of the Internet, big data and other technical means in the design of demand response information platform, and put forward new ideas for the transformation of the power supply and demand model, with full consideration such as the Internet, big data and other technical means in response to demand information platform design, implementation effect between grid - power users active two-way interaction, in line with the development trend of the reform of the traditional energy system, effectively maintain network security and stable operation and high quality.

2. Research status at home and abroad

2.1. Foreign research status

At present, some research institutions and scholars abroad have played an important role in the design and implementation of demand response information platform.

In 2012, the Laurence Berkeley National Laboratory Research Center released OpenADR demand response 2.0A communication protocol, Auto-DR system installation section in the Seattle area of commercial buildings, as well as the Pacific Gas and electric automation platform to implement demand side bidding project based on Realization of load reduction targets [1]. Matsushita Electric Tokyo headquarters use of new energy-saving technology, using a large data means to analyze the construction of energy saving potential of the building energy management system, which can provide users with response to demand for energy-saving programs. Europe relies on the establishment of a wide range of smart energy demand response project features and services platform, they carry out an effective response to the needs of the project [2-4].

Foreign demand response construction application of the information platform is relatively perfect, but cutting-edge technology failed to measure the full integration of applications, a large number of load side data resources have not been fully utilized, the supply and demand side needs to improve the strength of interaction.

2.2. Domestic research status

The construction of domestic demand response information platform combines power service management platform, electricity information collection system and electric power dispatching system, which can realize the real-time online monitoring of user load, using BS mode, APP mobile phone or SMS to interact with users, alleviate the peak, promote the development of energy saving and emission reduction work [5].

At present, the demand response infrastructure includes: power information collection system, electric vehicle charging pile, intelligent park and intelligent community.

Jiangsu province electric power company intranet deployment of demand response platform, grid information, demand information, solicitation planning through the network service interface onto the APP system (extranet), an invitation sent to the user through the mobile phone APP and information query, and user feedback should be to demand response platform.

In Shanghai and Beijing, the power load management system and the power demand side management integrated service platform are used as the demand response information platform.

Domestic demand in response to the construction of the information platform to meet the needs of the demand response of pilot work to a certain extent, it promotes the establishment and implementation of demand response scheme and strategy, but there are still some problems such as: the load side of large amounts of data are not fully utilized, intelligent demand response is not enough, the lack of interaction between supply and demand side.

3. New demand of electric power demand

With the development of power demand side management and demand response, the traditional demand response mechanism has been unable to meet the development needs of power demand side management and user needs. In the Internet era, the Internet thinking and technology will drive the transformation of traditional power supply and demand model industry.

(1) Development of power demand response industry based on internet.

The Internet represents a kind of advanced productive forces, which promote economy constantly evolve, so as to promote the social economy vitality, it provides a broad platform for the network can reform, development, innovation, which is known as "the new engine" for Chinese upgrade the quality and efficiency of economic.

Currently in the industry, finance, commerce, communications, transportation, people's livelihood, the government is widely used in various industries, and in the field of smart energy industry is only a clue, in the user side needs to respond less.

In addition, with the construction of the global energy Internet system, the demand side management of electricity needs to be integrated into the Internet elements, to promote the demand for the development of the internet.

(2) The demand response visualization applications.

Automation and intelligent demand response field is not a new topic, but the present aggregator fight the enemy separately and the user half believe and half doubt interactive service system incomplete.

(3) The strategy of intelligent demand response

Based on the large data technology, this paper analyzes the implementation effect of the demand response plan, and explores the potential of demand response, which provides support for the intelligent formulation and decision of demand response.

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References are cited in the text just by square brackets [1]. Two or more references at a time may be put in one set of brackets [3, 4]. The references are to be numbered in the order in which they are cited in the text and are to be listed at the end of the contribution under heading references, see our example below.

4. Intelligent demand response design

4.1. Overall design

Based on the "Internet plus" smart energy demand response information platform is the use of the Internet and mobile Internet technology, we build a wisdom energy information platform to users.

The platform can be used to monitor the energy consumption and energy consumption of each energy consuming equipment and energy consuming unit in the enterprise, and to integrate the demand response technology to realize the reduction and transfer of the power consumption.

The platform uses the big data technology to construct the multi response model of the demand response to the user side. The model includes the potential demand response resource model, demand response execution model, demand response evaluation model, through large data demand response model, implementation and feedback analysis, explore the potential resources in response to demand response optimization strategy and demand response evaluation of implementation effect. The platform can make use of self-learning ability, pattern recognition technology and so on to realize the automatic optimization and improvement of the model.

The overall architecture design of demand response information platform is shown in figure 1.

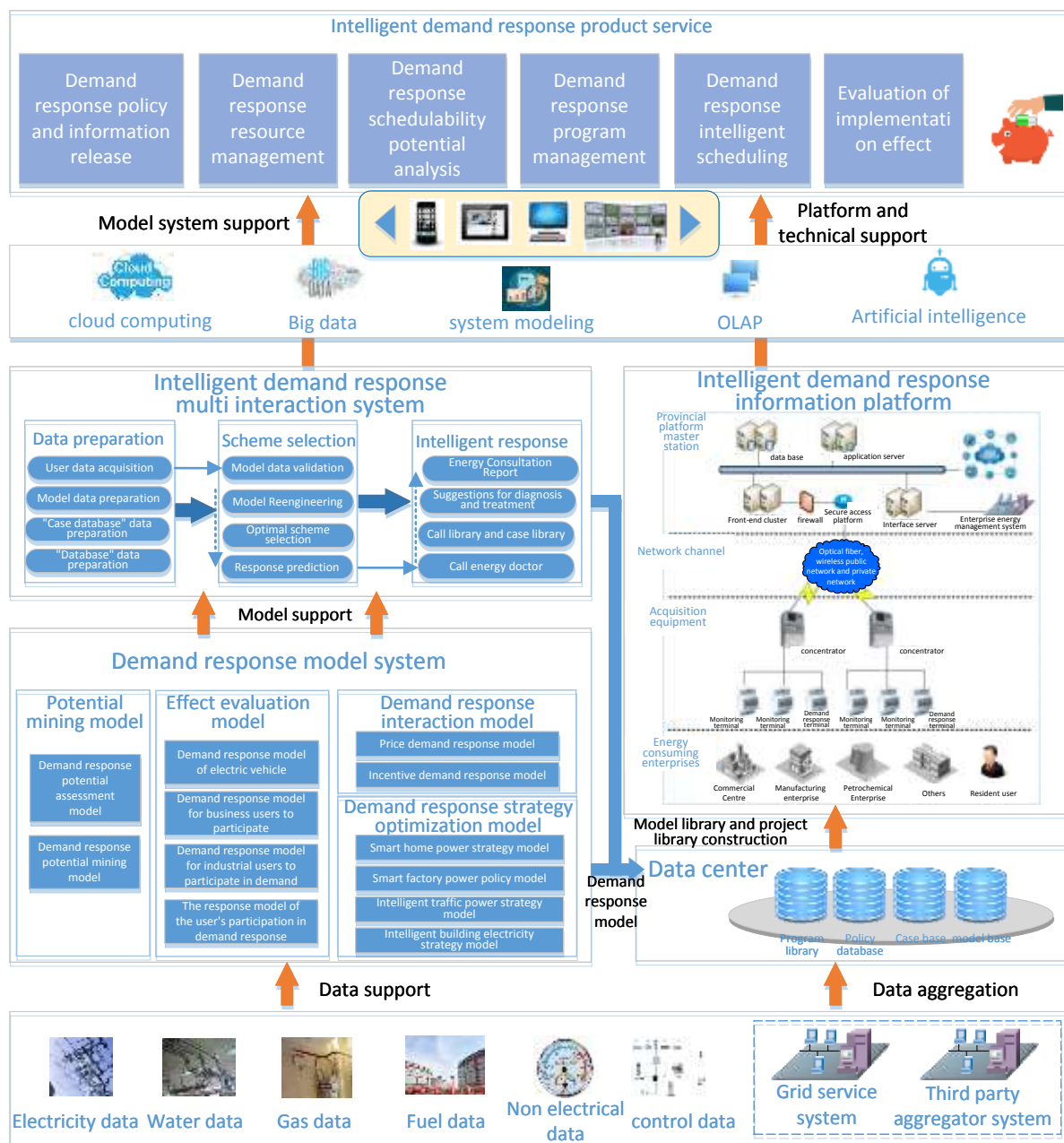


Figure 1. General Architecture of Demand Response Information Platform.

4.2. Demand response strategy

Demand response participation object categories are different in response to load demand in response time [6], response capacity [7] and the scheduling potential of different load characteristics [8], the demand response strategy is the factors that cannot be ignored, can be realized through the optimization of air conditioning [9] and water heater [10] start and stop strategy and electric vehicle [11] charging and discharging strategy to achieve the demand response. Demand of diversity of response, such as in [12] power supply side interests based on the maximization of real-time electricity pricing strategy of demand response, literature [13] considering the minimum delay time and minimum electricity appliances two targets proposed by the power equipment power adjustable scheduling strategy for demand response.

Response to the needs of different users, the demand response strategy is different, its development process is as follows:

(1) In response to user needs clear categories, user participation for industrial users, commercial users and residents to participate in the user load, demand response resource [14] category belongs to a simple adjustable load, energy storage device or distributed power supply;

(2) The load data is obtained by using the electric energy service management platform combined with the electric power dispatching system, and the load characteristics of the demand response are determined by means of data mining and load forecasting;

(3) According to the load characteristics of (2) using the mechanism analysis method to establish the demand response load regulation model;

(4) We need to determine the response objectives and constraints, combined with the demand response load regulation model using intelligent control technology, measurement technology and remote control technology. The demand response strategy is established, and the optimization of the demand response strategy is realized through the multi-objective optimization theory.

Based on the analysis of load characteristics of multi class load in the process of response to different needs, the demand response strategy database is constructed. Relying on the Internet platform to provide customized demand response strategies for specific users, considering the interests of both sides, to recommend the optimal response strategy for users. The demand response strategy formulation process is shown in figure 2.

4.3. Intelligent Implementation of demand response

Response to the needs of the pilot work in the process of promoting the process, the need to respond to the specific implementation of the process can promote a clear response to the need to complete. "Jiangsu province electric power demand response" rules for the implementation of demand response given in the implementation process, to promote the development of experimental work in the construction of demand response plays an important role in promoting. The development of demand response has gone through 3 stages, from manual, semi-automatic to fully automatic [15]. The development of intelligent response to the requirements of the development of automatic data cannot be separated from the use of intelligent methods and applications. Based on the application of demand response to user data and historical load data, by selecting the user performance index, the demand response is automatically selected. In this paper, the requirements of the implementation process of intelligent response shown in figure 3.

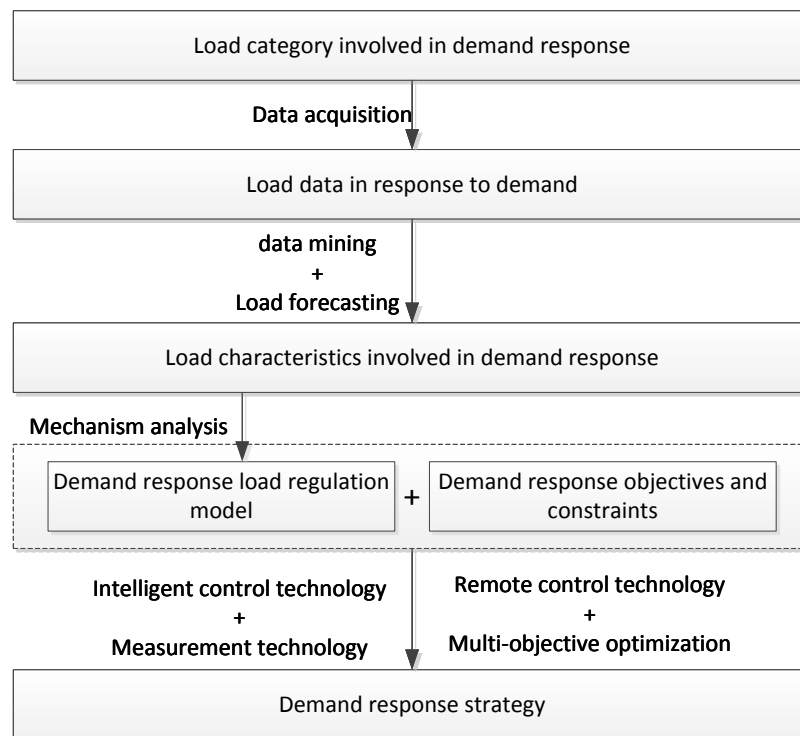


Figure 2. Demand Response Strategy Making Process

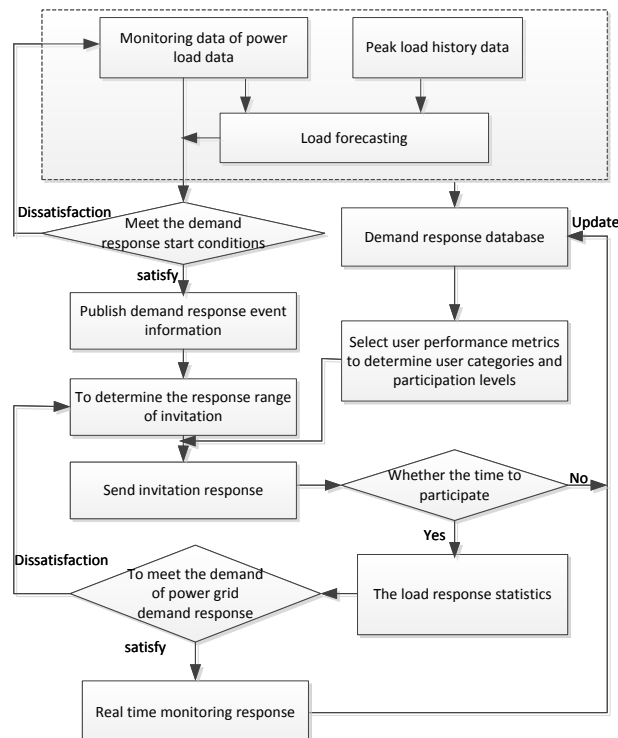


Figure 3. Demand Response Intelligent Implementation Process

(1) Based on the monitoring data of power load data and combining with the historical electricity peak data. By using the time series neural network, regression analysis or load forecasting means to

determine whether the demand response starting conditions such as power gap, the maximum load and peak valley ratio meet the demand response starting conditions, automatically determine whether should carry out demand in response to the incident.

(2) When the response requirements are met, the response information, such as demand response type, duration and response load. Through the response of user database, the method of index classification is used to deal with the performance index of the user's demand response. In order to determine the level of user participation in demand response, demand response in the solicitation process offer higher level user priority.

(3) In response to a user sends a response to the priority needs an invitation, when the user fails to offer feedback information in a timely manner, to demand response and timely feedback of user database update statistics offer user response to load whether meet the grid load demand response. When does not meet the need to re determine the offer range, according to the updated demand response database to rule out the invitation before the user, recalculate the solicitation of response variables, response level in accordance with the demand for an invitation. To monitor the response time and to update the requirements in response to the user database in order to meet the needs of the next time to prepare for the event.

4.4. Big data demand response

Driven by the Internet and big data era, big data analysis and application of the key factors of the rise of the industry. We consider the demand response load database and the demand response information database, to achieve the application of large data in response to the needs of the response, to promote the development of the demand response in many ways. Specific performance in the following areas:

(1) The application and improvement of relevant policies on demand response.

Demand response in the pilot cities in response to the needs of the relevant policies, such as electricity prices, incentives and other settings are different. However, considering the diversity of user load and power consumption, there are some limitations in the demand response policy. Based on the demand response information platform, the response mechanism model of different requirements is established. Combined with the relevant demand response strategy, through statistical analysis of large data means demand response simulation results, according to the results are retained in the pilot work to promote, promote the improvement of demand response policies.

(2) Refinement of demand response strategies.

At present, there are a variety of demand response strategies based on electricity price policy and incentive policy, which have some adaptability to some extent. From the platform to obtain the specific user load operation data, through large data statistics, mining and analysis of the load characteristics of the load in response to different scenarios, to predict the load response potential. Based on this, the load demand response control model is established, which provides the model support for the formulation of the demand response strategy and the establishment of the demand response strategy.

(3) New demand response service model.

Demand response service model is mainly based on business model. With the liberalization of the electricity market, the business model will not be able to meet market demand, demand response service model needs to break through innovation. Through the analysis and integration of large data understanding of user needs and wishes, to provide users with customized service model, analysis of the role of market diversification. It can provide users with value-added services such as energy management, equipment maintenance and energy saving services.

(4) Build a demand response case database.

Domestic demand response pilot practice work is everything in good order and well-arranged development, plays a promoting role in the peak, etc. In order to promote the needs of the pilot part of the work can be replicated to promote the need to establish a demand response case database. The demand response simulation case is based on the demand response platform, which provides the basis for the demand response scenario setting. At the same time, we need to use large data statistics and

integration of demand response pilot example, to provide a basis for the construction of demand response case database.

4.5. Construction of demand response interaction system

Interaction is an essential part of the development of intelligent power, there are related to the relevant literature on smart power interactive system [16], model [17], service [18], etc. And demand response as a means of intelligent power. Study on the interaction of power demand response system to realize high-speed data read, enhance customer service levels, improve the efficiency, reduce the cost of electricity users can promote the same, it is also our country demand response is an indispensable part of pilot project construction work.

In this paper, four levels of demand response interaction architecture are described, the specific interactive architecture as shown in figure 4.

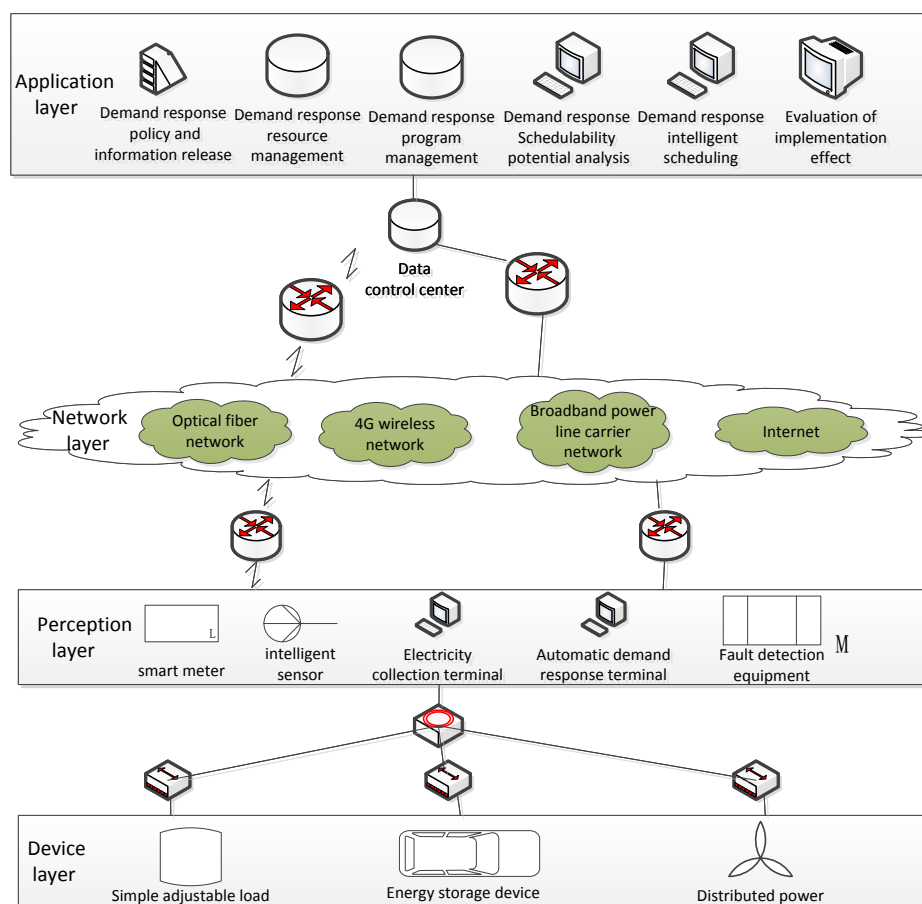


Figure 4. Demand Response Interactive System Architecture

(1) Application layer

Based on large data mining, statistics, analysis and integration of data resources, combined with the example of the pilot work for demand response, demand response situation, explore the new interactive model of demand response, the use of Internet technology, features as a support to provide operational platform for user interaction.

(2) Network layer

Demand response communication network information interactive platform is composed of light network, 3G or 4G wireless network, broadband power line carrier network and Internet, the main link for interactive business and information background.

(3) Perception layer

The sensing layer can be divided into three categories: data measurement, data acquisition and data sensing, which can realize the functions of data collection, aggregation and forwarding.

(4) Equipment layer

The device layer contains elements that are the user side device, the response to the demand for interactive terminals, which are essential elements of the demand response interaction.

4.6. "Internet" + "Demand response"

As a kind of virtual green power plant, the demand response is of great significance to the sustainable development of the intelligent energy. The rapid development of the Internet technology brings the opportunity for the rise of traditional industries. With the support of Internet technology, it can realize the interconnection of demand response resources, the information symmetry of supply and demand, and the energy balance. The combination of Internet and demand response is an inevitable trend, which has the following advantages:

(1) The concept of demand response can be extended to encourage more users to understand the demand response. The application of demand response theory in different industries to promote the effective use of resources, energy conservation and emission reduction;

(2) The demand response resources can be widely understood, so that more users can respond to the needs of the users to participate in the construction of the demand response;

(3) The combination of the Internet and demand response can promote the development of high quality demand response service, by means of large data related to the integration of data resources, the user can be provided to satisfy the different requirements of the demand response service, while improving the user awareness of science of electricity and electricity comfort;

(4) The combination of the Internet and the demand response can promote the development of automatic demand response. The use of the Internet means, within a certain range of independent access to data information and to determine the response to the needs of the event information, to provide a response to the needs of human strategy, while the realization of intelligent response to demand.

5. Design and implementation of demand response information platform

5.1. Design of data acquisition and interactive architecture

The development of demand response cannot be separated from the effective use of data resources. At present, the intelligent electric meters and other measuring devices collect a large number of load side data, and the utilization ratio of the data information resources is low. However, the study of information interaction can promote the sharing of information resources and the interaction between supply and demand. The information interaction between the grid side and the user side consists of three parts. Interactive information is the content of the demand response interaction, independent of the implementation of interaction. Interaction depends on whether the user is involved and the degree of user participation, interactive channel for the smooth implementation of interactive support path. Specific information interaction architecture shown in figure 5.

(1) Interaction

Interaction is divided into manual and automatic mode. Manual mode is the user to view the demand response event information, selectively participate in the demand response; Automatic mode is to set the user needs to participate in response to the automatic mode, set a certain demand response capacity, according to the response to the needs of the event information received, to determine whether to participate in the demand response; Semi-automatic mode is similar to automatic mode, but it is manually operated when deciding whether to participate in the demand response.

(2) Interaction channel

Interactive channel for demand response event information sending and receiving the network form, divided into the power line carrier network, light network, 3G or 4G wireless public network and internet.

(3) Interactive information

Demand response interactive information includes information resource base, load resource pool and response information. The information resource library includes user information, environmental information and policy information; the load resource library includes simple adjustable load, energy storage device and distributed power supply information; the response information includes the user's participation in demand response history information and real-time information. Through the realization of information interaction, we can realize the efficient optimization of demand response.

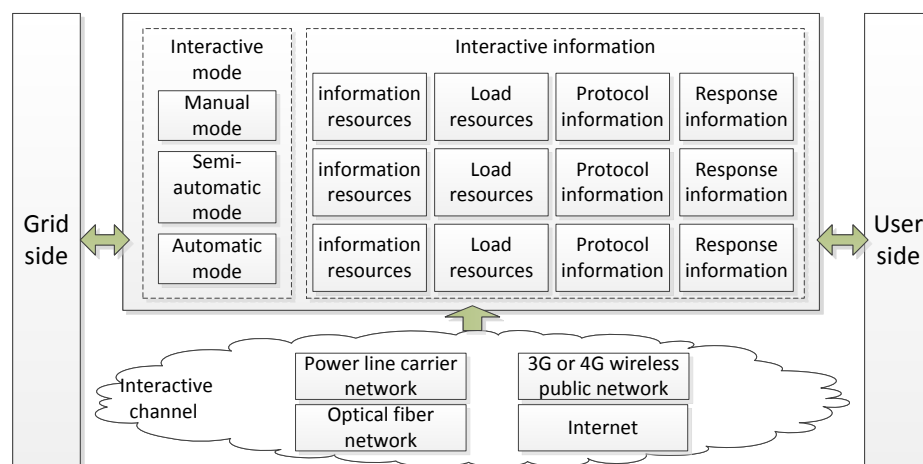


Figure 5. Information Interaction Architecture

5.2. Demand response control architecture design

With the popularization of the Internet, the real-time monitoring of electricity load increase. The application of the Internet of things sensing technology to the real-time monitoring of the load equipment operation state information, the determination of the demand response load resources participation, and the establishment of the demand response business control plan has the support function. At the same time, the design of the control structure can help to sort out the demand response event information as well as the Internet, the Internet of things and the demand response.

Through the management of the control log, we can understand the operation of each module, and put forward the demand response control framework. The architecture design is shown in figure 6.

(1) Communication layer

The communication layer includes platform communication and sensor network communication. Platform communication is responsible for docking with the various systems, data receiving and transmitting information, sensor network communication is responsible for communication with the demand response perception layer devices.

(2) Business logic layer

The business logic layer implements the control business processing function, which is composed of platform interaction, information interaction, real-time acquisition and control, online monitoring, data archiving and external interface module. The main function of this system is to get the load data in real time, and to transfer the data through the interface.

(3) Platform support layer

The platform support layer is provided with three groups of modules, which are a protocol library module, a device management module and a data interface module. Protocol library module provides protocol parsing function. The device management module provides the sensing layer communication

equipment status query and the related operation interface function. The database interface module provides the function of database access interface.

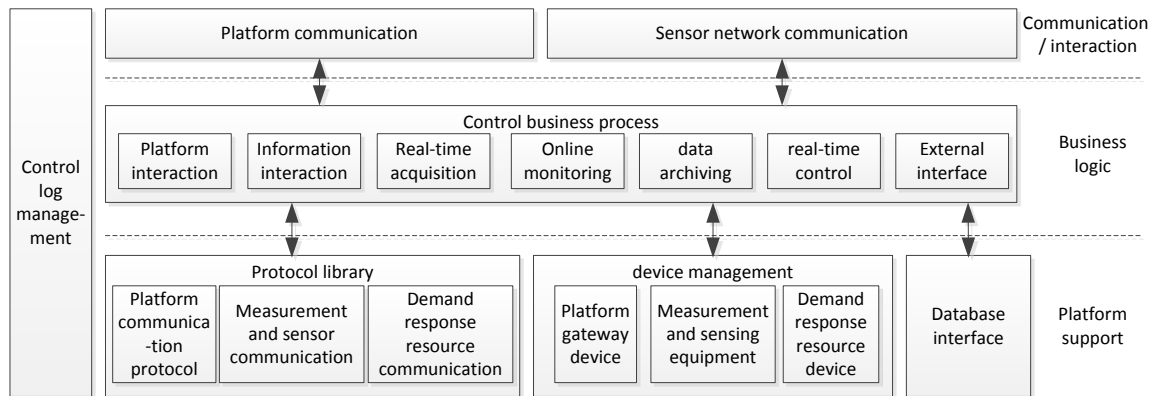


Figure 6. Demand response Control Architecture

5.3. Functional design

In order to promote the interaction between supply and demand, and realize the visualization of demand response information. The platform has the functions of the demand response policy and information release, resource management, schedulability analysis, program management, intelligent scheduling and implementation effect evaluation. Specific function structure shown in figure 7.

(1) Demand response policies and information dissemination

Demand response information platform to provide information and policies to respond to the needs of the release of information. Demand response policy information includes: legal regulations and policies, implementation policy, price policy and incentive policy; demand response event information including notification time, the implementation of demand response type, duration, response capacity etc. According to the platform to provide policy and information, the user needs to understand the dynamic response of timely information and analysis of demand in response to the incident response demand environment, selective response policies and event types, this can promote the active participation of users. At the same time, according to the feedback result of the demand response, the response information of the specific environment and the user group is adjusted, and the information is published in the demand response information platform.

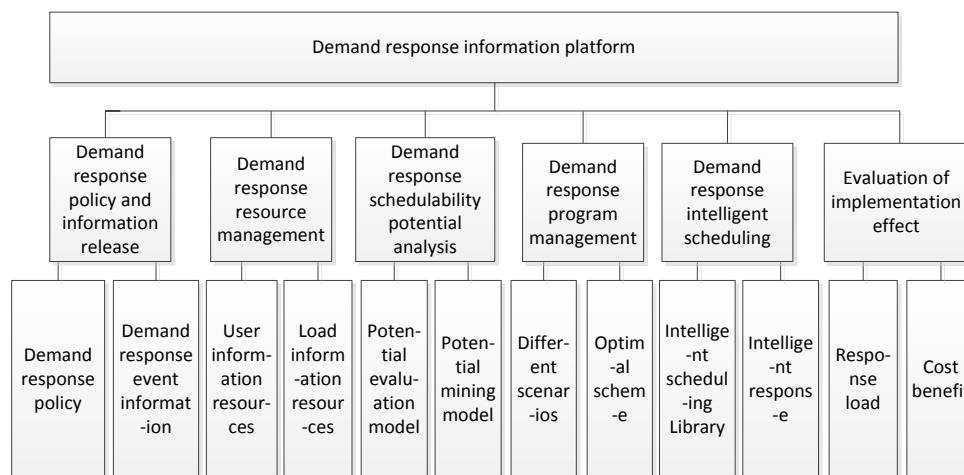


Figure 7. Functional Structure of Demand Response Information Platform

(2) Demand response resource management

The demand response information platform provides the resource archive management function, and the demand response resources are divided into two forms: demand response user information and load resources. Load resources mainly include simple adjustable load, energy storage device and distributed power supply. Control center data classification storage of user information and load information resources, to understand the needs of users in response to implementation of the use of the Internet online real-time dynamic, the use of networking means to monitor the equipment running information, and save data information for demand response scheduling potential demand analysis and response strategy use.

(3) Demand response potential analysis

Based on the model of load potential mining and the evaluation model of the load potential, the demand response information platform provides the potential function of load dispatch. Electrical operation characteristics, adjustable load has the characteristics of diversity, by means of large data mining analysis of user load data characteristics, selected measure of load characteristics index, using the relevance assessment of technical analysis tools evaluate construction load, load model and load model to assess the potential of mining potential, realize the analysis of user load potential, reasonable load scheduling.

(4) Demand response program management

Demand response information platform provides a demand response program management function, according to the traditional data, historical data and other means, relying on big data and Internet technology, built a variety of demand response operation scene and simulation test, the establishment of suitable for different application scenarios of demand response plan. And storage management program can be run by a small range of pilot, the implementation of the program and correction. Through the Internet real-time understanding of meteorological, environmental information. According to the different demand response events, we can develop a user-friendly response plan which can be selected by users.

(5) Demand response intelligent scheduling

The demand response information platform provides the demand response intelligent scheduling function, which is triggered by the demand response. And the application of user information to participate in the use of intelligent means for screening. The demand response intelligent scheduling library is established, and the response scheduling is carried out. At the same time, the data in the scheduling process is aggregated to the demand response database.

(6) Performance evaluation

The performance evaluation system is shown in figure 8. The integration of different areas of performance evaluation scheme, through screening the different evaluation index of different demand response events, select the corresponding performance evaluation scheme, combined with the use of large data analysis and evaluation results of evaluation schemes are constantly updated, to plan specific evaluation form specific environment, realize the scientific and reasonable evaluation.

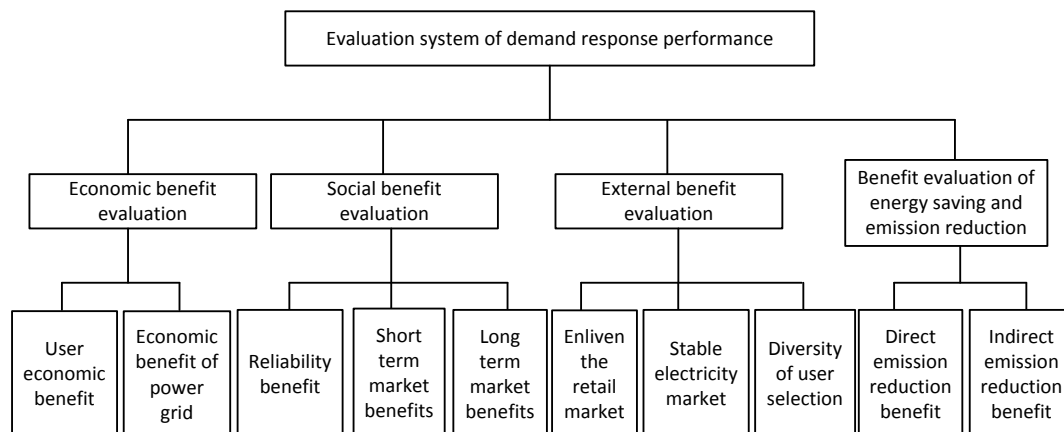


Figure 8. Implementation Effect Evaluation System of Demand Response

6. Conclusion

In order to adapt to the development trend of the Internet, to promote the development of demand response information visualization and good interaction between supply and demand side, this paper is based on "Internet plus" smart energy construction demand response information platform, the Internet, networking and big data and other methods combined, realize the interaction of supply and demand side, to provide quality services and electricity to provide platform to support fine demand response strategies for the user, can be copied, promotion.

Acknowledgments

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