

# Design of demand side response model in energy internet demonstration park

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**Abstract.** The implementation of demand side response can bring a lot of benefits to the power system, users and society, but there are still many problems in the actual operation. Firstly, this paper analyses the current situation and problems of demand side response. On this basis, this paper analyses the advantages of implementing demand side response in the energy Internet demonstration park. Finally, the paper designs three kinds of feasible demand side response modes in the energy Internet demonstration park.

## 1. Introduction

As early as 1990s, demand side management has been introduced into China, and promotes China's energy-saving emission reduction. However, in practice, there are various problems and obstacles<sup>[1]</sup>, and the demand side response is not effectively promoted. To some extent, the development of the energy Internet overcomes these problems and obstacles, and promotes the application of demand side.

## 2. The status and problems of demand side response

### 2.1. The status of demand side response

Under the background of the market-oriented reform of electric power industry, in order to overcome the shortcomings of traditional demand side management, maintain the system reliability and improve the efficiency of the system, the concept of demand side response is proposed in the United States firstly. Electric power demand side response is a kind of market participation behavior, which is based on the price signal or incentive mechanism. Based on the experience of the domestic and international demand side response, the demand side response mainly includes two types: price based demand side response<sup>[2]</sup> and incentive based demand side response<sup>[3]</sup>.

### 2.2. The problems of demand side response

At present, the basic concept of demand side response has been widely accepted and recognized, there are no technical barriers, and many countries have accumulated relevant experience. However, there are still some problems in the application of demand side response in China.

First, the demand side participation awareness is not strong. At present, China is still in the demand side management stage<sup>[4-5]</sup>, the market is not strong, user participation is low. China has also implemented a number of demand response policies, such as since 2004 in Jiangsu, Hebei, Fujian,



Shanghai, Zhejiang and other provinces have carried out the practice of interruptible load. But overall, the implementation of the work is still in its infancy, and interruptible load compensation standards are too general, did not take into account the type of user. Therefore, the user can't produce effective incentives, user participation enthusiasm is not high.

Second, the cost of relevant support technology is high<sup>[6-7]</sup>. Without the technology and facilities necessary for measurement, comparison and compensation, consumers cannot respond appropriately to the price, incentives and instructions of the operating system. The funds required for the construction, upgrading and maintenance of the equipment are in greater demand, and recovery cycle is longer, the average users are difficult to accept.

Third, the user's ability is insufficient. Users to participate in the demand side response should be certain numbers and have the demand and ability to adjust the load. At the same time, the load participating in the demand side response should have the following characteristics: the amount of electricity is large, electricity time is flexible, and electricity load can be adjusted, such as home water heater, central air conditioning, municipal water pump, etc. However, the adjustable load power of single type of user or a single large user is limited, and the adjustment form is also relatively simple.

### **3. The advantages of the implementation of demand side response in energy internet demonstration park**

Energy Internet is a kind of energy system which is based on the multi energy network, physical information system, and realizes the value of the energy system. As the deep integration of the energy technology and Internet technology and thinking, Energy Internet demonstration park has a natural advantage on demand side response.

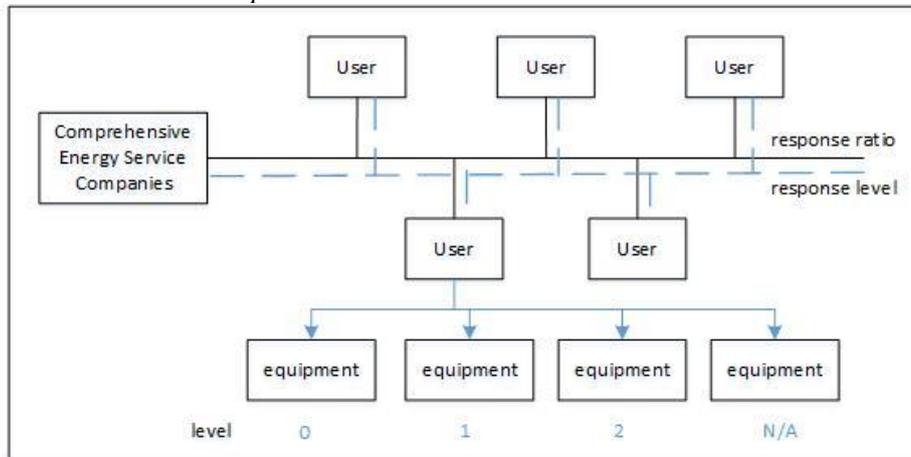
First, there are sound information technology and infrastructure in Energy Internet demonstration park. The application of intelligent meter and advanced measurement system in the energy Internet demonstration park, realizes the data collection and transmission of the user's power and electricity and provides basic information for the user to adjust. In addition, as an important part of the energy Internet demonstration park physical layer construction, energy storage technology has brought great flexibility for the energy use of the demand side. By optimizing the operation scheme of the energy storage system, the load fluctuation can be reduced, and the load reduction demand of the power grid can be rapidly responded.

Second, there is a certain number of users with the demand and ability to adjust the load. At present, the energy Internet demonstration park is mainly with the industrial park, and has a large annual electricity consumption and load regulation potential, which is in line with the requirements of the demand side response to the users. At the same time, there are many types of users in the demonstration park, the load curves between some users show natural complementarity, through the combination of such users, the overall load curve tends to smooth.

Third, the comprehensive Energy Service Companies in the park have professional knowledge and complete information. As the main body of providing energy services of the energy Internet demonstration park, the integrated Energy Service Companies in the park have the most complete user load information, through data mining, they design a reasonable user incentive program to encourage users to actively participate in the demand side response. At the same time, integrated Energy Service Companies can get relevant policy information in time, reduce the demand side response barriers caused by asymmetric information.

#### 4. Design of demand side response model for energy Internet demonstration park

##### 4.1. Single user demand side response model



**Figure 1.** Process of two step clustering algorithm

For single power users, it can use direct load control as a means, and use a demand response control mode for peak load reduction or load transfer. Through the installation of energy systems in buildings or residential units<sup>[8]</sup>, such as the central system of the local system, and the use of smart sockets and other equipment which are used to monitor and control a single appliance, it achieves automatic demand response. In this response mode, the integrated Energy Service Companies send a response signal containing a load control response ratio and a response level to the end user, and the terminal user makes the decision locally according to the signal. The response ratio refers to the ratio calculated by the Energy Service Companies according to the target load regulation and the actual load demand, the response level indicates the urgency of the response task. The response center can adjust the signal in real time according to the adjustment of the local feedback. After several times, the load can reach the target value. Finally, the integrated Energy Service Companies give the corresponding incentives according to the degree of response of the power users.

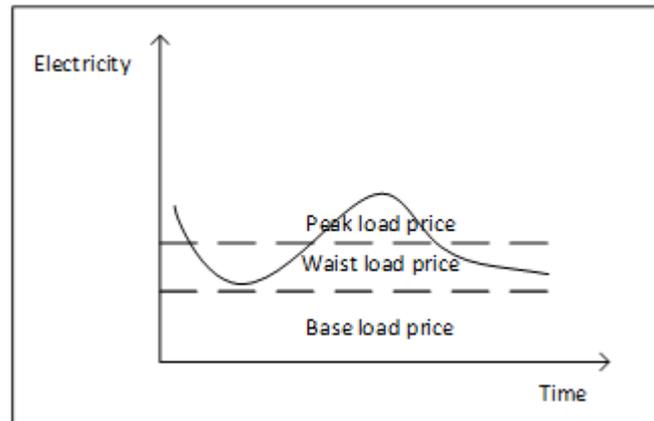
In this mode, on the one hand, the integrated Energy Service Companies can distinguish the current demand response level according to the different response levels, on the other hand, the power users can sort the local electrical appliances according to the response level. The response level can distinguish the elasticity of different kinds of loads, and get the current adjustable quantity, so that more electric appliances with different participation enthusiasm can be added to the demand response to improve the user participation. The end user can set the level of response of the electrical appliance locally, as shown in table 1.

**Table 1.** Level setting

Level	Explain
0	As long as there is a response to demand, you can participate in
1	Only participate in peak load to obtain high compensation
2	Only participate in when there are network security issues
N/A	Do not participate at any time

##### 4.2. Multi type user complementary model

In the electricity market environment, comprehensive Energy Service Companies participate in the purchase of electricity trading in electricity trading center, the transaction price is divided into base load electricity, peak load electricity price and waist load according to the load curve.



**Figure 2.** Electricity price mechanism in electricity market environment

In the energy Internet demonstration park, there are a variety of types of users, some types of user load curves show natural complementarity. Or through the demand side management, the load curves of different users show complementarity. Under this kind of electricity price mechanism, the integrated Energy Service Companies will combine the complementary user groups, so that the overall load curve tends to be stable. This allows more power to deal with low base load electricity price, which not only saves the cost of purchasing electricity of the park, but also increases the stability of the energy Internet demonstration park.

#### 4.3. Combined cooling and heating to reduce load demand

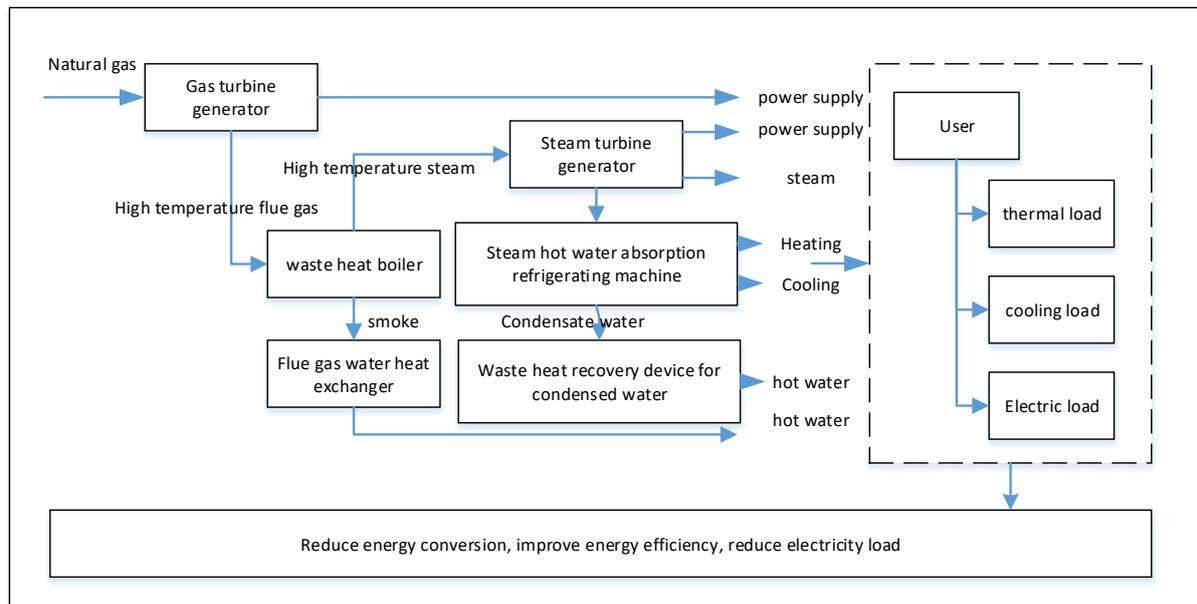
Through the construction of distributed fire engine in the energy Internet demonstration park, the park built a cold and thermal power supply model.

"Electricity": the supply side for the discharge of the wind power, photovoltaic, gas turbine, the demand side for the charge of nearby residents, industrial, commercial electricity and energy storage;

"Hot": the supply side for high temperature steam or hot water of distributed fire engine, the demand side for large industrial steam demand users and residents of the community to provide hot water supply and community heating, etc.;

"Cold": the supply side for low temperature gas of distributed fire engine, demand side for centralized cooling of industrial and community.

In the cold and heat power supply mode, the demand side replace the electric refrigeration, heating behaviour directly with cold, heat,. This will not only improve the efficiency of energy use as avoiding the energy conversion, but also reduce the demand to some extend, to meet the corresponding needs of the demand



**Figure 3.** Power load model for cooling, heating and power reduction

## 5. Concluding Remarks

The rise of the energy Internet as well as the ongoing construction of energy Internet demonstration park is conducive to the implementation of the demand side response. Energy Internet demonstration park has a unique advantage on support technology and access to information in the user groups,. As the main body of energy supply of energy Internet demonstration park, comprehensive Energy Service Companies shall make full use of customer load information, develop a targeted demand side response model, and encourage users to join in demand side response.

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