The Energy Accumulation of New Energy Internet Oriented to Customer Side

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Abstract. The energy accumulation of energy internet aims to accumulate various scattered energies at the customer side, such as distributed energy, energy storage, electric vehicle and typical load. The diverse power-supply interactive service system adopted to realize the supply-side and demand-side energy services. With the aid of modern technologies such as the internet of things, internet, big data analysis and cloud computing, it can realize the information sharing of power supply, the interconnection of energy information as well as energy coordination and mutual aid. The energy accumulation of new energy internet oriented to customer side can satisfy the diverse needs of the power supply market as well as further combine the new energy internet oriented to customer side with the information network.

1. Introduction
With the fast increase in the energy consumption and the worsening of energy shortage on a global scale, the energy accumulation at various customer sides based on internet has become the core of energy system development under the background of the challenging energy development and internet plus. The advantages of energy internet can be fully utilized to coordinate the energy development, allocation and utilization between different regions as well as realize the across-region energy coordination and mutual aid [1-2]. The effective allocation of various customer-side energies, such as distributed power, energy storage and electric vehicle charging pile can achieve the objectives of utilizing various customer-side energies efficiently, such as the on-the-spot consumption of distributed energy as well as efficient power storage and electricity consumption [3-5]. Moreover, a series of modern technologies can be utilized to integrate the energy information at the supply side and demand side. Various measures, such as the access of distributed energy and power storage system to the grid as well as the charging and discharging of electric vehicle charging pile at the proper time, can be taken to realize the energy accumulation of various customer sides between different regions as well as realize the energy interconnection, coordination and mutual aid[6].

At present, the customer-side energy is faced with the problems, such as the low rate of energy utilization, the scattered energy information, the inability to make the real-time feedback and the difficulty of energy accumulation. As a result, the energy interconnection can not be realized. Therefore, a mature across-region energy accumulation mechanism is urgently needed to better
develop and realize the solution to across-region energy optimization and utilization, the method of energy integration as well as the effective energy coordination and mutual aid.

This paper is devoted to researching the method of accumulating the scattered energy and the energy interconnection services aimed at the new energy internet oriented to customer side. The diverse power-supply interactive service system has been utilized to realize the friendly supply-and-demand interaction in different regions. The method of interconnection, coordination and mutual aid proposed in this paper has been also verified. Moreover, this paper has put forward a mature method of energy accumulation for the research into new energy internet oriented to the customer side. This method can be realized and promoted more widely.

2. Various customer-side energies and individual features

With the growing popularity of the resources such as new customer-side resource, the form and characteristics of various customer-side energies should be well understood so that the method of accumulation, integration, coordination and mutual aid between various energies can be mastered. The solar photovoltaic power and wind power, both of which are distributed power, are the important energy demanding much attention. Solar power and wind power have the feature of fluctuation. Under the condition of the control and adjustment of the external market, it can effectively participate in the load adjustment, thus relieving the problems such as energy shortage and the pressure on the grid as well as improving the reliability of the grid’s power supply greatly. According to the form of energy storage, it can be classified as electrochemical energy storage (such as battery storage device), electromagnetic energy storage (such as super-conducting energy storage and super-capacitor storage), mechanical energy storage (such as flywheel energy storage and compressed-air energy storage) or thermal energy storage. The load of energy storage has the feature of fast charging and discharging. Electric vehicle charging pile is the energy supply device for electric vehicle. The plug-and-play device of energy internet is used to sense the status of electric vehicle. The relevant load will be also uploaded to further control the charging pile. In most cases, the temperature-controllable load has the feature of being interruptible and adjustable, which means that it can be interrupted without affecting the users. As to the load which is not controllable, those users are encouraged to actively participate in the load adjustment on the precondition of not affecting the normal use of the users. In other words, the load will be transferred to the valley for the use.

Figure 1. Various customer-side energies and their features
3. Energy interconnection

3.1. Energy accumulation
There are a variety of typical loads. The individual feature varies from one to another. The plug-and-play device can be installed at the customer sides, such as distributed power and energy storage, to collect the data of the devices, such as photovoltaic device and wind fan. The data is related to the generation capacity, consumption rate and energy storage SOC. The modern technologies, including big data and cloud computing, are also utilized. Regional behavior analysis is adopted. By means of user portrait, time portrait and accumulation feature, energy accumulation will be further realized, thus leading to the features of energy accumulation and relevant analysis results. The customer-side energy accumulation with a high degree of effectiveness and accuracy can be realized in this way.

With the aid of the technologies such as internet, big data and cloud computing, various customer-side energies in the region will be integrated. The energy accumulation will be displayed in the form of energy cloud. Besides reflecting the energy production, energy use and load use in the region, it can also allocate the energy in the region. When this scheme is adopted in many regions, the regional energy cloud consisting of a number of energy clouds in various regions will be formed. The energy status in various regions will be further summarized to realize the macro control over the energy between different regions.

3.2. Energy allocation
The energy cloud will integrate the energy of distributed power, such as photovoltaic device and wind fan, and also motivate the users to take the measures, including the self-consumption of distributed power, transmitting the surplus power to the energy storage device for storage and backup as well as feeding into the power grid. The method of charging at the valley and discharging at the peak can be adopted to relieve the pressure on the power grid. The small-scale and high-frequency within-cloud energy allocation can realize the self-consumption of surplus energy and reduce the waste of energy. The across-region energy can be transmitted through energy storage device in the form of backup energy. Electric vehicle can be also used to allocate the energy according to the mode of charging and discharging at different time and in different places. Moreover, the customer-side scattered energy can be fed into the power grid for coordination and allocation.

![Figure 2. Structure diagram of energy internet](image-url)
3.3. The principle of energy allocation

First of all, one of the three objectives should be chosen as the principle for energy cloud. The three objectives are optimizing the economic benefit (giving priority to distributed power generation during the peak, maximizing the energy storage and utilization as well as encouraging the discharging at the valley), optimizing the energy-saving and green production and minimizing the load of power grid. The surplus energy, which can not be consumed or stored in the region with a low consumption rate of distributed power, a low rate of energy utilization and a high rate of wind and solar abandoning, will be transmitted to the region demanding a large quantity of energy consumption within the shortest distance with the aim of improving the energy utilization rate and reducing the energy loss during the process of power transmission.

In the case of energy shortage or energy surplus in the region, the energy import from or energy export to the neighboring region can be made to solve the problem. Energy allocation can realize the effective energy utilization and allocation between different regions. Finally, the objective of reducing the comprehensive energy consumption and decreasing the difference at the valley can be realized.

4. Energy service

Energy services refer to the energy internet based on the diverse energy-supply interactive service system. It consists of energy accumulation, regional energy-consumption behavior analysis, energy accumulation analysis as well as energy coordination and mutual aid. The functional framework of energy internet services can be seen in the table below.

![Figure 3. The functional framework of energy services](image-url)

With multiple dimensions such as power consumption analysis, load analysis, demand analysis, peak/valley power consumption analysis and power consumption mode analysis, the regional energy-consumption behavior analysis aims at the features of energy consumption, including users’ power consumption and energy-saving potential. Based on the information about power consumption in the region, such as whether various customer-side energies are available in the region, total power consumption and peak/valley electricity parameters, the methods, such as time portrait and accumulation features, will be adopted to summarize the habits of power consumption. The multi-dimensional analysis of various customer-side energies has been also conducted.
The energy services of diverse power-supply interactive service system are mainly reflected in energy accumulation and the relevant analysis. Various customer-side energies will be accumulated by the system to form the energy cloud which is used to display the energy allocation in the region. Through visual methods such as energy flow diagram and GIS map, the clustering load features of the customer-side energy, such as accumulation feature and responsive feature, can be displayed visually in a panoramic and full-dimensional manner. The integrated analysis will be also carried out based on the photovoltaic and wind power consumption, consumption rate, energy storage SOC and the utilization rate of charging pile in different regions. Based on the results of the regional energy-consumption behavior analysis and energy analysis, the customer-side energy in a certain region will be further integrated. Finally, the macro features of energy accumulation will be displayed dynamically in the form of regional energy cloud.

Based on the energy efficiency of the residents and enterprise users in different regions, this system is capable of analyzing and integrating the energy efficiency. Moreover, the relevant historical data of different types of energies and the influencing factors, such as weather, have been also taken into consideration. Some methods, such as multiple regression and prediction, have been adopted to predict the energy. Based on the overall energy efficiency analysis in the region, the regional energy optimization strategy has been chosen to further realize the energy coordination and mutual aid, which means the energy internet in a real sense.

5. Conclusion
Aimed at the problems such as the waste caused by the scattered use of customer-side energies and the energy shortage in some regions, this paper has designed a scheme for energy interconnection. Besides making an in-depth research into energy accumulation, this paper has also proposed the concept of energy cloud. Based on the energy-service modules of diverse power-supply interactive service system, this system can realize the accumulation of scattered energies and optimize the energy allocation. Therefore, the coordination and mutual aid between different energies have been realized.

References
[1] Qian Wang. Internet Plus Power Grid. The Useful Exploration of Energy Internet [J]. Internet Economy. 2015 (8): 16-19.
[2] Qing Yang. Energy Internet Changes the World [J]. State Grid. 2016 (10): 46-47.
[3] Zijuan Qiu. The Design of Pregnant Women’s Smart Home System Based on the Internet of Things [J]. China’s Strategic Emerging Industries. 2017 (44).
[4] Yunqian Peng, Chen Shidong and Zhou Renjun. The Flexible and Interactive Smart Power-consumption Services Management Platform [J]. Shaanxi Power. 2017.45(4): 34- 38.
[5] Changkai Shi, Zhang Bo, Sheng Wanxing, et al. The Discussion of Technical Framework of Flexible and Interactive Power Consumption [J]. Power System Technology. 2013, 37 (10): 2868-2874.
[6] Wei Pei, Du Yan, Li Hongtao, et al. The New Scheme and Key Technologies for the Interconnection and Interaction of the Large-scale Access of Micro-grid Group [J]. High Voltage Technology. 2015, 41 (10): 3193-3203.