Typical application scenarios of energy internet platform serving rural revitalization

Xie Anbang*, Li Peng, Zheng Yongle, Li Huixuan, Zhang Hongkai, Zu Wenjing
Economic Research Institute of State Grid Henan Electric Power Company, Zhengzhou, Henan, 450000, China
*Corresponding author’s e-mail: hndl-jyy@ha.sgcc.com.cn;904628449@qq.com

Abstract: Energy is an important material and dynamic basis to promote the implementation of rural revitalization strategy. With the rapid development of informatization and digitalization, energy internet platform has become a powerful driving force for the construction of a new rural energy system. First of all, this paper analyzes the functional requirements of the rural energy internet platform from four aspects: planning and decision-making, agricultural production, clean heating and market prosperity. Secondly, according to the functional requirements of the platform, a functional framework of rural energy internet platform is established. Finally, four typical application scenarios of planning and decision-making, intelligent agriculture, intelligent heating and platform economy are established. It is of a certain significance for serving rural revitalization through energy methods.

1. Introduction
Compared with urban areas, the energy infrastructure in the vast rural areas of our country is weak, and the level of information development lags behind, which affects the effective landing of the rural revitalization strategy to a certain extent. The energy internet platform replaces the traditional energy product-centered service model with the customer-centered new energy service model, which breaks down barriers in different energy categories and various links such as energy production, transmission, storage, consumption, trading and supervision. Through the construction of the platform, we can effectively meet the needs of diversified energy users such as the government, enterprises and farmers, and release the powerful power of energy in promoting rural revitalization.

At present, most of the researches on energy internet are about urban areas. Literature [1] discusses the functional system and application scheme of energy internet in urban areas. Literature [2] analyzes the application scenarios of energy internet in the process of urbanization in China. Literature [3] puts forward seven industrial convergence scenarios of energy internet, including agriculture and new rural construction. With the strategy of rural revitalization put forward, some scholars have studied the application of energy internet in rural areas. Literature [4] puts forward a clean heating solution based on energy internet. Literature [5] analyzes the way that electric energy replaces load to participate in demand response under the background of energy internet. Literature [6] introduces the concept and development trend of agricultural engineering energy internet.

It can be seen that the rural energy supply is characterized by many categories, scattered distribution and great differences, and different service subjects have different demands on industry, life, management, etc. There are great differences in the business types and operation modes of energy internet services in rural areas. Therefore, it is very important to analyze the needs of users and determine the typical application scenarios of energy internet platform in rural revitalization.
2. Function demand analysis of rural energy internet platform

2.1. Serving Planning Decision

With the overall victory of Poverty alleviation, the vast rural areas in China will enter a new stage of development. Planning is the first step for Rural revitalization. Planning decision-making needs a lot of data support. Through the energy internet platform, we can provide different levels of serialized, high-value digital products and services, to help the government governance capacity, improve the energy efficiency, convenience service level of enterprises, and empower rural revitalization with numbers.

In view of the current situation of rural population gradually shifting from rural areas to urban areas and the massive loss of human resources, we can analysis the development trend and characteristics of rural hollowing out, and judge the changing trend of population structure in rural areas. According to special families such as left-behind families, migratory bird families and lonely elderly families in rural areas, we can analysis and correlate their electricity consumption data, and carry out "energy consumption care" to serve social security and government care. In view of the improvement of government governance capacity, the relationship between economic and social development and energy consumption data is analyzed in depth. Based on massive energy consumption data and data analysis results, "electricity sees economy and energy sees development" is realized, which helps the government to make precise policies. In view of the industrial development, we can gather a large amount of development data in related fields, analysis the implementation results, and serve investors to make accurate decisions.

2.2. Serving Agricultural Production

As a large agricultural country, China has some problems in agricultural production, such as small scale, changeable growth environment, serious aging of labor force, low utilization rate of resource, etc. Through the energy internet platform, we can develop intelligent agriculture, explore the modern agricultural road of intensive production, efficient output, environment-friendly and product safety, to realize the intelligence, automation and precision of agriculture, improve agricultural production efficiency and reduce the level of energy consumption.

In view of the optimization of crop growth environment, a greenhouse with complementary agriculture and light can be built, and the fine monitoring of crop growth can be realized through new intelligent agricultural loads such as LED plant growth lamp, water and fertilizer integrated machine, plasma nitrogen fixation device, etc. In view of the operation of power grid with a high proportion of new energy access, we can count the adjustable flexible load on the station side, and participate in the demand-side response through the overall time arrangement of planting or breeding. For agricultural-light complementary connected areas, we can form the convergence effect through multi-point distributed photovoltaic, participate in power grid peak regulation and frequency modulation, which improve the grid operation efficiency and obtain benefits at the same time.

2.3. Serving Clean Heating

Clean heating in rural areas is related to people's livelihood. It is of great significance to the implementation of rural revitalization and the improvement of rural living environment. With the continuous improvement of policies and the coordinated promotion of all parties, rural heating methods show a diversified trend, while the traditional high-emission heating facilities still exist in rural areas, and the pollution problem is still very serious. The reasons are as follows: first, the lack of national development guidance planning, second, vicious low-price competition among enterprises, and third, clean heating costs are far beyond the affordability of rural families.

In view of the choice of heating methods, it is necessary to analysis the population and household area of each household to diagnose the typical household energy efficiency, to help residents grasp the overall household energy consumption, and guide residents to choose the most suitable clean heating mode according to local conditions. In view of heating cost services, it can be classified according to the heating equipment chosen by each household, and negotiate with equipment purchasers uniformly
to ensure that rural families can bear the cost of clean heating. In view of the demand-side response, through a unified analysis of the regional energy load in the heating season, we can interact flexibly with load aggregators, participate in power auxiliary services while realizing clean heating in rural areas, and help to cut peaks and fill valleys.

2.4. Serving Market Prosperity
With the implementation of the rural revitalization strategy, China has introduced a series of favorable policies for farmers, such as reducing agricultural taxes and fees, providing green credit and other measures. As a result, China's farmers' income has been increasing, their purchasing power has been gradually enhanced, and the consumer demand has been rising and diversified. However, at present, the rural industrial and commercial market still faces problems such as high financing threshold, low financing efficiency and imperfect capital supervision. The various factors have not yet fully converged, and the supply and demand market has yet to be fully activated.

In view of the financing threshold problem, internet-related technologies should be used to innovate financing products to improve the transparency of capital orientation and provide better financing services. In view of financing efficiency, block chain technology can be adopted to realize asset digitization and transaction intelligence, improve cooperation efficiency, and reduce cooperation risks and credit costs. In view of financial regulation issues, we can establish credible credit rating and realize real-time update to ensure the transparency of capital flow. In view of the construction of supply and demand market, the platform can realize the convergence of products, services and demands of both sides, and build a mutually beneficial and win-win energy internet ecosystem.

3. Functional architecture design of rural energy internet platform
According to demand analysis, the rural energy internet platform is mainly composed of planning and decision-making module, agricultural production module, clean heating module and platform economic module. Its functional architecture is shown in Figure 1.

4. The Construction of typical Application scenarios of platform-assisted Rural Revitalization

4.1. Planning and Decision-making Scene
Planning and decision-making scenarios mainly provide support for government policy-making, deployment strategy and planning through the processing and storage of economic and social development data, energy and electricity data, residential energy use data, etc. It can provide decision-making and consulting services for the development of rural agriculture and industry.
For the government, planning and decision-making scenarios mainly provide three kinds of services. First, deploy the development strategy. The industrial energy consumption is regulated by analyzing the power consumption of industrial structure and publishing the power index of resuming work. Evaluate the operation of the industrial pillar, assist the government to study and judge the economic trend, make orderly arrangements for resumption of work, and deploy strategies for economic development and energy development. Second, make policies. Through the prediction of terminal energy consumption and carbon emissions, combined with the actual household energy use, assist the government to formulate carbon peak, carbon neutralization, carbon trading, energy conservation and emission reduction and energy subsidy policies. Third, carry out rural hollow analysis. Through the analysis of residents' energy load, the construction of emptiness identification model, real-time measurement and query of rural emptiness, rural idle housing analysis, assist the government in industrial allocation, village appearance governance and accurate investment to improve the intensive utilization rate of land. For the rural industry, through carrying out the analysis of industrial structure adjustment and upgrading, the level of regional economic development, the level of rural industrial prosperity and the level of industry revival, we can help industrial investors grasp the situation of the industry and achieve...
accurate investment. Help industrial operators to adjust operation strategies and plan industrial scale, to promote the sustainable development of rural industry.

For rural agriculture, through the analysis of demographic data and energy use data, we can accurately identify specific family types such as families of rural left-behind population, families of migratory birds, families of lonely and widowed elderly, etc. Different levels of electricity subsidies are implemented according to household income and electricity consumption. For the families of the lonely and widowed elderly, according to the changes in their electricity consumption, the abnormal energy use should be found in time, and the local village committee should be notified automatically to inquire about the family situation, and send personnel to pay attention to prevent accidents of the elderly if necessary.

4.2. Intelligent agricultural scene

Intelligent agriculture scene takes rural planting industry and animal husbandry industry as samples, mainly provides local farming enterprises or farmers with environmental monitoring, energy efficiency management and real-time scheduling and other services to improve product quality and serve the construction of ecological civilization at the same time. By installing various front-end sensing devices and transmitting them to mobile application terminals through Internet, ZigBee, 5G, NB-IoT and other technologies, managers can integrate various types of information. Managers can understand the real-time dynamics of agricultural production before, during and after production, and complete parameter control remotely. While realizing the energy-saving, intelligent and efficient agricultural production process, it can effectively improve the efficiency of agricultural production and the quality of agricultural products, so as to achieve the purpose of high efficiency, high quality and safety of agricultural production.

In the aspect of intelligence monitoring, through the installation of environmental monitoring system, remote control system and video surveillance system, on the one hand, the platform can remotely monitor various environmental parameters such as air temperature and humidity, gas concentration, light intensity and noise. Linkage fans, air conditioners, sprinklers, water and fertilizer integrated machines and other power equipment to ensure that in the best growth environment, to achieve energy saving, intelligence and high efficiency. On the other hand, the energy consumption of each equipment can be monitored in real time, and combined with its production needs, diagnosis and optimization suggestions can be made in the aspects of energy use behavior, energy quality and energy safety, and intelligent alarm in case of abnormality can help save energy and reduce consumption.

In the aspect of real-time optimal dispatching, the platform participates in the demand-side response and provides auxiliary services for the large power grid by counting the adjustable flexible load on the station side and passing the planting or breeding time as a whole. On the power supply side, the convergence effect can also be formed by multi-point distributed photovoltaic, which can actively and effectively participate in the peak regulation, frequency regulation and voltage regulation of the power grid, improve the operation efficiency of the power grid, and provide support for the interaction between load and storage of the source network.
4.3. Intelligent heating scene

Intelligent heating scene takes heating in rural areas as a sample to provide farmers with services such as heating mode choice, heating equipment group purchase and demand-side response. The heating energy of users in rural areas is scattered, and the total load is small. The construction cost of central heating in urban areas is higher and the extensibility is lower. The energy selection of rural housing heating should follow the principle as follows: giving priority to the use of gas wall stove in areas with sufficient natural gas sources, electric energy heating under the condition of power grid expansion, water source heat pump heating under the premise of water supply, biomass boiler heating in areas with sufficient biomass, and reasonable selection of different clean energy according to local conditions.

In the aspect of choosing the clean heating mode, by analyzing the household population and household area of each household, the typical household energy efficiency diagnosis is carried out according to the energy saving and household appliance monitoring function, so as to help residents grasp the overall energy consumption of the house. Guide residents to choose the most appropriate clean heating mode to ensure that they can realize clean heating and bear the cost.

In the aspect of purchasing heating equipment, it is classified according to the heating equipment selected by each household, negotiate with equipment purchasers uniformly, purchase and install clean heating equipment for residents at the group purchase price, and sign a long-term equipment operation and maintenance contract with equipment purchasers as a group.
In the aspect of demand-side response business, through the analysis of the daily load characteristics of winter heating of the public, a large number of users are gathered internally, and the demand-side response service is signed with the load aggregator to achieve flexible adjustable load demand-side response.

4.4. Platform economic scene
Platform economic scene is mainly based on the development of new rural industries, services and other industries, and gathers resources through the platform to provide financial support and transaction windows for the development of local industries, including energy finance, third-party transactions and other functions.

In the aspect of energy finance, improving the transparency of capital trend and providing better financing services through innovation and supervision of financial products, which are mainly reflected in three aspects: first, lower the financing threshold. By converting bonds into smart contracts on the block chain, the issuance scale is reduced, and a new way is provided for financing small and medium-sized energy projects in rural industries. Second, improve financing efficiency. Through blockchain technology, bills receivable, accounts receivable and inventory in energy projects are transformed into digital assets, intelligent transactions are realized through intelligent contracts, information is made more transparent, cooperation risks and credit costs are reduced. Third, strengthen financing supervision. Through the supply chain technology based on block chain to achieve complete capital link tracking, create a new regulatory order of joint supervision, and through the establishment of credible credit...
ratings, solve the problems of information lag of traditional supervision institutions and the lack of information exchange among multiple financing platforms, and prevent the risk from expanding.

In the aspect of third-party transactions, on the one hand, users and new energy investors can be connected to collect fees for leasing land by using roofs, open spaces and farmland to build distributed photovoltaics, on the other hand, it can also act as an intermediary between users and energy stations. The conversion of electricity, heat and other energy and the recycling of crop resources are realized by means of garbage power generation, biological natural gas, biogas and other biomass resources generated by users, such as garbage, straw, livestock and poultry manure, to improve the rural environment while allowing users to obtain benefits.

**Figure 5. Scene of platform economic**

5. **Conclusion**

This paper takes the energy internet means to meet the better energy demand in rural areas as the starting point. First of all, it analyzes the market demand of the energy internet platform in different rural fields, so as to find the pain points of the industry and enhance the pertinence of the functional design. Second, a functional architecture of rural energy internet platform is proposed. Third, based on this architecture, four typical application scenarios are designed including planning decision-making, intelligent heating, intelligent agriculture and platform economy. The relevant research results can provide reference for government departments to formulate rural energy transformation and development policies, energy enterprises to carry out comprehensive energy services, farmers to expand energy income channels, the development of rural circular industry economy.
Acknowledgments
This paper is one of the stage achievements of the science and technology project "Lankao energy internet platform Operation Mode Research" of Henan Electric Power Company. Thanks to the project for supporting the publication of this article.

References
[1] Huang, R.L., Pu, T.J., Liu, K.W., Yang, Z.Y., Chen, N.S. (2015) Design of hierarchy and functions of regional energy internet and its demonstration applications. Automation of Electric Power Systems, 39:26-34.
[2] Zuo, Z.W., Yao, X.C., (2015) Research on the Application of energy internet in the Construction of New urbanization in China. Modern Management Science, 4:63-66.
[3] He, J.J., (2016) energy internet +? The prospect of seven kinds of industry convergence can be expected. China Strategic Emerging Industry, 17:30-31.
[4] Zi, Z.N., Zhao, D.Y., Gao, F., (2018) energy internet leads the Reform of Clean heating Technology. Electric Power, 51:117-121.
[5] Li, H.T., Wan, Y.X., Cheng, L., Guo, Y.F., (2019) Application Prospect and thinking of Electric Energy replacing load under the background of energy internet. Advanced Technology of Electrical Engineering and Energy, 38:46-59.
[6] Zhou, Y.Z., Fu, X.Q., (2019) Development Prospect of Agricultural Engineering energy internet. Power Demand Side Management, 21:7-11.