Exploration on development mode of rural electrification in Shandong Province

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Abstract. Rural electrification construction is an important foundation for promoting the rural revitalization strategy. On the basis of field investigation on the current situation of rural electrification development in 8 cities of Shandong Province, theoretical analysis is made on the methods of work development, and a development mode suitable for rural electrification construction in Shandong Province is explored. Government and company cooperation in full aspects is the key to success of rural electrification. Suitable operation mode with support system can help the expectation turn to reality by resolving the technical and financial problem.

1. Introduction

Rural electrification is an important guarantee for improving farmers' production and living, supporting the development of rural industries and promoting the revitalization of the countryside [1]. In 2019, document No.1 of the central government proposed to fully implement the rural electrification upgrading project and accelerate the completion of a new round of rural power grid transformation. The State Grid Shandong Electric Power Company (hereinafter referred to as the Company) requires that the four-year period from 2019 to 2022 be used to fully implement the rural electrification upgrading project.

Through various means such as upgrading the rural power grid, improving the service level of rural power supply, promoting alternative technologies for electric energy, promoting the construction of characteristic energy-using projects, and introducing new types of electricity-using products, the Company will strive to enhance the rural electricity-using guarantee capacity and enhance the electrification level of agricultural production, rural industry and rural life.

However, the promotion of rural electrification is still facing great challenges. The problems are summarized and resolutions are discussed. Through scientific theoretical analysis of rural
electrification construction find supporting development methods. Discuss the operation mode and support system. Enhance in-depth linkage between government and enterprise not only in policies, but also in implementation action, finance and standards fields.

2. Problems surveyed
Based on the field investigation of nearly 100 rural electrification projects in 8 cities and 22 counties (districts) in Shandong Province, the impact factors and existing problems of rural electrification operation in Shandong Province (Figure 1) are summarized as below.

![Figure 1. Shandong province map and place investigated.](image)

2.1. Impact factors
At present, agricultural production in various cities in Shandong Province is mainly based on traditional grain crops such as wheat and corn, with less promotion of new agricultural models. Rural electrification results are influenced mainly by geographical environment, farmers' income and government policies.

(1) Geographical environmental impact
The development of rural electrification is greatly affected by the local natural environment. For example, there are many electrification projects for aquaculture in coastal areas, and there are many electric tea production projects in hilly tea-producing areas such as Linyi and Rizhao.

(2) Impact of farmers' income
Farmers' income has great influence on the development of rural electrification. Rural electrification level in areas with higher farmers' income such as Jinan, Dongying and Yantai is higher than that in less developed areas such as Heze. At the same time, villagers with higher incomes have higher acceptance of electric heating, electric greenhouses and other electric equipment.

(3) Impact of government policies
Government policies have a direct impact on the development of rural electrification [2]. In cities where the government has issued relevant supporting policies and implemented them well, projects such as electric heating and electric greenhouses are well promoted, such as Jinan. Cities where the government focuses on poverty alleviation are also more conducive to the construction of large-scale rural electrification projects, such as Heze.
2.2. Project operation problems

The operation and management of rural electrification projects are generally undertaken by the customer owners. The power grid company only provides daily power supply services and pays less attention to the customer project operation. As for the effect of electricity utilization projects, the customer owners have generally reflected well.

(1) Operation mode

At present, the main operation modes of rural electrification projects are self-produced and sold by individuals, unified sales by cooperatives and large-scale operation of enterprises. At present, the main problems are unstable self-management, low demand for electrification of the project, and the need for large amounts of financial support.

(2) Project cost

Some projects have relatively large electricity expenses, such as constant temperature incubation, electric heating, electric drying and other projects. When basic units guide rural electrification projects, they lack the ability to quantitatively analyze the input and output of different types of electrification projects.

(3) Project results

Compared with before the renovation, the project after the electrification renovation can save labor costs, improve production efficiency, and also contribute to environmental protection. Therefore, the company needs to make a detailed summary of the achievements of various rural electrification projects and carry out targeted promotion.

3. Foreign experience

At present, most developed countries have realized the automation of rural power distribution management and information management, and the rural electrification level is relatively high. Taking the United States as an example, the United States government attaches great importance to the construction of rural electrification. In terms of power grid construction and daily operation and maintenance, the United States has adopted a large number of new technologies and equipment. All substations (institutes) in rural areas are unattended. Dispatching centres are all "four remote" and general electrical equipment can be exempted from inspection. At the same time, the advanced information management system, load control system and distribution management automation system of the rural power grid in the United States have increased the reliability of the power grid and the work efficiency of managers [3].

At the same time, the U.S. federal government set up the Rural Electrification Bureau, with the president directly appointing the director. In order to encourage the supply of electricity to rural areas, the federal government provides long-term low-interest loans for 30 years and negotiates with power companies on the use of loans to supply electricity to rural areas. In addition, in order to resolve the contradiction between the supply and use of electricity in rural areas and help rural residents to solve the problem of electricity use, the government led the establishment of rural electricity cooperatives, which effectively promoted the construction of rural electrification [4,5]. With renewable energy development fast, rural electrification has more tools to use. Such as PV system enhance rural tourist village’s function [6,7].

Through the study of rural electrification experience in foreign countries, especially in developed countries, we have the following enlightenment for the development of rural electrification in our country: First, to establish a scientific understanding of rural electrification according to the national conditions of our country, the realization of rural electrification is bound to be a long process; Second, we must adhere to unified planning and standards. Third, new equipment and technologies should be widely used in rural power grids on the basis of scientific management and technological progress [8,9].
4. Process analysis and discussion

4.1. Process analysis
The analysis of various rural electrification projects is an important basic work for the follow-up targeted publicity and promotion and lean operation management. Based on the customer's perspective, through in-depth comparison of the input and output of electricity and other energy-using projects, grasp the competitiveness and promotion advantages of various electrification projects, support the follow-up accurate marketing and promotion work, deepen the customer's understanding of the advantages of electrification projects, and improve the customer's acceptance of rural electrification projects.

On the basis of previous research, collect customer needs and product plans, and conduct value analysis. On the one hand, it is necessary to specify the specific project requirements of the customer, including power demand, energy consumption time, equipment usage, available capital, etc. On the other hand, it is necessary to collect all kinds of energy-using solutions prevailing in such projects on the market, mainly including the functions, power, construction requirements and applicable subjects of all kinds of energy-using equipment.

After the user demand collection and product plan collection are completed, the total input and total output of different energy consumption plans need to be calculated based on the same scale project or unit scale project (such as building an acre of agricultural greenhouse, drying 1 ton of grain, etc.) according to the user project demand, and the direct digital display is carried out in the form of tables and graphs, so that customers have clear value judgment on various energy consumption plans.

The total project input includes equipment procurement or renovation costs, daily operation and maintenance costs, line renovation costs, energy consumption costs, labour costs, etc. The total project output includes production efficiency improvement, product quality improvement, life quality improvement, etc. In addition to quantifiable project input-output analysis, environmental protection requirements, local natural conditions, government policies, production and living habits and other factors need to be taken into account to analyse the social value and development value of project promotion. Finally, a comprehensive value analysis conclusion of this type of project is drawn, thus clarifying the competitive advantages of electrification projects over other energy-using projects and the suitable promotion objects.

Through big data analysis technology, the potential demand user groups of various types of rural electrification projects are accurately located, the potential contribution of the projects is analysed, and the pertinence and success rate of subsequent publicity and promotion are improved. The accurate marketing of rural electrification takes the electricity consumption characteristics of users as the breakthrough point, integrates various channels and system data, and finds out the electricity consumption difference between the users to be tested and the electrified users before the transformation by analysing the information such as the average monthly electricity consumption value, the average electricity consumption growth rate month on month, the proportion of peak and valley electricity consumption, etc.

Process the monthly electricity consumption data of users for 3 years, and carry out feature extraction and screen. By calculating the characteristics of the electrified samples before transformation and the characteristics of the samples to be tested, the number of transformed user samples within the range of users to be tested is obtained (the more transformed users within the range, the higher the possibility that the users to be tested will promote electric energy substitution transformation projects), and then the possibility level of the users to be tested to promote electrification transformation is determined.

4.2. Operation mode
The operation and promotion of rural electrification projects need to be promoted by power companies as a whole, with clear importance, emphasis on active marketing awareness, convergence of forces from all sides, formation of rural electrification ecological circle, expansion of rural electrification
application scenarios, improvement of rural electrification level, and support for the implementation of the national strategy for rural revitalization.

In technical research and development and improvement, electric power companies can combine with relevant technology manufacturers to develop and improve the technology of electricity products (agricultural electricity machinery, heating, electric heating, etc.) to meet the needs of the current rural electrification development.

To improve service capability, the reform of the rural power network should continue to be strengthened. The Company should strengthen all staff's active service and marketing training, encourage district managers to provide customers with technical guidance on electricity utilization, and conduct input-output analysis according to different user groups and application scenarios to formulate differentiated electrification solutions for customers.

For finance shortage, electric power companies can provide certain financial support to typical demonstration rural electrification projects and change business model (financial leasing, etc.) actively.

The Company participates in the construction process of client-side projects, guides farmers to carry out industrial chain, large-scale and enterprise-oriented production, such as industrial development of incubation, breeding and processing, and unites all parties to provide ecological services for farmers (introduction of insurance institutions, docking of production and marketing, promotion of industrial park construction, etc.)

4.3. Support system

The rural electrification construction support system consists of government policies, standards and norms, capital investment, technological research, product list, and personnel team.

In China, government’s intent and action decides half of success. The government should formulate an electrification plan for the demonstration park, increase support for electricity substitution (coal to electricity), and explore new modes such as government guarantee and service sharing [10]. The government also can help to solve the problem of capital shortage hindering project construction. Combined action can improve action results. The government and the company issue unified specifications for electrification construction, such as the construction specifications for all-electric scenic spots and all-electric residential accommodation, etc. All parties should increase capital investment in rural electrification construction process.

![Figure 2. Schematic diagram of rural electrification system.](image-url)
To solve the current problems of substandard process technology and excessive energy consumption of electrification equipment, organize professional forces to carry out equipment renovation and technical research and development [11].

In the process of rural electrification development, all kinds of subjects need to cooperate to jointly promote the development of rural electrification. The partners are mainly government, village collective/cooperative, upstream and downstream enterprises, financial/internet enterprises, scientific research institutions in colleges and universities, pro-poor public welfare organizations, home appliance stores and other industry entities shown as figure 2.

5. Conclusions
For rural revitalization, electricity is the first. Rural electrification is an important basis for promoting rural revitalization strategy. On the basis of on-the-spot investigation of rural electrification construction in 8 cities in Shandong, this paper summarizes the current situation and existing problems of rural electrification construction in Shandong, and makes theoretical analysis of rural electrification development in Shandong with reference to foreign construction experience.

Through scientific value analysis, accurate marketing, operation promotion and publicity and display, grasp the diversity, difference and regional characteristics of villages in Shandong Province, reasonably set the standards for rural electrification construction, and promote rural electrification construction in combination with the actual conditions of cities and counties. Rural electrification construction should focus on construction, reflect local characteristics, rationally allocate resources, promote the construction of pilot demonstration projects, and effectively play a leading and driving role.

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