

Study on the Change of Power Consumption Structure in Xumai Township, Nimu County, Lhasa, Xizang

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Abstract: The research on the evolution of rural power consumption structure in Xizang reflects the information on rural power development in Xizang, and the information on rural power development shows the people's living standards and demand trends. In order to understand the depth of changes in the power consumption structure of farmers and herdsmen households, the project team conducted a field survey of the changes in power supply sources, power consumption structure, power consumption equipment, and operation and management status of Sumai Township, a typical village in Nimu County, Lhasa City, Xizang over the years, and explored the history and trend of power development in remote villages in Xizang. Field research has found that before 2014, the township mainly relied on small-scale independent solar photovoltaic power supply, which was almost used for lighting; Since the implementation of the State Grid in 2014, electricity consumption has shifted from low voltage to wide voltage. In the past three years, the annual electricity consumption growth rate in Xumai Township has exceeded 6%, and the power supply stability has reached 90%. At the same time, the township utilizes solar photovoltaic street lights. The electrical appliances used have developed from a single lamp to power appliances such as household appliances, agricultural electric vehicles, tsamba machines and oil presses. The distribution line of the township is gradually being replaced with medium and low voltage, and is equipped with a 35kV Xumai substation. The 10kV medium and low voltage distribution network project of the rural power grid is gradually being put into operation and put into practice. However, research has found that villagers hope to use more clean energy such as solar energy for power supply and heating, in order to reduce the cost of electricity and gas bills.

Keywords: Tibet; Rural Areas; Electrical Structure; Survey.

1. Introduction

The remote villages in Xizang generally have a small population, live scattered, live on the plateau, and the environment is poor. It is difficult for the power grid to supply centralized power. In the past 30 years, clean energy power supply methods such as small independent photovoltaics and small and medium-sized hydropower stations have been the main reliance. By the end of December 2020, the total installed power capacity of Xizang was 4.1885 million kWh, compared with 2.2943 million kWh at the end of December 2015, the pace of power grid construction was further accelerated, the scale of clean power sources was also growing rapidly, and Xizang has gradually formed a unified power grid. Although the power supply of general remote rural power grids in Xizang is still unstable at present, the survey data shows that the average outage time is about 25h/household year, while that of developed areas in Beijing and Shanghai is less than 1h/household year[1], but the stability of power supply and consumption has changed fundamentally compared with the previous ones. Xizang has abundant solar energy resources and water resources[2]. Due to technical bottlenecks, geographical location and power consumption, it has not yet been fully developed and utilized[3]. Xizang started to set up Xizang Electric Power Co., Ltd. in 2007. With the completion of the interconnection and rural power grid upgrading projects in Xizang, Sichuan Tibet in 2014, Tibet in 2018 and Ali in 2020, Tibet is no longer an isolated network[4]. Xumai Township, Nimu County, Xizang belongs to Lhasa City, Xizang Autonomous Region, and is located in the western region of Lhasa. The whole county is about 4200 meters above sea level, and belongs to the semi-arid monsoon climate of plateau temperate zone.

Rainwater is mostly concentrated in summer and autumn, with strong radiation. The annual sunshine hours are about 2800 hours. For the past few decades, this township has been benefiting users by using solar photovoltaic and small-scale water conservancy power generation methods for power supply. In 2014, Mai Township was covered by the national power grid, and the power supply structure underwent fundamental changes. Its farmers and herdsmen have also generally shifted from "using electricity" to "using electricity well".

2. Change of Power Consumption Structure in Xumai Township, Xizang

2.1. Introduction to Xumai Township

Xumai Township is under the jurisdiction of Nimu County, Lhasa City, approximately 11 kilometers away from the county seat. It governs six villages: Hode, Hedong, Angang, Shangang, Nixu, and Xumai. There are approximately 1017 households and 4768 villagers in the township, with over 80% of them being agricultural households. They have also established projects such as breeding farms, brick factories, farmland renovation, and engineering construction. Xumai Township recently relied on municipal electricity as the main source of power supply, with a total installed capacity of 5670kVA and a power supply area of 234 square kilometers.

According to our research on the change of power consumption structure in Xumai Township, through the comprehensive implementation of the rural power escrow policy by the State Grid in 2014-2016, the launch of a new round of rural power grid transformation and upgrading projects in Xizang in 2017, and the implementation of the

measures of canceling all rural power "escrow" and realizing "direct management" during 2019-2021, the power shortage and power consumption problems in Nimu County have been greatly improved. The last village in Xumai Township, Nimu County to cover the national power grid is Huode Village. After the launch of the "Three Districts and Three States" power grid construction project in 2019, it solved the electricity demand and difficulties of over 400 local people; In January 2021, Xumai Township completed the upgrading and renovation of the rural power grid, as well as the renovation of some courtyard and indoor power lines for farmers and herdsman. We conducted on-site research on the electricity consumption of Xumai Township Government and 6 villages, including the sources of power supply for farmers, electricity equipment, maintenance, and other related content.

2.2. Changes in Electricity Consumption Structure in Xumai Township

2.2.1. Electrical Structure

During the 12th Five Year Plan period, Xumai Township installed 35kV transmission lines and was equipped with a 35kV Xumai substation. The power supply was changed from the original 110kV Tarong substation 10kV Rongta 145 line to the 35kV Xumai substation 10kV Xuhuo 141 line. The insulation replacement rate of the 10kV main line and the 400V low-voltage main line reached 98.9%, and the power supply reliability increased by about 99.8%. With the benefits of the new round of rural power grid renovation projects in 2017, Xumai Township built and renovated a total of 18.591 kilometers of 10kV overhead lines, 80 meters of 10kV cables, and 22.63 kilometers of 400V low-voltage lines; 19 new transformers will be built, with a capacity increase of 1500kVA, and 916 household meters will be renovated. The distribution network project of 10kV and below medium and low voltage distribution network in Nimu County, Lhasa City in 2019 started construction and has been put into operation in Huode Village, Xumai Township.

In the past three years, the continuous growth rate of electricity consumption in Xumai Township has exceeded 6%. According to the sales data of Nimu Power Supply Company, the actual electricity consumption in 2022 was 3.2029 million kilowatt hours, which is 347100 kilowatt hours more than the estimated electricity consumption. The following figure shows the trend of electricity consumption in Xumai Township, Nimu County in the past four years. And according to the actual needs of farmers and herdsman and the continuous development of the power system, the electricity consumption of farmers and herdsman's households has changed from low voltage to wide voltage.

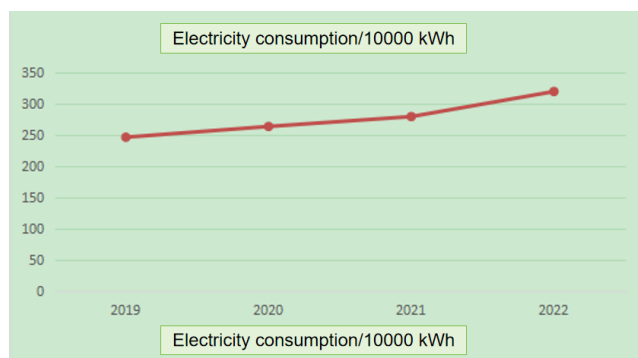


Fig 1. Changes in electricity consumption in Xumai Township from 2019 to 2022

2.2.2. Electricity Source

The village residents in Xumai Township use State Grid power supply as their power source, which is basically stable with a stability rate of 90%. Photovoltaic street lights are installed every 30-50 meters on village roads, and a pilot village is equipped with wind solar complementary street lights. The solar street lights covering the entire township are supported by national projects. The power supply for pastoral grasslands is mainly based on photovoltaic household systems [4].

2.2.3. Electrical Equipment

The common household appliances used by farmers and herdsman in Xumai Township are complete, and it is conservatively estimated that the total power consumption per household appliance is over 4600W. Each household has a TV, sound system, washing machine, refrigerator, electric kettle, rice cooker, butter and yogurt machine, etc. Each family has electric vehicles, and each village collectively has a tsamba machine, an oil press and other large electric machines; Approximately 1-3 households in each village use solar water heaters to supply warm water.

More than 70% of households are using energy-saving lamps, and less than 30% of households are equipped with incandescent lamps. The price of incandescent lamps in local township and street shops is 3 yuan/unit, while the price of energy-saving lamps is 12 yuan/unit. The main advantages of energy conservation are long lifespan and low power consumption. Some households using incandescent lamps believe that the purchase price of energy-saving lamps is too expensive, and the price of incandescent lamps is much cheaper compared to others.

2.2.4. Electricity Analysis

The photovoltaic household system is easy to carry, easy to install, can operate independently, and is environmentally friendly. It also compensates for the lack of electricity traction in pastoral areas due to long-distance and high consumption.

Currently, less than 2% of households in Xumai Township are equipped with solar water heaters. Villagers generally believe that the purchase price is too expensive and occupies the indoor area of the house during installation and use. The hot water used in daily life comes from burning cow manure stoves and using electric water heaters.

Villagers hope to use clean appliances such as solar energy that save electricity or do not consume electricity to boil water, in order to reduce the cost of electricity and gas bills. The current household electricity used by villagers is mainly from the secondary energy of State Grid Corporation of China, but the overall energy consumption is also accompanied by biomass energy from cow manure and new firewood for a long time.

3. Electricity Bills and Maintenance of Electricity Faults in Xumai Township

3.1. Electricity and Electricity Fee Collection in Xumai Township

3.1.1. Electricity Consumption and Cause Analysis

Among farmers and herdsman, 50% of households consume more electricity in summer, 25% consume more electricity in winter, and 25% consume almost the same amount of electricity in winter and summer. The summer electricity consumption is mainly due to the busy farming

season, where farmers and herdsmen use three wheeled electric vehicles for farming, electric kettles for boiling water, making butter and yogurt, and washing clothes. In winter, they burn cow manure stoves and firewood for heating and hot water; The reason for the high electricity consumption in winter is due to the high power consumption of washing machines or unknown reasons. The factory consumes less electricity in winter than in summer, and due to more construction and operation in summer, the workload is high. The on-site survey photos are shown in Figure 2.



Fig 2. Photos of on-site investigation

3.1.2. Electricity Collection and Pricing

The electricity bill for each village is collected and collected by State Grid Electric Power Company based on the total electricity consumption of the village level meter. The specific implementation is that the village committee appoints a team leader or other team members to collect the electricity bill in proportion when entering the household. The collected electricity bill is then handed over to the electric power company by the village committee. Due to construction technology, network, etc., in accordance with the requirements of State Grid Corporation of China, county electricity bills are collected on a monthly basis, while rural electricity bills are collected on a quarterly basis. County residents implement card payment, with units paying based on the total electricity consumption per meter, and rural and pastoral areas charging based on the total electricity consumption per meter at the village level. Residential electricity consumption is 0.48 yuan/kWh, while nonresidential electricity consumption is 0.73 yuan/kWh.

3.2. Reasons for Power Outage among Residents in Xumai Township

If a large-scale power outage occurs, it will affect the power system and directly affect the user side. Although Xumai Township strives to ensure reliable power supply, there are an average of 2-3 power outages per month, one of which is planned power outages, including line maintenance, new equipment integration, etc; The second is power outage due

to faults, which mainly includes emergency repair, external force, and compulsory short circuit. Fault repair mainly comes from natural disasters, including strong winds, and equipment defects; The main causes of external force are vehicle collisions with power poles and three-phase electrical damage caused by mechanical construction. The probability of daily emergency repair failures is high, and there are fewer failures caused by external failures. The third is a voluntary short circuit, often caused by children hanging wires or birds carrying things. The fourth issue is the quality of the equipment in the factory or the aging, poor quality, overload, and improper use of equipment in households, which leads to tripping and power outage of transformers in the entire village. The destructive and potential impact of livestock on power outages is minimal.

3.3. Xumai Township Electricity Maintenance



Fig 3. Photos of on-site investigation

All power maintenance work in Xumai Township is carried out free of charge by professional maintenance personnel dispatched by State Grid Corporation according to the responsible area. There are no professional electricians in the township or village, but there are amateur electricians. Every village has its own amateur electrician who provides free daily troubleshooting and maintenance work. The complex work of organizing and renovating the indoor and indoor wiring in the farmers and herdsmen's courtyard is operated free of charge by the operation and maintenance personnel of State Grid Corporation of China. State Grid Electric Power Company conducts 1-3 monthly inspections on transformers and other equipment in each village. The occurrence of electricity failures in each village is also relatively rare, mostly due to natural disasters or power line problems. Nimu Power Supply Co., Ltd. will quickly repair the power outage area after receiving a power outage request, and implement live work more often when safety measures are met. Xumai Township has now covered three-phase electricity, and the corresponding risk of electricity consumption is also increasing. There are relatively few incidents of electricity

accidents in the entire township. Due to the frequent popularization of electricity knowledge [5], no one actively damages the electricity and other similar electric shock accidents occur. The on-site survey photos are shown in Figure 3.

4. The Expectations of Farmers and Herdsmen

(a) Villagers are eager to utilize more clean energy sources like solar energy to reduce the cost of high energy consumption;

(b) Villagers hope to use a large number of lightweight and small electric agricultural tools, which are easy to operate and convenient, and they also hope to receive government subsidies;

(c) Some villagers who have not undergone home line renovation and upgrading hope that relevant units or construction units can re-enter their homes and renovate the indoor and courtyard lines to reduce the risks of line damage, aging, and disorder.

5. Research Conclusion

(a) The power structure of Xumai Township has evolved from simple household photovoltaics and small hydropower stations to the current State Grid; The development of electrical equipment from a single lighting fixture to a diversity of agricultural appliances; Gradually shifting from bulky fuel devices to lightweight electrical equipment. From unorganized maintenance to professional maintenance of the State Grid; From a decrease in electricity consumption to a

continuous increase; Gradually moving towards stability from unstable electricity consumption, achieving a balance between power supply and consumption.

(b) Farmers and herdsmen's awareness of electricity consumption has also changed, from weak awareness to strengthening risk prevention and self-protection, from passive acceptance to active awareness.

(c) The changes in electricity structure have brought tangible benefits to the lives of local farmers and herdsmen. Farmers and herdsmen are also eager to use more solar energy to reduce high energy consumption expenses.

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