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Research and demonstration of 20kW wind and solar complementary coupling power supply in Xiangmao Township, Tibet

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Abstract: In this paper, through technological research and development, we will improve the existing technology of domestic wind / light complementary power stations, apply wind power generation equipment with a single unit capacity of 5kW and 10kW in Xiangmao Township, Naqu City, Tibet, and optimize the system design. The completed power station will supply power to 42 herdsmen in Xiangmao Township through centralized power supply, and use the form of wind and light complementary coupling power generation to reduce the construction cost of the power station and improve the reliability of the system, It will provide a scientific basis for the next promotion and application of wind and solar projects.

Keywords: Pv/ Wind hybrid; Coupling power supply; Research and demonstration; Tibet region

1. Introduction

Xiangmao township of Naqu County is located in the area with abundant solar energy resources from the central and eastern part of Naqu to Changdu on the surface of Himalayas. It has long sunshine time, large annual total radiation and stable resources. Due to geographical reasons, the remote villages and towns in Naqu city are not covered by the power grid, and these areas are remote and poor areas. Due to the lack of conventional energy, less coal and oil, the electricity and other domestic energy of towns and herdsmen need to be imported from other regions, and the cost is relatively expensive, As shown in Figure 1.

Xiangmao Township, Naqu County, Naqu City, 4683 meters above sea level, is located 72 kilometers south of Naqu County, Tibet, with 272 villagers from 42 households in the village. According to our investigation, the village has used the solar household system with a capacity of 150W as early as 1999, but many household systems have been unable to use due to the long history. Zongrege village, Xiangmao Township, is dominated by animal husbandry, of which 42 households live relatively concentrated. According to the field measurement, these herdsmen live within a radius of 800 meters, and the other 20 households live very scattered, with a distance between households of more than 300 meters. Some villagers do not use electricity, but still use candles or butter for lighting, and some even use firewood for heating and lighting, The lack of electricity has restricted the local economic development and the improvement of people's production and living conditions. This village urgently needs to solve the problem of electricity. According to the local solar energy resources and wind resources, solar power stations with complementary wind and solar energy coupling are used to solve the problem of power consumption.

Fig.1 Local scattered farmers' and herdsmen's houses

2. Design of 20kW wind solar complementary coupling power station

2.1 Basic principles

The wind / light complementary power generation system consists of PV array and fan array of battery modules, charging controller, inverter, battery, energy consuming load, AC distribution cabinet and other components, As shown in Figure 2[1-3].

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Working principle: in the daytime, under the irradiation of sunlight, solar cells generate direct current; Driven by the wind, the alternating current generated by the wind turbine is rectified and turned into direct current; Part of the direct current generated by solar energy and fan is transmitted to the inverter through their respective controllers to convert into current and supply it to users, and the other part is stored after charging the battery; When sunlight or wind energy is insufficient, the battery sends power to the inverter through the DC control system, which is converted into AC for AC load[4].

Fig.2 20kW wind solar complementary coupling power station after completion (left: 5kW fan, middle: 5kW photovoltaic, right: 10kW fan)

2.2 Solar module design

According to the provisions of GB50797-2012 code for design of photovoltaic power stations, in the photovoltaic array, the electrical performance parameters of each photovoltaic module in the same photovoltaic module string should be consistent. In this paper, a total of 32 165Wp solar panels are used, which are connected by 8 series as a group, 4 groups and a charging circuit. The output charging circuit is 4 channels, and the actual power output of the photovoltaic array is 5.28kW, as shown in Figure 3[5-6].

Fig.3 Site photo of solar photovoltaic array

2.3 Fan selection

According to the site conditions, the annual average wind speed in Xiangmao township is 5.1m/s, of which the wind speed is the largest in winter and spring, and the wind speed is slightly weaker in August and September every year. The fan is installed in the open ground in the south of the power station control room, with an interval of 55m. There is high wind speed and no shelter. Because the fan is installed in the open ground, it is convenient to maintain in the later stage. During installation, the cable tower is used for installation. The controller of the fan rectifies the three-phase unstable AC into 220V DC, and has the functions of emergency braking, short-circuit protection, reverse connection protection, etc, as shown in Figure 4[7].

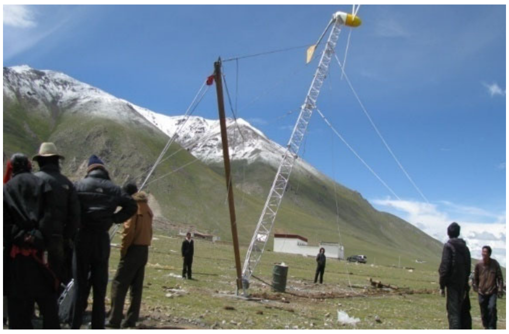


Fig.4 Fan installation site

2.4 Control and inverter design

The controller is a control unit connecting the solar photovoltaic module array and the energy storage battery pack. It charges the battery by controlling the current and voltage, and has the function of protection and monitoring. Photovoltaic inverter is mainly used to convert DC power supply into AC power supply. The inverter configured in the system of this power station adopts dc220v power supply. The function of the inverter is to convert DC power from solar cells into AC power for AC loads. The controller is matched with the photovoltaic module, and the capacity of the inverter should be determined according to the actual load, with additional consideration of capacity reduction at high altitude[8].
The inverter capacity in this paper is 30KVA. Inverter is the core equipment of photovoltaic power station, and the load is mainly motor inductive load. The impulse current of motor load is large when starting. Considering the guarantee of actual power supply, it is generally 1.2-5 times. A total of 3 sets of 10KVA off grid inverter equipment are selected for this project, and the power supply mode of two for use and one for standby is adopted, as shown in Figure 5[9].

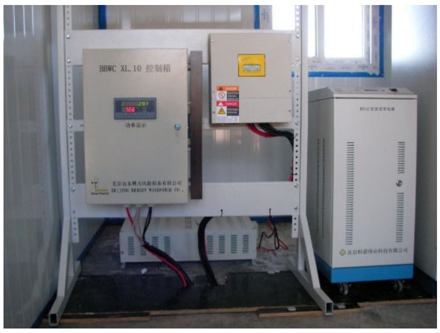


Fig.5 Site photos of controller and inverter

2.5 Battery pack design

In this paper, the DC voltage of the power station system is designed according to dc220v. In this project, the discharge depth coefficient of the battery is 0.7, the efficiency is taken as 90%, and the continuous rainy days are considered as 2 days. The 20kW off grid photovoltaic power station generates an average of 4.6 hours of electricity per day. Based on the calculation of 2-day daily electricity consumption, the batteries in this paper are installed in two groups, with 108 batteries in each group, a total of 216 batteries, single batteries of 800ah/2v, and the net weight of the whole battery group is about 14.47 tons, as shown in Figure 6[10-11].

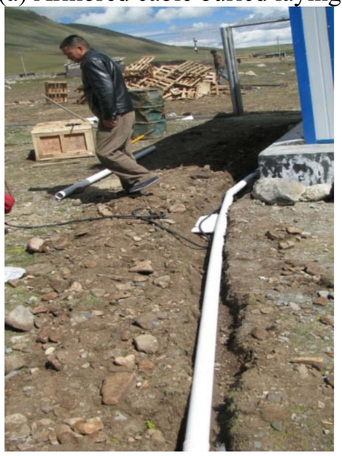
Fig.6 Site photo of battery pack

2.6 Transmission line design

Tab.1 Transmission line design

Order Number	Name	Design content
1	Voltage level	AC220
2	Frequency	50Hz
3	Power supply radius	800 meters
4	Trunk line	16mm^2 armored cable
5	Incoming line	4mm^2 power cable
6	DC incoming line	2.5mm^2 special cable, laid with PVC sleeve for entry
7	Power installation of each household	One set of three 18W energy-saving lamps, lamp caps and hangers, one drag line board and one set of lines
8	Trunk line to branch line, branch line to user, use trunk line box and branch line box for connection and protection.	

(a) Armored cable buried laying



(b) PVC casing laying

Fig.7 Photos of on-site implementation of transmission lines

3. Benefit analysis

The 20kW wind solar complementary coupling power station demonstrated in this project is located in Xiangmao Township, Naqu City, Tibet. The power station is expected to generate 34310 kWh per year. According to the actual data, the average annual power generation in recent years is about 36100 kWh. According to the average on grid electricity price of Naqu City, Tibet is 0.7 yuan / kWh (regardless of dry season, wet season and peak valley level), and the annual income is 36100 kWh × 0.7 yuan/degree =25270 yuan ≈ 25000 yuan. After the completion of the project, the daily electricity consumption of 272 people in 42 households has been solved, and their living conditions have been improved. This is of great significance to solve the problem of electricity consumption of farmers and herdsmen in Naqu power free area of Tibet, improve the quality of life of farmers and herdsmen, build a harmonious and prosperous Tibet, promote the stability and prosperity of Tibet, and promote the construction of a new socialist countryside in Tibet. The social benefits of the project are very significant.

According to the calculation of 4 tons of standard coal consumed per 10000 kwh of electricity, 0.5 tons of dust and 10 tons of carbon dioxide emitted into the atmosphere, it is equivalent to saving 14.4 tons of standard coal per year, and reducing 1.8 tons of polluted dust and 36 tons of carbon dioxide emissions at the same time.

4. Conclusion

Photovoltaic and wind energy are clean and renewable energy. The development and wide application of photovoltaic and wind energy technology plays an important role in alleviating the shortage of conventional energy in Tibet, solving the problem of electricity consumption by the population without electricity, and reducing environmental pollution. It is very important both from the perspective of energy conservation and environmental protection. The ecological status of Tibet Plateau is very important, and the ecological environment is fragile. It is an important ecological security barrier in China. Once damaged, it cannot be restored. After the construction of the photovoltaic power station, it will make a certain contribution to the protection of the ecological environment in Tibet. Vigorously developing and utilizing solar energy is of great significance to solve the daily electricity consumption problem of people in border areas without electricity, improve the living conditions of local people, and improve the quality of life.

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