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Investigation and Research on the Application of Clean Energy in Nagqu School in Tibet

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Abstract

This article is based on an investigation of the current energy consumption status and the proportion of clean energy in the main buildings of schools in the Nagqu region of Tibet, and summarizes the main problems of school energy consumption and teaching building buildings in the region. By analyzing the relationship between the energy consumption of the main buildings in the school and the building layout, enclosure structure, and energy consumption methods, we aim to identify the building layout and energy consumption methods that are suitable for different climate conditions in the Nagqu region of Tibet.

Keywords

Nagqu School in Tibet; Energy consumption survey; Energy utilization method.

1. INTRODUCTION

Education revitalizes the country. Education should start with children, and prioritizing the development of basic education is a strategic national policy in China. The quality of primary and secondary school buildings for implementing basic education is crucial. In January 2012, the Ministry of Housing and Urban Rural Development issued a revised version of the design standards for primary and secondary school buildings, emphasizing the energy efficiency of schools and buildings. There are clear regulations on design principles, sunlight, heating, insulation, and other aspects[1]. The education industry in Tibet is an important component of border governance and stability. Since the peaceful liberation of Tibet, the Central Committee of the Communist Party of China has given special care, adopted a series of policy measures to vigorously develop various levels and types of education, increased investment in education, and improved educational conditions. In the 14th Five Year Plan and 2035 Long Range Goals of Tibet, it is emphasized that we should accelerate the construction of a high-quality education system, comprehensively improve the allocation of educational resources, and accelerate the filling of the shortcomings in educational conditions in agricultural and pastoral areas. In the 2022 Economic Work Conference of the Party Committee of the Tibet Autonomous Region, it was also mentioned that we should adhere to putting the people at the center and solidly promote the "Top Ten People's Livelihood Projects" such as the "Education Priority Project". According to the statistics of the Education Department of the Tibet Autonomous Region, in recent years, the autonomous region has also invested 3.085 billion yuan to implement the school heating full coverage project, which shows the high importance that the Party Committee and government of the Tibet Autonomous Region attach to the education industry. The Tibet region is rich in new energy resources such as solar and wind energy, while traditional fossil fuels such as coal and natural gas are scarce. In the report of the 20th National Congress of the Communist Party of China, it was explicitly proposed to "accelerate the planning and construction of a new energy system". Therefore, mastering the application of new energy in

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schools in the Tibet region is of great significance for optimizing school conditions and improving students' learning and living conditions during their school years.

This article investigates the current energy consumption status and the proportion of clean energy in the main buildings of schools in the Nagqu region of Tibet, and analyzes the relationship between the energy consumption status of schools in the region and the building layout, enclosure structure, and energy consumption methods. The aim is to provide basic data and basis for future research on energy conservation and emission reduction in school construction in the Nagqu region of Tibet.

2. SURVEY OBJECT

The survey object in this paper is the relevant primary and secondary schools in Naqu, Tibet. According to the field survey and the division of schools in the general cognition of the society, schools are defined as: a) urban schools, that is, schools located within the Naqu urban area; b) Township schools, which are located in the surrounding towns of Nagqu city, mostly come from the surrounding pastoral areas.

In this paper, the factors considered in the survey of school site selection are: a) different climatic characteristics and thermal zoning; b) The main types of teaching buildings in the school (including plane form, enclosure structure, building scale, and construction era). Therefore, this paper investigates 1 city/county (Naqu City), covering 11 towns (Luoma Town, Gulu Town, Xiangmao Township, Youqia Township, Namache Township, Kongma Township, Daza Township, Luomai Township, Sexiong Township, Nima Township, Daqian Township), involving 23 schools. The on-site survey photos are shown in Figure 1.

Figure 1. Site Survey Photos

3. INVESTIGATION CONTENT

3.1. Main building layout and structural types

The main types of teaching buildings in the Nagqu area of Tibet include open south/north corridors, enclosed corridors, central corridors, and bungalows, as shown in Figure 2. The specific types of enclosure structures are shown in Figure 3, with most (over 80%) of them being ordinary brick walls (24/37 structures) and 68% not having insulation layers. From 2010

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to 2020, the majority were newly built or renovated, accounting for 79%. The typical survey school statistics are shown in Table 1.

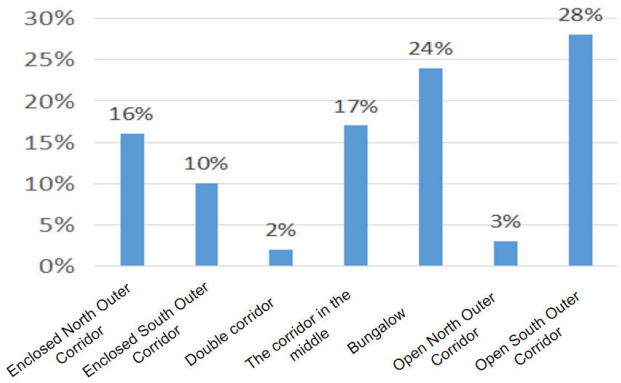

Figure 2. Research on the Plane Form of Teaching Buildings in Schools

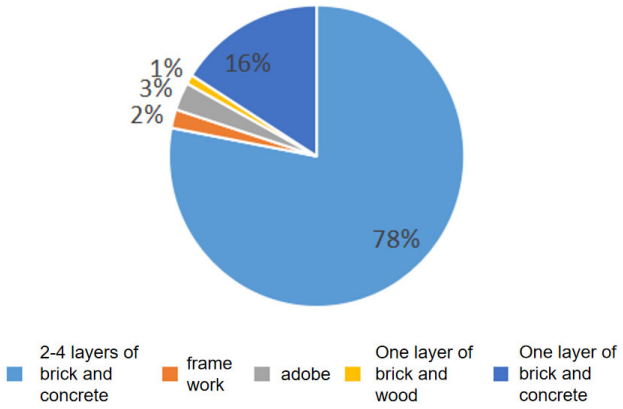

Figure 3. Research on the Structural Types of Teaching Buildings in Schools

Table 1. Statistics of Survey Content of Typical Research Schools

Survey Region	Regionalism	School Definition	Thermal insulation Structure	Outer wall Thickness	Energy usage Type	Indoor thermal Comfort	Number of Surveys
Nagqu urban area and surrounding towns	Severe cold regions, plateau continental climate, and pastoral areas of the Qinghai Tibet Plateau	Urban schools	not have	24/37	Municipal power supply; Municipal heating; Biomass fuel is used for cooking.	Good from July to October; October to June is average.	7
		Township schools	not have	50	Municipal power supply; Local solar hot water; Local solar bathroom.	Good from July to October; Poor from October to February; February to June is average.	16

3.2. Energy consumption types

Conduct on-site interviews to investigate the types, composition, methods, energy consumption, and proportion of clean energy used by the school. It was found that the main types of energy used by schools in the Nagqu area of Tibet are traditional energy and clean

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energy, among which traditional energy mainly includes: electricity, coal, oil, gas, heat, etc; Clean energy mainly includes solar heating and solar street light power supply. The energy consumption mainly includes four aspects: heating, lighting, cooking, and teaching power. The amount of energy consumption is relatively large. Taking the demand for electricity in the city as an example, there are about 2700 teachers, students, and faculty members at Tibet Naqu Vocational and Technical School, with an average annual electricity consumption of about 400000 to 500000 yuan. The proportion of clean energy is relatively small. The clean energy of schools in the urban area of Nagqu area is only reflected in biomass fuel cooking and nighttime solar street lighting, while rural schools are only reflected in local solar heating water and solar bathrooms. The survey statistics are shown in Table 2.

Table 2. Statistics of Energy Consumption in Research Schools

Energy usage type		Energy composition				Heating function	
Types	Sources	Heating	Cooking	Lighting	Power	Ways	Proportion of surveyed schools
Tradition Energy	Coals	85%-90%	/	/	/	Municipal heating	30.5%
	Natural gas	/	20%-30%	/	/	Separate cafeteria	47.8%
	Electric supply	10%-15%	/	78%-86%	3%-5%	Municipal power supply	100%
Clean Energy	Solar heating	8%-12%	/	/	/	Solar heater	43.5%
	Solar powered	/	/	1%-2%	/	Solar street light	100%
	The burning oil of biomass	/	70%-80%	/	/	Separate cafeteria	21.7%

From Table 2, it can be concluded that the utilization rate of clean energy in urban schools in the Nagqu area of Tibet is very low. The use of clean energy is mainly reflected in the use of biomass fuel in canteens for cooking activities, which accounts for 70% -80% of the cooking energy consumption. Additionally, a small amount of solar street lights are used for nighttime campus lighting, which only accounts for about 2% of the lighting energy consumption. Photos of solar street lights are shown in Figure 4. The winter heating method for urban schools is unified heating through municipal pipe networks, with a heating period from October to April of the following year. Centralized heating is distributed in classrooms and student dormitories, and the electricity used is from the municipal power grid system. Almost no schools in the urban area of Nagqu use clean energy systems for heating and power supply, and due to the high temperature demand in winter, some schools have installed electric water heaters for auxiliary heating. b) All the electricity required for township schools comes from the municipal power grid system, and due to the distance between township schools and the urban area of Nagqu, the municipal heating system has not yet been connected, and almost no heating system has been set up for teachers and students' dormitories. The teaching building, duty room, and office are equipped with household air conditioning heating, cow manure stove burning coal/cow manure heating, or small solar electric heating. The current usage status of cow manure stove is shown in Figure 5, and its winter heating energy consumption is the most important aspect, accounting for 60% -80% of the total energy consumption of the school. c) Due to the average altitude of over 4500m in the Nagqu area, which is dry and cool in summer, the vast majority of schools do not have refrigeration equipment and do not need to consider the energy consumption required for summer cooling.

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Figure 4. Solar streetlights for Nagqu School

Figure 5. Cow manure stove used in the duty room of Nagqu School

Compared to urban schools, township schools in the Nagqu area have a higher proportion of clean energy usage, as shown in Figure 6.

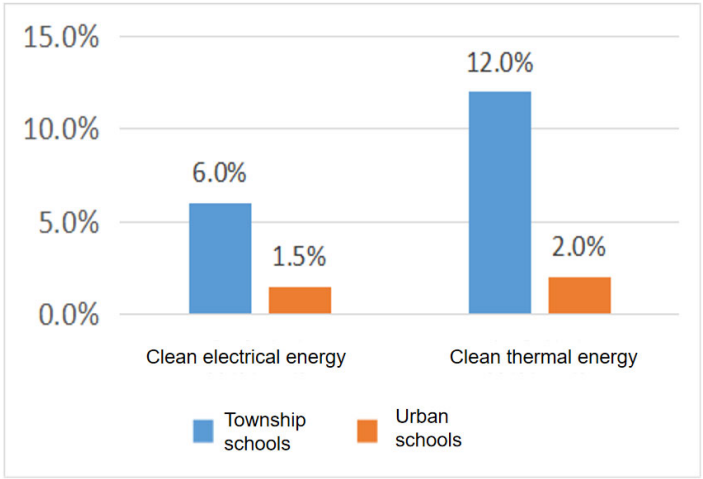

Figure 6. Proportion of Clean Energy

In terms of clean heat energy, due to the relatively remote location of township schools compared to the urban area of Nagqu, they have not yet been connected to the municipal pipeline heating system. Therefore, schools often have solar bathrooms and local solar heating systems to solve some of the heat consumption problems; However, due to the connection to the municipal pipeline heating system, urban schools have almost no independent construction

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in clean energy heat utilization, such as solar, wind, geothermal and other heating. Only a few schools have built solar bathrooms, so in terms of clean energy heat utilization, township schools are almost six times that of urban schools. In terms of clean energy, due to the relatively weak power supply guarantee ability of the municipal power grid, township schools have installed solar photovoltaic power generation systems in some offices, duty rooms, and other places, and the number of solar street lights installed is more than that of urban schools. Therefore, in terms of clean energy electricity utilization, township schools are almost four times that of urban schools.

3.3. Classroom thermal environment and thermal comfort status

This article uses questionnaire surveys and on-site interviews to evaluate indoor comfort satisfaction and determine the indoor thermal comfort level. The overall statistics are shown in Table 3.

Table 3. Survey Statistics of Thermal Comfort in Research Schools

Thermal comfort range			Compliance rate of thermal comfort			Indoor Comfort Satisfaction Survey		Thermal comfort evaluation	
			Whole	Itemize				Condition	Grade
Summer	Temperature (℃)	23-28	8.5%	45.4%	81.7%	Satisfied	18.4%	Temperature, humidity, and wind speed are all within the thermal comfort range	Good
	Relative humidity (%)	30-60			86.2%				
	Wind speed (m/s)	0.1-0.7			41.3%	Good	46.1%	Within the thermal comfort range of temperature, humidity, and wind speed	Common
Winter	Temperature (℃)	18-25		15.2%	9.5%				
	Relative humidity (%)	30-80			78.8%	Dissatisfied	35.5%	One or all of temperature, humidity, and wind speed are within the thermal comfort range	Range
	Wind speed (m/s)	0.1-0.7			27.5%				

According to Table 3, it can be seen that schools in the Nagqu area mainly have flat single corridors, accounting for 43%, and there are more closed corridors, followed by central corridors; 74% of the peripheral protective structures have no insulation layer; The thermal comfort in summer is good, while in winter, the thermal comfort is mostly average or poor. At the same time, for schools that use centralized heating with municipal pipe networks, due to the hard water quality in the Nagqu area and the large temperature difference in winter (with a maximum temperature difference exceeding 30 ℃), it is easy to experience water blockage, pipe explosion, or ineffective heating at the heating end in winter.

4. PROBLEMS IN CLEAN ENERGY UTILIZATION AT NAGQU SCHOOL

Nagqu School is basically a non-profit public institution, and its activities are not aimed at profit, which makes it easy for the school to overlook management costs, neglect energy consumption work, and lack effective management methods and systems. In the construction of energy-saving campuses, although schools have begun to realize the importance of energy management work, they have established relevant energy-saving committees and established energy-saving management offices[2]. However, the effective utilization of energy has not yet been implemented, and there are still many problems in energy-saving work.

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4.1. Weak concept of clean energy utilization

Naqu School does not attach enough importance to the energy management department, the budget of relevant departments is insufficient, professional and technical personnel are generally lacking, and the internal training mechanism is not sound. The staff are engaged in daily affairs and are not interested in the input-output benefits of clean energy utilization. Lack of utilizing the abundant solar and wind resources of Nagqu on the basis of existing school facilities to build independent wind and solar complementary heating and power supply systems, in order to reduce the consumption of heating and power costs in schools[3]. At the same time, the administrative organs, teaching, dormitory management, and other areas of most schools are open to the use of various energy sources such as water, electricity, gas, and oil, and the school pays for them uniformly. Due to the fact that the amount of expenses is not directly related to the user's interests, no one cares about the waste of public resources. This energy supply method has led to a lack of sufficient understanding among school teachers and students of the importance of energy conservation. The phenomenon of energy waste is common and cannot be effectively solved, as people walk with their lights on and fine water flows freely. Many offices and teaching buildings have more severe electricity waste; The management of students' electricity and water usage is not strict enough, and some students burn "hot quickly" in their dormitories and illegally use electric stoves, water heaters, etc.

4.2. Lack of special funds for clean energy

With the continuous expansion of school scale, the country's investment capacity is relatively insufficient, and many schools even lack the most basic energy infrastructure investment. Taking the second vocational and technical school in Nagqu City as an example, due to its newly built campus, the municipal heating system has not yet been connected, and there has been a long-term lack of sufficient investment in energy-saving technical transformation work, resulting in insufficient application of energy-saving new technologies, new products, new energy, new processes, etc., making winter heating supply a problem for the school and lacking the necessary enthusiasm for clean energy utilization and management work. At the same time, school energy management is mostly limited to meter reading, purchasing coal, paying heating and power supply fees, and solving energy supply problems. In order to avoid operational risks, logistics entities, based on their own interests, will try to increase their energy budget as much as possible, invisibly increasing the school's energy expenditure[4]. This mode of energy management is lack of market mechanism awareness, and the incentive and constraint mechanism of supply, use and management is not perfect, so it is difficult to form an effective school energy consumption market. In recent years, the energy expenditure directly or indirectly used for teaching by schools has significantly increased year by year. The development of various teaching forms, infrastructure projects, and other undertakings has made the work of energy management in schools increasingly heavy. It is necessary to build a consumer market dominated by clean energy[5].

5. CONCLUSION

a) In terms of architectural layout, the layout and orientation of schools in the Nagqu area do not take into account environmental factors such as climate and geography, and neglect the adaptability of the buildings to the environment, resulting in an increase in energy consumption;

b) In terms of heating methods, municipal pipe networks are the main source of centralized heating, accounting for 85% -90%. Coal is the main energy source, and coal furnaces consume a large amount of coal for heating, resulting in low combustion efficiency (average of 15% -25%), uneven indoor temperature, and poor thermal comfort;

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c) In terms of the external enclosure structure, whether it is a newly built or renovated school, the building's external enclosure structure basically has no insulation layer, resulting in poor indoor thermal comfort and high heating energy consumption per unit area;

d) In terms of clean energy utilization, although schools in the Nagqu area have adopted clean energy utilization methods such as solar bathrooms, solar thermal collectors, solar photovoltaic power generation systems, and solar street lamps to varying degrees, the overall proportion of clean energy in the school energy consumption system is very small, and the abundant advantages of clean energy resources such as solar and wind energy in the Nagqu area have not been fully utilized.

6. SUPPORTED PROJECT NAME

"Investigation and Research on the Promotion and Application of New Energy in Schools in Tibet Region"

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