

Research on the Application of New Energy Photovoltaic Power Generation Technology

Weimin Liu^{1*}, Yue Qi²

¹Qingdao Railway Investment Energy Technology Co., Ltd., Qingdao 266000, China

²Shandong Institute of Commerce and Technology, Jinan 250000, China

*Corresponding author: Weimin Liu, 18660168999@163.com

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Abstract: With the rapid development of technology and economy, the demand for energy in society is increasing. People are gradually realizing that fossil energy is limited, and the development of new energy may also face situations where it cannot meet social needs. The problem of resource shortage is gradually exposed to people. Therefore, the development of usable new energy has become an urgent problem for society to solve. At present, electricity is the most widely used energy source worldwide and photovoltaic power generation technology is gradually becoming well-known. As an emerging industry, the development of photovoltaic power generation still requires continuous promotion by national and social policies to be extended to various industries and ensure the stability of its energy supply. This article mainly outlines the principles, characteristics, and advantages of photovoltaic power generation, and briefly explains the current technology types and application aspects of photovoltaic power generation to contribute to its promotion and better serve all aspects of social life with new energy.

Keywords: New energy; Photovoltaic power generation; Application

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1. Introduction

Against the backdrop of continuous progress in science and technology and rapid socio-economic development, various sectors of society have gained more development opportunities, and regional economic activity has been significantly stimulated. However, the development of the economy cannot do without the support of energy, and electricity is the material basis for the normal operation of various industries. Although traditional thermal power generation can meet the needs of society, it has high energy consumption, low efficiency in converting heat into electricity, and generates a large amount of exhaust gas and harmful substances during the combustion process, which can easily cause environmental pollution. Although wind power generation is clean, it depends on weather and wind speed, and is highly unstable. Under normal circumstances, nuclear power generation is safe, clean, and efficient. However, due to the high cost, cutting-edge technology, and the danger of nuclear leakage, it cannot be fully popularized. Therefore, driven by the concept of sustainable development, photovoltaic power generation technology has become the new favorite of new energy generation with its clean energy source and stable power

output. The development and construction of photovoltaic power generation projects have become a trend, and research on the application of photovoltaic power generation technology also has high value.

2. The power generation principle of new energy photovoltaic power generation technology

The new energy photovoltaic power generation technology mainly relies on the photovoltaic effect of semiconductors, which directly converts solar radiation energy into electrical energy. The photovoltaic power generation system consists of a solar cell array, a battery pack, a charge and discharge controller, an inverter, an alternating current (AC) distribution cabinet, a solar tracking control system, etc.^[1] When sunlight shines on a semiconductor solar panel, photons with sufficient energy excite electrons in P-type silicon and N-type silicon from covalent bonds and collide with them, forming electron-hole pairs in the semiconductor. Under the action of an electric field, non-equilibrium electrons in P-type silicon transfer to N-type silicon, and non-equilibrium holes in N-type silicon transfer to P-type silicon, forming a photo-generated electric field. A thin layer of photo-generated electromotive force is generated between N-type silicon and P-type silicon, and electrode circuits are connected on both sides of the semiconductor chip to generate current. The more electron-hole pairs there are, the greater the current^[2]. Generally speaking, photovoltaic modules are connected in series or parallel to form a photovoltaic array to increase the output current power.

3. Characteristics of new energy photovoltaic power generation technology

3.1. The necessity of developing photovoltaic power generation technology

After the Second Industrial Revolution, the issue of the energy crisis began to emerge. To ensure the sustainable development and normal operation of society, the development and research of new energy are essential. Moreover, it has become a consensus that traditional energy sources will cause pollution to the environment. The awareness of protecting the environment, energy conservation, and emission reduction has taken root in the minds of the public. The development of new energy photovoltaic power generation technology can provide new energy choices for social enterprises and the people, and contribute a key force to the sustainable development of society. Additionally, with the advancement of technology, new energy photovoltaic power generation technology has been applied in various industries' production activities. However, to better solve the problems of energy shortage and environmental degradation, photovoltaic power generation technology still has broad development prospects. For example, in the remote areas of northwest China where energy is scarce, but the terrain is open and the sunshine is abundant, there is a natural advantage in establishing photovoltaic power stations^[3]. Photovoltaic power generation technology can also be based on this to achieve significant development.

3.2. The importance of new energy photovoltaic power generation technology

Currently, new energy photovoltaic power generation technology is mainly researched and developed in the northwest of China as a pilot area. The new energy photovoltaic power generation technology can convert solar energy into electrical energy with a conversion rate of up to 80%^[4]. Solar energy is inexhaustible, and the use of solar energy in new energy photovoltaic power generation technology can achieve sustainable development and effectively alleviate the problem of resource shortage. Moreover, considering various factors comprehensively, photovoltaic power generation equipment is generally selected to be built in areas with low population density such as northwest China, effectively utilizing idle land resources. Furthermore, the assembly process of photovoltaic power generation equipment is simple and easy to maintain. Compared with traditional thermal

power, it can effectively reduce labor input and save costs under the same power generation capacity. It has a very good development prospect for widespread promotion.

4. Specific advantages of new energy photovoltaic power generation technology

4.1. Wide application range

The sun provides significant energy to the Earth, and new energy photovoltaic power generation technology requires the use of sunlight to convert solar energy into electrical energy, with high and stable conversion efficiency and low probability of being affected by other factors ^[5]. China has a wide area of sunshine, and there are many sites where photovoltaic equipment can be built. Therefore, photovoltaic power generation technology has been widely applied in China.

4.2. Clean and pollution-free

Traditional power generation requires fossil energy for thermal power generation, but fossil energy is limited and non-renewable, and carbon dioxide and dust generated during the combustion of fossil energy will cause serious environmental pollution, such as the greenhouse gas effect, haze, etc., which will melt polar glaciers in serious cases, rise in sea level, and long-term inhalation of air with haze by people or animals will greatly increase the rate of lung cancer ^[6]. Photovoltaic power generation only requires semiconductors and sunlight. Solar energy is a renewable resource, and using photovoltaic power generation can save fossil resources and effectively improve the current situation of environmental pollution.

4.3. Large exploitable reserves

China's fossil energy reserves account for only 10% of the world's total, and the per capita reserves are relatively low compared to the world level. But solar energy is a renewable resource, and the total amount of solar radiation reaching the Earth's surface each year is about $13 \times 1,013$ tons of coal fuel, far exceeding actual energy consumption needs ^[7]. Currently, human technology for the development of solar energy is quite rare, and there is still a lot of room for development.

5. Technical types of new energy photovoltaic power generation

5.1. Water photovoltaic technology

Although photovoltaic power stations have been promoted and applied in various industries, most of the photovoltaic equipment is built on land, which requires high accessibility to the power grid and construction location ^[8]. With the development of technology, water-based photovoltaic technology has emerged, effectively solving this problem. Building photovoltaic power stations on water bodies can not only reduce the negative impact of power generation equipment on the environment and expand construction space but also utilize water surface temperature to help dissipate heat from various components of the photovoltaic power generation system, ensuring the normal operation of the equipment and providing continuous and stable power supply.

5.2. Independent photovoltaic power generation

Independent photovoltaic power generation systems can operate independently and provide relatively stable electricity without being connected to the grid, which is very convenient and fast, and has been widely used. For some relatively remote areas, the use of independent photovoltaic power generation systems can reduce conflicts with the public power grid and can be moved according to actual usage, making it capable of supplying power

even in relatively harsh environments. Moreover, the energy storage components of independent photovoltaic power generation systems can be used for emergency response on cloudy or nighttime days to meet the electricity needs of users.

5.3. Energy storage technology

Although photovoltaic power generation technology has many advantages, there are still problems such as power supply volatility, intermittency, and difficulty in scheduling^[9]. To solve the above problems, the role and value of energy storage technology cannot be ignored. Energy storage technology is a crucial component in the process of utilizing photovoltaic technology for power generation. Firstly, energy storage technology can solve the problem of power supply fluctuations. Photovoltaic power generation mainly utilizes solar energy. Once there is cloudy or rainy weather, or short days and long nights in winter, it is easy to cause an unstable power supply and affect normal electricity demand. Configuring a dedicated energy storage system can provide stable electricity when solar panels are unable to supply power or during peak usage periods. Additionally, energy storage technology can improve the ability to track planned power generation. There are many uncertain factors in the process of photovoltaic power generation, which affect the planned power generation and stable operation of the power grid. Reasonable compensation using energy storage systems can effectively balance unpredictable power generation curves, improving the adjustability and controllability of photovoltaic power generation systems. Furthermore, voltage transients may occur during the power grid supply process. Energy storage technology can control charging and discharging, adjust wind and voltage reasonably, and improve the overall stability of the power station. The current mainstream energy storage technologies include supercapacitors, electrochemical energy storage, etc. and photovoltaic power plants mainly use electrochemical methods for energy storage^[10].

6. Application of new energy photovoltaic power generation technology

6.1. Integrated photovoltaic building

With the development of the times and policy adjustments, the population is gradually migrating to cities, and rural urbanization is also in full swing. Urban buildings are constantly increasing, and the consumption of traditional energy is also growing exponentially. To reduce the consumption of traditional fossil fuels in cities, achieve energy conservation and emission reduction, and effectively utilize solar energy, integrating photovoltaic power generation systems with buildings is the best solution. With the increasing emphasis on environmental protection technology, the integration of photovoltaic power generation and building technology has become the main research direction for clean energy generation in future cities, and there have been some achievements so far. There are mainly two types of integration between the two. The first is the installation of photovoltaic equipment in buildings, which needs to meet the conditions of receiving light and ventilation during building design so that the photovoltaic equipment can work normally and meet the electricity needs of the building. Simultaneously, cost savings need to be paid attention to during the construction of both, so that social resources can be efficiently utilized. The second type is at the top level of the equipment, which needs to be connected to the equipment and build a complete photovoltaic power generation system with the power grid. The installation method is somewhat complex and cumbersome, but it can optimize the building environment and save a lot of energy^[11]. Regardless of the integration scheme, it is necessary to consider the actual situation of the building, achieve a comprehensive unity of aesthetics and practicality, and unleash the true value of photovoltaic building integration.

6.2. Grid-connected photovoltaic power generation system

New energy photovoltaic power generation also plays a significant value and role in the operation of the power

grid. In the actual power generation process, grid-connected photovoltaic power generation systems need to be connected to the public power grid in advance, and reasonable allocation and adjustment need to be made during power supply. The two work together to make power supply safer and more reliable. The output current of photovoltaic power generation is generally a direct current ^[12]. By using an AC inverter, direct current can be converted to alternating current of the same frequency, which can improve the safety and stability of electricity use. The use of photovoltaic grid-connected power generation systems can meet the electricity demand of areas with high electricity consumption and provide strong support for urban power supply.

6.3. Single-user photovoltaic power supply

For individual users, independent photovoltaic power generation systems can meet their electricity needs and achieve good results. Some users and enterprises have remote addresses and cannot obtain electricity through the public power grid. To meet the electricity needs of this group of users, research on photovoltaic power generation systems is also moving towards independent photovoltaic equipment for individual users ^[13].

6.4. Hybrid photovoltaic power generation system

A hybrid photovoltaic power generation system refers to a power supply system that combines photovoltaic power generation technology with other energy generation methods. The composition of the lines and equipment in a hybrid power generation system is complex, and diverse electrical modes can be used to ensure a stable power supply. For different regions, climates, and seasons, appropriate hybrid power generation methods should be selected based on the actual situation of power generation equipment ^[14]. For example, in coastal plain areas with short winter sunshine hours but strong sea winds, a hybrid photovoltaic power generation system can be constructed by combining wind turbine power generation with photovoltaic power generation. Hybrid power generation technology can make full use of resources, improve energy utilization efficiency, and maintain a stable power supply for the overall power supply network in the region.

6.5. Combining photovoltaic power generation with LED lighting

Light-emitting diode (LED) lights, with their advantages of low energy consumption and high brightness, have gradually replaced tungsten light bulbs and entered millions of households. LED lights can convert electrical energy into light energy, with the most important component being semiconductors ^[15]. The similarity between photovoltaic power generation and LED lights is that they both use direct current and have a lower operating voltage. Therefore, they can be effectively combined to improve the efficiency of solar energy utilization, reduce the step of converting current from direct current to alternating current, increase lighting intensity, and have distinct environmental characteristics. They also have the advantage of long service life, with simple and convenient maintenance methods.

7. Conclusion

In today's world where fossil energy reserves are decreasing, the focus of scientific research has shifted from traditional energy to new energy, and traces of the utilization of new energy can be seen in various industries and fields. Solar energy, as a clean and pollution-free renewable resource, can effectively solve the problems of environmental pollution and energy scarcity by utilizing photovoltaic technology in production and daily life. However, the development of solar energy and photovoltaic technology by humans is still not thorough, and it requires joint efforts from all industries to strengthen the development and utilization of new energy, bringing more opportunities for social development.

Disclosure statement

The authors declare no conflict of interest.

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