Proceedings of CONF-MCEE 2026 Symposium: Geomaterials and Environmental Engineering
DOI: 10.54254/2755-2721/2026.MH30397

The Achievements and Challenges of China's Poverty Alleviation Efforts Through Photovoltaic Power Generation

Anxin Dong[1], Qianxun Zhang[2*], Bingchen Zhou[3]

[1]School of Optoelectronic Engineering, Changzhou Institute of Technology, Changzhou, China
[2]College of Geophysics, China University of Petroleum, Beijing, China
[3]Chongqing Yucai Middle School, Chongqing, China
**Corresponding Author. Email: 2021011017@student.cup.edu.cn*

Abstract. This paper systematically studies the feasibility, internal logic, practical models, remarkable achievements, and challenges faced by China in carrying out poverty alleviation work through the photovoltaic power generation industry. Through research, it has been found that by leveraging the unique mountainous terrain and light resources of poverty-stricken counties, integrating photovoltaic power generation with poverty alleviation and rural revitalization strategies can create multiple poverty alleviation models that promote the common development of photovoltaic power generation and agriculture, employment, village collective economy, as well as other aspects. These models not only directly bring stable economic income to impoverished populations and villages, improving their production and living conditions, but also promote the development of green energy, achieving a multiple win-win scenario in economic, social, and environmental benefits. However, the project also faces challenges such as high initial investment, pressure for local consumption, slow progress in supporting local industrial development with green electricity, the need to improve the mechanism for generating revenue and distributing it to residents, the lack of effective breakthroughs in developing "under-panel economies," and high long-term maintenance costs. The paper concludes with policy recommendations for future sustainable development.

Keywords: Photovoltaic Power Generation, Photovoltaic Poverty Alleviation, Poverty Alleviation, Clean Energy

1. Introduction

Rural poverty and unequal distribution have always been major obstacles and long-term challenges to the development of Chinese society. Eliminating poverty is an urgent requirement for China to achieve socialism. To achieve complete and effective poverty alleviation, it is not only necessary to create income for rural populations, but also to form long-term stable income and achieve a transition from "blood transfusion" to "blood production" to prevent rural families from falling back into poverty. In the practice of poverty alleviation in China, photovoltaic poverty alleviation, as an innovative and precise poverty alleviation model, has opened up new directions for poverty alleviation work.

© 2026 The Authors. This is an open access article distributed under the terms of the Creative Commons Attribution License 4.0 (https://creativecommons.org/licenses/by/4.0/).

DOI: 10.54254/2755-2721/2026.MH30397

In rural areas of China, the majority of impoverished families lack labor and have a single and unstable source of income. According to statistics, the proportion of people in rural China who fall into poverty due to illness or disability accounts for 42% and 14% of the total number of impoverished people, respectively. This group has lost its ability to work, faces unstable sources of income, high medical expenses, and other issues, leading to a higher risk of recurrent poverty [1]. In addition, some remote and arid areas lack traditional economic value, have low agricultural productivity, and are difficult to increase income [2]. This makes it difficult to implement traditional poverty alleviation methods, such as developing agriculture and animal husbandry, and requires opening up new paths for poverty alleviation. In this case, photovoltaic poverty alleviation combines the development of the clean energy industry with poverty alleviation efforts, providing a new way to alleviate poverty by utilizing solar energy resources.

Based on this, this paper mainly studies the feasibility and basic principles of using photovoltaic power generation for poverty alleviation in China. By analyzing two successful practical cases, the achievements and possible challenges of photovoltaic poverty alleviation work in recent years are summarized, aiming to propose feasible solutions for photovoltaic poverty alleviation.

2. Feasibility of photovoltaic poverty alleviation

Photovoltaic poverty alleviation is a simple, efficient, and long-term beneficial poverty alleviation project with significant feasibility for implementation in rural areas of China. China's impoverished areas, especially the central and western regions, have abundant solar energy resources and superior conditions for the construction of photovoltaic power stations, making them a good location for introducing photovoltaic power generation technology. Including the impoverished population in the photovoltaic power generation market may improve productivity and transform production relations, providing stable sources of income for rural households.

In addition, photovoltaic poverty alleviation technology is reliable, and the income is stable. It can also carry out a variety of "photovoltaic+" applications in combination with agriculture and forestry. With the development and maturity of technology, the cost is also reducing, and the economic feasibility is continuously improving. The introduction of photovoltaic power generation technology can effectively stimulate the economic development of poor areas. In 2016, the National Energy Administration proposed an energy poverty alleviation project combining rural power grid transformation in poor areas, rural power grid coverage, and photovoltaic poverty alleviation at the “13th five-year” plan working conference. Through energy poverty alleviation with photovoltaic power generation industry as the core, the project promotes the transformation of rural power grid while helping the poor, which is of great significance to the improvement of infrastructure conditions and poverty alleviation in poor areas [3].

As a kind of clean energy, photovoltaic power generation can contribute to poverty reduction, reduce fossil fuel pollution, reduce carbon dioxide emissions, and promote the sustainable development of the environment. This is not only in line with the targeted poverty alleviation and poverty eradication strategy, but also in line with the national clean and low-carbon energy development strategy.

DOI: 10.54254/2755-2721/2026.MH30397

3. Principles of solar Photovoltaic (PV) power generation

3.1. Theoretical basis

The theoretical basis of solar PV power generation is the photoelectric effect in physics. This primarily refers to the phenomenon where photons strike a metal or semiconductor material, causing its electrons to be emitted. PV cells utilize the internal photoelectric effect, where electrons absorb photon energy and transition from the valence band to the conduction band, forming mobile electron-hole pairs within the material, rather than being completely emitted.

The core of PV power generation is the PV cell made from semiconductor materials, with silicon being the most commonly used material. By doping silicon wafers with other elements (such as phosphorus and boron), negatively charged N-type semiconductors and positively charged P-type semiconductors can be formed. When these two are combined, a built-in electric field directed from the N-region to the P-region forms at the junction, known as the P-N junction. When sunlight (photons) strikes the cell, the photons transfer their energy to electrons within the silicon atoms. Electrons that gain sufficient energy break free, becoming free electrons. Under the influence of the built-in electric field, these electrons move directionally (electrons from the N-region move towards the P-region, holes from the P-region move towards the N-region), thus forming an electric current. By connecting numerous cells in series and parallel and encapsulating them into PV modules (solar panels), the generated direct current (DC) is converted into alternating current (AC) via an inverter, which can then be fed into the grid or used by electrical loads [4].

3.2. Technology trends and challenges

Driven by technological advancements, economies of scale, and supply chain optimization, the Levelized Cost of Electricity (LCOE) for solar PV power has become highly competitive, making it the cheapest form of energy in many regions worldwide. Furthermore, PV power generation is evolving towards system integration and intelligent development. Through initiatives like "PV + Energy Storage," integrated PV-charging-storage systems, Building-Integrated Photovoltaics (BIPV), and smart microgrids, its energy utilization rate and grid compatibility are gradually improving.

After the 1990s, as costs decreased, solar cell production grew rapidly. Solar cells began to be applied in the industrial sector and for rural electrification, leading to steadily expanding markets. National and local governments started formulating PV development plans. Between 2003 and 2005, driven by substantial demand from the German market, the production capacity of domestic Chinese PV enterprises expanded rapidly, and output increased significantly. In 2005, cell production was approximately 150 MW, module production was about 284 MW, domestic installations were around 5 MW, and cumulative installations reached 70 MW.

Today, PV technology still faces challenges such as how to further improve conversion efficiency, reduce material and manufacturing costs, address intermittency and instability (weather dependency), and manage recycling and reuse after large-scale deployment. Based on the specific requirements of China's national conditions, PV power generation is an essential pathway for building a moderately prosperous society in rural areas. Additionally, there are still 7 million households in China without access to electricity, which cannot be solved by extending the conventional power grid [5]. PV power generation can help maintain the results of ecological construction and improve the living environment in rural areas. Currently, over 200 million people are threatened by desertification. However, burning traditional biomass remains the primary energy

DOI: 10.54254/2755-2721/2026.MH30397

source for household use in many regions, leading to excessive deforestation, severe vegetation destruction, and continuous deterioration of the living environment. Establishing a clean and convenient energy mechanism can provide a reliable guarantee for the "Grain for Green" and grassland restoration projects [4].

4. Implementation measures of photovoltaic poverty alleviation and successful practice cases of photovoltaic poverty alleviation

4.1. Successful practice cases

Wushan County, Chongqing: A Model of Village-level Photovoltaic Power Stations and Revenue Distribution

Wushan County, located in the mountainous area of Chongqing, has poor soil but good sunlight conditions. The local government innovatively combined photovoltaic poverty alleviation with relocation poverty alleviation, making full use of the rooftops of relocation settlements and the surrounding barren hills and slopes to build a number of photovoltaic power stations with clear property rights and belonging to the village collective.

The revenue distribution mechanism of these power stations is particularly meticulous, forming the core of sustainable development. About 60% of the power generation revenue is directly used to subsidize registered poor households, providing stable and reliable cash income for left-behind elderly people and families impoverished by illness, and building a dam against poverty recurrence. 30% of the revenue is used to cover the operation and maintenance costs of the power stations and public welfare expenditures in the village, ensuring the long-term stable operation of the power stations and indirectly improving the living environment of the entire village. The remaining 10% is set aside as the village collective's reserve fund, accumulating internal driving force for the future development of the village.

This measure has transformed sunlight into a stable source of income for impoverished people and significantly enhanced the "blood-making" capacity of poor villages. The once idle and barren hillsides have been turned into sustainable "treasure troves", and their successful practice provides valuable reference experience for the rural revitalization of similar areas [6].

Wuzhong, Ningxia: Synergy between Solar Power Generation and Ecological Management

Some areas in Wuzhong City, Ningxia, are located in the transitional zone between arid and semi-arid regions, and have long been threatened by land desertification. Through the innovative model of "solar power generation and grazing complementation", the local area has successfully found a balance between ecological restoration and economic development [7].

Under this model, the photovoltaic power station has gone beyond the sole function of energy production and has become an important carrier for ecological governance. Official monitoring data (source: CCTV's "Focus Interview") shows that the shading effect of the photovoltaic panels can reduce the surface temperature by 2-3 degrees Celsius and reduce soil moisture evaporation by more than 20%, significantly improving the microclimate environment under the panels. This change creates favorable conditions for the recovery and growth of drought-resistant forage, increasing the vegetation coverage in the project area from the original approximately 30% to over 70% (source: CCTV's "Focus Interview", Ningxia News Network). The high-quality forage, such as purple clover and sand thistle planted under the panels, can produce 400-500 kilograms of dry hay per mu, not only playing a role in sand fixation and soil enrichment, but also providing sufficient natural feed for sheep and other livestock.

DOI: 10.54254/2755-2721/2026.MH30397

At the same time, farmers are allowed to conduct zone-based rotational grazing in the photovoltaic park. This scientific breeding model effectively reduces the breeding cost. According to calculations, the breeding cost of each sheep can be saved by approximately 150 yuan (source: "Ningxia Daily"). At the same time, it avoids excessive grazing. Eventually, a three-dimensional, space-efficient utilization pattern of "solar power generation on the surface, planting in the middle, and grazing under the panels" is formed, achieving a win-win situation in energy output, ecological restoration, and economic benefits. This model not only curbs desertification and delivers green electricity but also helps farmers increase income through multiple channels, such as land rent, forage sales, and livestock breeding, providing a replicable, successful experience for sustainable development in global ecologically fragile areas [8].

4.2. Implementation measures for poverty alleviation through photovoltaic power generation

For photovoltaic poverty alleviation to truly take root and achieve long-term effectiveness, two major problems need to be addressed: "Where does the money come from?" and "How will the benefits be distributed?". The experience of Wushan County in Chongqing shows that successful fund integration requires the establishment of a diversified investment mechanism of "the government provides the platform, enterprises perform the show, finance offers support, and the masses participate". Central financial subsidies play a guiding role, and local governments should coordinate and integrate various funds for poverty alleviation relocation, east-west cooperation, etc., as project capital, while actively guiding energy enterprises to invest and build, and encouraging financial institutions to provide green credit support. Only in this way can the financing difficulties for project initiation in poverty-stricken areas be solved.

In terms of benefit distribution, the Wushan model proves that establishing a transparent and standardized distribution system is crucial. It is recommended to follow its "six-three-one" distribution ratio method: most of the income should be directly distributed to poor households to ensure basic living; a portion of the funds should be used for power station maintenance and village-level public welfare positions to ensure sustainable operation; a small amount of funds should be used as village collective provident funds to facilitate long-term development. This distribution method takes into account both the current poverty alleviation needs and leaves sufficient momentum for rural revitalization.

In particular, it is important to note that photovoltaic poverty alleviation should go beyond the limitation of simple power generation and transform into a diversified integration of "photovoltaic +". The "sheepgrass-mountain complementarity" model in Wuqiong, Ningxia, provides valuable experience: in ecologically fragile areas with good sunlight conditions, a three-dimensional development model of "power generation on the panels, restoration under the panels, and planting between the panels" can be promoted. The photovoltaic array can provide a micro-environment of shade and moisture for grass growth, promoting vegetation restoration; grass planting can also fix sand and fertilize the land, providing support for power station operation. This model not only turns the former barren hills into a "treasure basin" but also realizes the coordinated development of ecological restoration, clean energy, and the livestock industry [6].

It is suggested that when promoting photovoltaic poverty alleviation in various places, local resources endowments should be fully considered: in mountainous areas, the experience of Wushan can be borrowed, and village-level power stations can be built on the rooftops of resettlement areas and on barren mountains; in grassland pastoral areas, the practices of Wuqiong can be followed, and the "sheepgrass-mountain complementarity" model can be implemented. At the same time, local characteristic industries should be cultivated so that photovoltaic power generation can serve

DOI: 10.54254/2755-2721/2026.MH30397

agricultural product processing, cold chain logistics, etc., forming a complete "photovoltaic-agriculture integrated" industrial chain. Only in this way can photovoltaic poverty alleviation truly become a fulcrum for driving rural revitalization, achieving a fundamental transformation from "blood transfusion" to "self-renewal".

5. Conclusion

The PV poverty alleviation practices in Wushan County and Wuzhong City fully demonstrate the feasibility and multiple benefits of combining clean energy with the rural revitalization strategy. This is specifically reflected in the "PV+" poverty alleviation model, which integrates PV power generation with other industries, promoting a multi-win situation for economic, social, and environmental benefits. However, numerous challenges remain, such as uneven future benefit distribution and how to further promote the innovative development of the "economy under the panels." With policy support and technological upgrades, PV power generation can play a more significant role in promoting sustainable rural development and achieving the "Dual Carbon" goals. PV poverty alleviation ensures project economic viability and targeted support to households through innovative fund integration and precise allocation. Its core lies in exploring "PV+" industrial integration models, such as "agriculture-light complementarity" and "pasture-light complementarity," achieving synergy between clean energy production, ecological protection, and agricultural development. Successful cases include the village-level power stations in Wushan, Chongqing, which help impoverished households achieve stable income growth through scientific distribution of benefits. The "pasture-light complementarity" model in Wuzhong, Ningxia, achieves power generation on the panels and planting/grazing underneath them, balancing ecological restoration with economic development, providing replicable sustainable development experience for similar regions.

Authors contribution

All the authors contributed equally and their names were listed in alphabetical order.

References

[1] Yuan, C., Ding, T., & Wu, B. (2024). Targetedness, effectiveness, and sustainability of China's photovoltaic poverty alleviation programmes. Energy, 300, 131515.
[2] Wu, J., Mi, S., Meng, J., & Yu, N. (2025). Does the residential photovoltaic station programme aid poverty alleviation? Evidence from rural China. Energy Policy, 200, 114538.
[3] Gao, F., & Dong, J. (2020). Research on the diversified evolution path of the photovoltaic poverty-alleviation industry. Journal of North China Electric Power University (Social Sciences Edition), (4), 34–39.
[4] Zhao, C. (2008). Current research status and application prospects of photovoltaic power generation technology. Journal of Shanghai Dianji University, (2), 104–109.
[5] Ma, H. (2023). Current status and development analysis of solar photovoltaic power generation technology. Light Source and Lighting, 9, 114–116.
[6] National Energy Administration. (2018). Notice on matters related to photovoltaic poverty alleviation. Retrieved from http: //www.nea.gov.cn/
[7] Liu, Z. (2023). Research on the complementary development of photovoltaic power stations and ecological industries. Light Source and Lighting, 10, 118–120.
[8] Ningxia Daily. (2020). Wuzhong‘s “animal husbandry–photovoltaic complementarity” lights up the poverty alleviation path. Retrieved from http: //nxdaily.com/