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The "Digital Inclusive Finance + Photovoltaic Agriculture" Project in Meizhou: Lessons for Rural Low-Carbon Transformation

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Abstract: *The low-carbon transformation of rural production and daily life is essential yet challenged by a significant funding gap, as traditional banks are often reluctant to finance the initial development of green industries like photovoltaic power generation and ecological agriculture. With the growing penetration of mobile phones and internet access, digital inclusive finance—defined as inclusive financial services delivered through digital tools—has emerged as a pivotal solution. Focusing on the "Photovoltaic + Digital Inclusive Finance" pilot project in Meizhou City, Guangdong Province, this study investigates how this model facilitates rural low-carbon transformation. It analyzes the project's implementation outcomes, identifies persistent challenges, and summarizes transferable experiences, aiming to provide valuable insights for other regions pursuing synergistic development of rural green industries and farmer prosperity.*

Keywords: *Rural Low-Carbon Transformation, Digital Inclusive Finance, Photovoltaic Power Generation, Ecological Agriculture, Financial Innovation, Sustainable Development*

1. Introduction

Rural low-carbon transformation has gained increasing prominence as a crucial element in achieving Carbon Peak and carbon neutrality goals, amid global efforts to combat climate change and promote Carbon Emission Reduction. In China, the agriculture and rural sectors have been identified as significant contributors to Greenhouse Gas Emissions, highlighting the urgent need for a green and low-carbon shift in rural development models. At the same time, the rapid evolution of digital technologies—including the internet, Big Data, and Artificial Intelligence—has led to the rise of Digital Inclusive Finance, which has brought renewed momentum and opportunities to support rural low-carbon transformation. Recent studies have demonstrated that Digital Inclusive Finance has significantly facilitated the adoption of green technologies in rural areas by lowering barriers to financial services and enhancing the efficiency of resource allocation [1]. For instance, in the rural regions of Guangdong Province, digital financial support has led to an increase of over 30% in farmers participation in photovoltaic projects [2].

2. Background Analysis of the Application of Digital Inclusive Finance in Rural Low-Carbon Transformation

Global Climate Change and the Dual Carbon Targets: In response to the ongoing trend of global warming, countries worldwide have implemented proactive measures. China has introduced the Dual Carbon targets, recognizing that the agricultural and rural sectors are significant contributors to carbon emissions. Advancing Rural Low-Carbon Transformation is essential for achieving the Dual Carbon goals and demands comprehensive support. In this context, Digital Inclusive Finance has emerged as a vital driving force. Rural economic development and the need for industrial upgrading: Traditional agriculture, marked by high energy consumption and low productivity, has led to sluggish income growth for farmers. An urgent transformation is required, with a focus on developing low-carbon industries such as Ecological Agriculture and green agricultural product processing. These emerging sectors demand significant upfront capital investment for technology acquisition and equipment procurement, creating ample opportunities for Digital Inclusive Finance to contribute meaningfully.

Rapid advancement of digital technologies: The swift progress of digital innovations, including Big

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Data, Cloud Computing, and Artificial Intelligence, has provided essential technical support for the expansion of inclusive finance in rural areas. Leveraging these technologies, financial institutions are able to accurately assess the creditworthiness and funding needs of rural clients, thereby lowering service costs and mitigating risks, while overcoming traditional limitations. Limitations of traditional financial services in rural areas: Due to the scarcity of collateral and underdeveloped financial infrastructure, traditional financial institutions—driven by cost and risk considerations—tend to offer limited service coverage and have low operational efficiency. Digital Inclusive Finance, powered by digital technologies, has the potential to address these shortcomings. Empirical studies have demonstrated that, by leveraging Big Data and Risk Controls, digital finance can reduce the rural Credit Default Rate to below 5% [3]. In addition, its Spatial Spillover Effect has been shown to facilitate Coordinated Emission Reduction in neighboring regions [4].

3. Understanding the concept and implications of how Digital Inclusive Finance supports Rural Low-Carbon Transformation

The term *Digital Economy* first appeared in the 1990s, referring to a new form of economy driven by interactive multimedia, information highways, and the internet, and grounded in the networked intelligence of human beings. The widely recognized concept of the digital economy originates from the G20 Digital Economy Development and Cooperation Initiative adopted at the Hangzhou Summit of the G20 Leaders in September 2016 . The digital economy is defined as a series of economic activities in which digitized knowledge and information serve as key production factors, modern information networks function as essential platforms, and the effective application of Information and Communication Technology acts as a major driver for enhancing efficiency and optimizing economic structures.

Digital Inclusive Finance supports Rural Low-Carbon Transformation by integrating digital technology with inclusive finance, facilitating its application in rural low-carbon development. This process aims to promote the coordinated advancement of rural economies and environmental sustainability. The concept primarily encompasses the use of digital technologies to enhance financial services, thereby improving their accessibility and coverage in rural areas. This enables rural residents, agricultural enterprises, and other stakeholders to access financial resources more efficiently. Simultaneously, financial resources are directed toward rural low-carbon industries and projects, including support for the development of Ecological Agriculture, the promotion of Clean Energy adoption, and the advancement of rural Green Infrastructure construction. These initiatives are intended to drive a shift in rural production and lifestyles toward low-carbon and environmentally friendly models, fostering rural economic growth while reducing carbon emissions and preserving the rural ecological environment. Ultimately, these efforts aim to achieve the goal of Rural Low-Carbon Transformation.

The primary objective of this research is to explore how Digital Inclusive Finance can be effectively promoted to support the advancement of Rural Low-Carbon Transformation.

4. Analysis of the Model and Process by Which Digital Inclusive Finance Supports Rural Low-Carbon Transformation in Meizhou City

In the Photovoltaic Agriculture Project in Meizhou City, Digital Inclusive Finance has been leveraged to support Rural Low-Carbon Transformation through the following model and process:

• Model:

Bank-Enterprise-Farmer Cooperation Model: A collaborative framework is established among financial institutions, photovoltaic enterprises, and farmers. Financial institutions, such as the Rural Commercial Bank in Meizhou City, offer dedicated loan products like the *Yuefeng Green Photovoltaic Loan* to support farmers. Photovoltaic enterprises provide the necessary equipment and technical assistance to facilitate the construction of Photovoltaic Power Generation facilities. Farmers utilize their rooftops or idle land to build Photovoltaic Power Stations, enabling the conversion of solar energy into electricity—part of which is used for self-consumption, while the surplus is sold to the grid. Leveraging the new model of Party-building and government-bank cooperation, Fengshun Rural Commercial Bank has actively promoted the *Photovoltaic Access for Every Village* initiative. The first loan of RMB 487,500 under the *Yuefeng Green Photovoltaic Loan* program was issued to the Shareholding Economic Cooperative Union of Changbu Village, Dalonghua Town. Upon completion, the project is expected to reach an Installed Capacity of 195 kilowatts, with an estimated annual power generation of 245,700

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Kilowatt-hour. This is projected to increase the village collective's annual income by nearly RMB 100,000.

Whole Village Advancement Model: For villages that meet specific criteria, financial institutions implement Whole Village Credit Granting by evaluating the village's overall credit profile and providing a unified credit line. In the case of Sanlong Village, with strong support from the Stationed Town Assistance and Village Support Work Team and coordination by the Financial Assistant, a special photovoltaic loan of RMB 940,000 was secured from the Agricultural Bank of China. Photovoltaic panels were installed on the rooftops of 16 buildings in the resettlement area, with 9 of them already achieving Grid-Connected Power Generation. The project is expected to generate nearly RMB 300,000 in annual income, significantly enhancing the village collective's economic strength.

• Process:

Needs Assessment and Application: Once farmers or village collectives express an intention to develop Photovoltaic Agriculture, loan applications are submitted to financial institutions. Through the application of digital technologies, Big Data Analysis is employed to efficiently evaluate applicants' credit history, income level, asset portfolio, and other relevant indicators, enabling a rapid assessment of repayment capacity and associated loan risks.

Loan Approval and Disbursement: During the approval stage, the Intelligent Risk Control System within the framework of Digital Inclusive Finance is utilized to simplify cumbersome manual review procedures and improve approval efficiency. Upon successful approval, loans are promptly disbursed by financial institutions.

Project Implementation and Supervision: In accordance with contractual terms, photovoltaic enterprises install Photovoltaic Power Generation Equipment for the farmers and assume responsibility for ongoing maintenance and technical support. Financial institutions leverage the digital platform to monitor loan fund flow in real time, ensure earmarked fund usage, and track the operational performance of photovoltaic projects, thereby safeguarding investment returns and loan security.

Income and Repayment: Farmers earn electricity revenue through photovoltaic power generation and make regular repayments of loan principal and interest in accordance with the loan agreement. Any surplus income contributes to increasing household earnings, achieving a dual benefit of rural economic development and low-carbon transition.

5. Case Study on Digital Inclusive Finance Supporting Rural Low-Carbon Transformation in Meizhou City

5.1 Advantages and Achievements of the Digital Inclusive Finance + Photovoltaic Agriculture Project in Meizhou City

Economic development in rural areas of Guangdong Province remains uneven, with some remote mountainous regions still dependent on traditional high-carbon industries such as coal and low-efficiency agriculture. Financial support is essential for the low-carbon transition; however, credit access in rural areas remains limited under traditional financial institutions. Digital Inclusive Finance—including Mobile Payment, Internet Lending, and Big Data Risk Control—has lowered barriers to financial services, thereby enabling financing channels for rural low-carbon initiatives.

Meizhou City is situated in the northeastern region of Guangdong Province.It shares borders with Fujian Province to the northeast, Jiangxi Province to the northwest, Heyuan City to the west, Shanwei and Jieyang to the southwest and south, and Chaozhou to the southeast. Covering a total area of 15,836 km², the city is predominantly mountainous, with mountains comprising 47.5% of the land area, followed by hilly terrain at 39.2%. Plains, terraces, and tablelands account for approximately 12.4%, while rivers, reservoirs, and other water bodies make up 0.9%.Situated within the subtropical monsoon climate zone, the region functions as a transitional belt between the southern and central subtropical areas. The influence of tropical storms is limited, while the diverse natural geography supports the growth and development of a wide range of forest plant species. More than 140 mountain peaks in the city rise above 1,000 meters in elevation. Meizhou City possesses abundant solar energy resources; however, certain rural areas remain economically underdeveloped and continue to rely on the coal as a primary energy source.

In 2021, a *Photovoltaic Assistance for Agriculture* initiative was launched by the Meizhou Municipal

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Government in partnership with the Agricultural Bank of China and photovoltaic enterprises. This program aimed to encourage rural households to install rooftop photovoltaic panels and to advance the Agro-Photovoltaic Complementarity model (combining photovoltaic power generation with agricultural cultivation).

An online microloan application was introduced by the Agricultural Bank of China, offering loans of up to RMB 50,000 at an annual interest rate of 4.5%, which is lower than that of conventional commercial loans. Farmers submit applications via Mobile Banking, and creditworthiness is automatically assessed by the back-end Big Data Risk Control system, enabling loan disbursement in as little as one day. Installation and maintenance are handled by photovoltaic enterprises. Revenues from power generation are first used to repay the loan, with any surplus retained by the farmers. Electricity is connected to the China Southern Power Grid, and farmers can monitor real-time power generation income through an app. Additionally, Meizhou City has been included in Guangdong Province's Carbon Inclusive pilot program, allowing farmers to convert Carbon Emission Reduction from photovoltaic power generation into cash or credit points.

The index stood at 46.29 in 2011 and rose consistently each year, reaching 280.91 by 2021. This indicates a robust development trajectory for Digital Inclusive Finance in Meizhou, marked by continuous improvements in the accessibility and coverage of financial services. It also reflects the gradual enhancement of the regional digital financial ecosystem and the sustained vitality of its development.

Data source: Peking University Digital Inclusive Finance Index

By 2023, over 8,000 rural households in Meizhou City had installed photovoltaic systems, leading to an estimated annual reduction of approximately 15,000 tons of CO_2 emissions. Each household saw an average annual income increase of RMB 4,000–6,000, while the repayment rate for photovoltaic loans exceeded 98%. These developments have stimulated local employment in photovoltaic installation, operation, and maintenance, and have contributed to the upgrading of rural industries. Similarly, research by Sun Kai and Li Xuesongon the Photovoltaic Poverty Alleviation Project found that digital inclusive finance reduced the cost of photovoltaic installation for rural households by 20%, and that the Carbon Emission Intensity in projects-covered areas declined by an average of 8.5% per year [5] .

5.2 Issues in the Implementation of the "Digital Inclusive Finance + Photovoltaic Agriculture" Project in Meizhou City

5.2.1 Unbalanced development

From 2017 to 2021, the total digital inclusive finance index in all counties and districts of Meizhou City exhibited a consistent upward trend. In horizontal comparison, relatively high index values have been observed in certain counties and districts such as Meijiang District, while others, including Wuhua County, exhibit comparatively lower values. This indicates regional disparities in the development of digital inclusive finance across Meizhou City, with notable differences in the pace of Digital Advancement and the breadth of financial service coverage. These imbalances call for targeted attention and the implementation of appropriate measures to reduce disparities and foster coordinated development.

5.2.2 Weak digital Financial Awareness among rural residents

During the implementation of the photovoltaic digital inclusive finance project in Meizhou City, Guangdong Province, issues such as limited Financial Awareness and a general lack of trust among rural residents have emerged as particularly prominent. Due to the generally low educational attainment among rural residents, many lack access to systematic financial education, making it difficult to understand the complex Financial Terms, Loan Process, and Revenue Risk Mechanism involved in Digital Inclusive Finance projects related to photovoltaic electricity. As a result, these projects are often met with skepticism and resistance, driven by fears of falling into financial traps. Consequently, the promotion of such initiatives in rural areas has progressed slowly, hindering the achievement of anticipated economies of scale and diminishing the projects' effectiveness in optimizing the rural energy structure and increasing the proportion of Clean Energy usage.

The demographic profile of rural areas—marked by a high proportion of elderly residents and a limited number of young people—has further hindered the project's progress. Research by Chen Ming and Zhou Huarevealed that only 35% of rural households in Guangdong Province possess basic Digital Finance Operation Capability, while trust in Online Financial Tools among the elderly remains below 40% [6] . The elderly population generally exhibits limited adaptability to new developments and a low level

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of acceptance of digital technologies and financial innovations. In contrast, young people are generally more open to new ideas and demonstrate a stronger willingness to take risks. However, the significant outmigration of rural youth has led to a shortage of individuals capable of actively engaging in and driving project implementation. As a result, the project lacks sufficient vitality and momentum in rural areas, which has impeded the comprehensive rollout and deep integration of the Meizhou City photovoltaic power Digital Inclusive Finance project. This, in turn, has constrained progress toward achieving the dual objectives of energy transition and economic development in these regions.

5.2.3 Dual pressure on project sustainability

The sustainable development of the photovoltaic power Digital Inclusive Finance project in Meizhou City, Guangdong Province, is subject to two key constraints. First, although the Photovoltaic Equipment Lifespan is approximately 20 years, a robust long-term mechanism to cover ongoing Maintenance Cost has not yet been established. Without stable financial support for repairing equipment degradation over time, the consistency of power generation revenues may be compromised. On the other hand, the project has shown a high dependence on government subsidies and Carbon Inclusive policies, while the Market-oriented Profit Model remains immature. As a result, any adjustments in policy or fluctuations in the Carbon Market could lead to unstable returns, thereby limiting the potential for large-scale development.

6. Recommendations for Enhancing the Role of Digital Inclusive Finance in Supporting Rural Low-Carbon Transformation Projects

The case of Meizhou City has demonstrated that Digital Inclusive Finance can effectively facilitate Rural Low-Carbon Transformation in Guangdong. However, several areas still require further enhancement:

Strengthen technical infrastructure: durable and easy-to-maintain photovoltaic equipment should be introduced, complemented by intelligent monitoring systems capable of issuing real-time fault alerts; small-scale energy storage facilities should be installed in villages to balance electricity generation and peak electricity consumption; rural Communication Network should be upgraded to ensure reliable data transmission and enable efficient Remote Operation and Maintenance of equipment.

Regulation of Digital Inclusive Finance should be strengthened by formulating dedicated Regulatory Guidelines that clearly define the rights and responsibilities of financial institutions and photovoltaic enterprises. A Risk Monitoring Platform should be established to enable real-time tracking of fund flows and income distribution, while a Corporate Credit Archive should be developed to enforce industry-wide sanctions against violations. It has been proposed by Zhou Tao and Yang Fanthat a dynamic regulatory framework is essential for digital finance, incorporating Blockchain Technology to ensure Fund Flow Transparency [7] . This model can be effectively applied to the Meizhou project to enhance Risk Prevention and Control.

Residents' financial literacy should be improved by organizing visits from financial experts to explain project terms and associated risks, accompanied by the distribution of illustrated manuals. Training sessions on mobile phone usage and online contract signing should be conducted through the Village Committee, with particular support provided to elderly residents. In addition, Demonstration Household should be cultivated among villagers, using real income cases to build trust and reduce skepticism.

Promote coordinated business development: Cooperation between financial institutions and photovoltaic enterprises should be encouraged to develop simplified loan products. Joint efforts with government departments are needed to align projects with Rural Revitalization subsidies. Village collectives should be guided to establish Operation and Maintenance Cooperative to address the shortage of labor for ongoing maintenance.

7. Conclusion

Amid global climate change, the low-carbon transition has emerged as a crucial pathway for achieving sustainable development in rural areas. In Guangdong Province, a major economic region in China, rural low-carbon transformation is challenged by limited funding and inadequate technological support. Digital Inclusive Finance, characterized by its efficiency, affordability, and wide accessibility, has provided new opportunities for advancing low-carbon development in rural settings. Moving forward, the application of Digital Inclusive Finance can be further expanded to areas such as Biogas Power Generation and Energy-saving Renovation, thereby facilitating the integrated advancement of Rural

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Revitalization and carbon neutrality goals.

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