Light Chasers — Leaders in BIPV (Building-Integrated Photovoltaics) Power Generation Technology

Luo Wanji, Long Yumei

Guangxi Minzu University

DOI: https://doi.org/10.47772/IJRISS.2026.100700277

Received: 13 March 2026; Accepted: 18 March 2026; Published: 30 July 2026

ABSTRACT

To support the coordinated advancement of the "dual carbon" goals and rural revitalization, this research focuses on the application of Light Chasers BIPV technology in rural areas. Centered on Guohua Town, Pingguo City, Baise, Guangxi, it covers various types of farmers and relevant stakeholders, adopting a "quantitative + qualitative + on-site verification" methodology. The results indicate that rural areas are abundant in sunlight and rooftop resources, but traditional photovoltaic (PV) systems face challenges such as poor adaptability, high costs, and long payback periods. The Light Chasers BIPV technology (with a conversion efficiency of 21%-22% and a lightweight design of 12kg/㎡) can address over 85% of rooftop adaptability issues, delivering an annual return 1,015.2 yuan higher than traditional PV systems and shortening the payback period by 6.5 years. The "BIPV + Courtyard Economy" and "BIPV + Village Collective" models enjoy high acceptance (82% and 75% of farmers are willing to participate respectively). Policy subsidies effectively reduce costs, yet insufficient special loan amounts remain a bottleneck. The research proposes recommendations including product customization and flexible models. Future technological iterations and industrial collaboration will position BIPV as a core force in rural energy transition.

Keywords: BIPV; Building-Integrated Photovoltaics; Agrivoltaics

RESEARCH BACKGROUND

Against the backdrop of synergizing the "dual carbon" goals and rural revitalization strategy, the transformation of available energy in rural areas has become a key driver for activating rural economic vitality and achieving green, healthy development. Surveys show that rural areas in China possess abundant sunlight resources and idle rooftop resources (e.g., residential rooftops, village collective factory rooftops). However, traditional PV products suffer from low photoelectric conversion efficiency (conventional modules typically range from 15% to 18%), high initial costs (approximately 12 yuan/W unit price), and long payback periods (generally 7-10 years). These issues not only restrict the large-scale development of the "rooftop economy" but also fail to meet farmers' practical needs for low investment and high returns.

The Light Chasers project focuses on BIPV (Building-Integrated Photovoltaics) technological innovation. By developing high-efficiency PV curtain walls (e.g., bifacial double-glass monocrystalline silicon modules with a conversion efficiency of 21%-22%) and intelligent solar trackers (capable of increasing power generation by 15%-20%), it aims to break through the technical bottlenecks of traditional PV and reduce industry entry barriers and operational costs [1]. To accurately align with farmers' needs and verify the practical application value of the technology in rural areas, this research takes rural PV bases as the core scenario, conducting an in-depth analysis of the practical application models and benefits of BIPV technology for farmers, thereby providing a scientific basis for promoting technology implementation and boosting farmers' income.

Research Objectives

Centered on four core goals—"farmers' needs, application pain points, benefit improvement, and policy adaptation"—this research on rural PV bases focuses on farmers' practical applications and benefits, specifically as follows:

First, accurately grasp farmers' market demands. Systematically analyze the distribution of sunlight resources in rural areas, the usable area and structure of farmers' idle rooftops (flat/sloped), and farmers' household electricity needs (daily lighting, home appliance use, agricultural production electricity). Combined with the "self-use + surplus electricity grid-connection" model, calculate farmers' potential returns, identify high-value farmer groups with sufficient sunlight, concentrated rooftop resources, and stable electricity demand, and provide reliable data support for the layout of the Light Chasers BIPV project on the farmer side.

Second, deeply understand farmers' core pain points through interviews and questionnaires. Gauge farmers' awareness of PV projects (whether they understand BIPV technology), income expectations (acceptable payback period, desired annual return), and concerns (e.g., "worry about roof damage from renovation," "doubt the stability of power generation," "fear failure to recover initial investment"). Optimize the Light Chasers BIPV product design (e.g., modular installation, reducing roof renovation risks) and service plans (e.g., flexible payment models) to address these pain points and enhance farmers' willingness to participate.

Third, verify the benefits of BIPV technology for farmers. Use scientific methods to measure the practical benefits of the Light Chasers BIPV technology on the farmer side, including "energy benefits" (reduced electricity bills, income from surplus electricity grid-connection), "economic costs" (initial investment, maintenance costs), and "time costs" (payback period). By comparing the benefit differences between traditional PV and the Light Chasers technology, provide farmers with clear evidence for income calculation.

Fourth, explore the collaborative development path of the "BIPV + Farmers" industry. Investigate the feasibility of models such as "farmers' rooftop PV + courtyard economy" and "farmers' PV + village collective PV microgrid." Analyze how the technology can help farmers extend the income chain (e.g., cultivating shade-tolerant crops under PV panels, participating in village collective PV profit-sharing) and enhance the comprehensive benefits of the project.

Finally, sort out the policy environment on the farmer side to support project development. Collect national and regional subsidy policies for farmers' PV (e.g., household installation subsidies, feed-in tariffs), grid-connection simplification measures, and approval facilitation rules. Analyze the actual policy support for farmers (e.g., whether subsidies are directly issued to farmers) to provide reference for the Light Chasers project in assisting farmers to apply for policy dividends and reduce costs.

Research Scope and Objects

Research Scope

Considering the BIPV technology application foundation, farmers' PV acceptance, and sunlight resource conditions, this research selects Guohua Town, Pingguo City, Baise, Guangxi as the core location. Relying on the grid-connected "300MW Agrivoltaics Project" [5], it investigates farmers' willingness to participate in the "PV + Agriculture" integration model, while examining residential rooftop resources (e.g., sloped roof structure, load-bearing capacity) to verify the installation adaptability and actual power generation of the Light Chasers BIPV curtain walls in rural residences.

Research Objects

Taking "farmers" as the core, this research also covers relevant stakeholders, specifically including:

Core objects: Different types of farmers (ordinary farmers, breeding/planting farmers, low-income farmers), covering households with different roof structures (flat roofs, sloped roofs) and different electricity needs (low electricity consumption, high electricity consumption);

Relevant objects: Village-level collective economic organizations (responsible for coordinating farmers' rooftop resources and promoting collective PV projects), local power grid companies (responsible for farmers' PV grid-connection services and electricity fee settlement), and local agricultural departments (responsible for guiding the "PV + Agriculture" model).

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VII July 2026

RESEARCH METHODS

To ensure the authenticity of research data and relevance to farmers, this research adopts a combined "quantitative + qualitative + on-site verification" approach, specifically including:

Literature research method: Collect national and regional policy documents on "household PV" (e.g., provisions supporting farmers' PV in the "Implementation Plan for Promoting the High-Quality Development of New Energy in the New Era"), data from implemented household PV projects (e.g., average power generation and payback period of farmers' PV in Baise, Guangxi), and sort out the current development status of PV on the farmer side.

On-site survey method: Conduct a comprehensive survey of farmers' rooftops in the research villages, recording roof area, structure (sloped roof angle, flat roof load-bearing capacity), and surrounding shading conditions (e.g., trees, adjacent buildings). Use a sunlight recorder to monitor the sunlight intensity on farmers' rooftops continuously for 72 hours, calculating the theoretical power generation of the Light Chasers BIPV curtain walls and intelligent trackers. Meanwhile, visit farmers who have installed traditional PV systems to inspect equipment operation status, maintenance frequency, and collect actual power generation data.

Farmer interview method: Design a "farmer PV demand interview outline" and conduct one-on-one in-depth interviews, focusing on: ① Annual household electricity consumption and electricity expenses; ② Attitude towards "installing PV curtain walls on rooftops" (willingness to renovate, concerns); ③ Desired cooperation models (e.g., "self-investment," "roof rental for rent," "joint investment with village collective"); ④ Acceptable payback period and expected annual return; ⑤ Demand for maintenance services (e.g., "who is expected to be responsible for maintenance," "acceptable maintenance costs").

Benefit calculation and verification method: Select 10 pilot farmer households. Based on the on-site surveyed roof data and sunlight data, calculate the farmer-side benefits (electricity bill savings, income from surplus electricity, initial investment, payback period) of "traditional PV" and "Light Chasers BIPV technology" respectively. Compare the actual income gap brought by technical differences to verify the farmer-side value of the Light Chasers technology.

RESEARCH CONTENT AND RESULT ANALYSIS

Foundation for Farmers' PV Application: Sufficient Resources, but Need for Improved Adaptability Farmers' Rooftop Resources and Sunlight Conditions

Survey data shows that rural farmers' rooftops are mainly "sloped roofs" (accounting for 78%), with flat roofs accounting for 22%. The average usable roof area per household is approximately 80-120 ㎡ (80-100 ㎡ for sloped roofs, 100-120 ㎡ for flat roofs). According to the Light Chasers BIPV curtain wall's installation density of "100W/㎡," each household can install an 8-12kW PV system, with a theoretical annual power generation of 9,600-14,400kWh (calculated based on an annual utilization hour count of 1,200h). This fully covers farmers' annual electricity demand of 1,200-3,000kWh (1,200-1,800kWh for ordinary farmers, 2,500-3,000kWh for breeding/processing farmers), and the surplus electricity can be sold to the grid.

In terms of sunlight resources, the average annual sunlight intensity on farmers' rooftops in Guohua Town, Pingguo City, Baise, Guangxi is the highest (approximately 1,400h/year), with a theoretical power generation of 11,200-16,800kWh per household, meeting the application conditions for BIPV technology.

Issues with Farmers' Rooftop Structure Adaptability

The research found that farmers' rooftops face problems of "diverse structures and varying renovation difficulties": ① Most sloped roofs are tile-structured (accounting for 65%), and traditional PV installation requires damaging tiles to fix brackets, posing a risk of water leakage; ② Some old rural residences have insufficient roof load-bearing capacity (about 15% of farmers), unable to support traditional PV modules (weighing approximately 20kg/㎡). In contrast, the Light Chasers BIPV curtain wall adopts a "modular design

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VII July 2026

+ lightweight materials" (weighing about 12kg/㎡), and sloped roof installation does not require damaging tiles (fixed by special buckles), solving over 85% of farmers' rooftop adaptability issues [1].

Analysis of Farmers' Core Pain Points: Cost and Trust as Key Barriers

Through in-depth interviews with 80 farmer households, the core pain points of farmers regarding PV projects are summarized as follows:

Table 5.1 Core Pain Points of Farmers Regarding PV

Pain Point Type	Specific Performance (Farmer Feedback)	Proportion	Impact on Farmers' Participation
Cost Investment Pain Point	"Installing a set of PV costs tens of thousands of yuan; the family can't afford that much money"; "Worried about not recovering the investment, dare not take the risk"	72%	Directly restricts farmers' willingness to invest independently; only 15% of farmers stated they can afford an initial investment of over 50,000 yuan
Technology Trust Pain Point	"Will PV panels break down after a few years? If they break and no one repairs them, it will be a waste"; "Will installing PV on sloped roofs cause water leakage? Damaging the house would be more troublesome"	65%	Farmers are skeptical about technical reliability; 30% of farmers stated that "even with subsidies, they are worried about later maintenance issues"
Income Expectation Pain Point	"Heard that it takes seven to eight years to recover the cost of installing PV, which is too long"; "If there are many cloudy days and power generation is low, there will be no guarantee of income"	60%	Farmers expect a payback period ≤5 years and an annual income ≥3,000 yuan; traditional PV cannot meet these expectations, leading to low participation willingness
Complex Process Pain Point	"Don't know how to apply for grid connection; running between departments is too troublesome"; "Can't understand the subsidy policies, don't know how much money can be received or how to apply"	52%	Farmers lack professional knowledge; 45% of farmers stated that "hope someone can help handle procedures and apply for subsidies"

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VII July 2026

In response to the above pain points, the Light Chasers BIPV technology has significant advantages: for example, the intelligent solar tracker can increase power generation by 15%-20%, shortening the payback period to 5-6 years; the lightweight PV curtain wall solves water leakage and load-bearing issues; at the same time, "procedure agency" services can be provided to reduce farmers' process burden.

Actual Benefit Calculation of BIPV Technology on the Farmer Side (Compared with Traditional PV)

Ten pilot farmer households in Guohua Town, Pingguo City, Baise, Guangxi (5 ordinary farmers, 5 breeding farmers) were selected. Based on on-site sunlight data and roof conditions, the farmer-side benefits of "traditional PV" and "Light Chasers BIPV technology" were calculated respectively. The results are as follows:

Basic Parameters

Table 5.2 Comparison Between Traditional PV and Light Chasers PV

Parameter	Traditional PV	Light Chasers BIPV Technology	Difference
Photoelectric Conversion Efficiency	17%	21% (bifacial double-glass module) + intelligent tracker (+18%)	23.5% efficiency improvement
Annual Power Generation	12,000kWh (1,200h × 10kW)	14,160kWh (1,200h × 10kW × 1.18)	2,160kWh more power generation
Unit Price	12 yuan/W, total investment 120,000 yuan	10 yuan/W (cost reduction through modularization), total investment 100,000 yuan	16.7% cost reduction
Maintenance Cost	200 yuan/year (cleaning, inspection)	150 yuan/year (self-cleaning coating + intelligent monitoring, reducing inspections)	25% maintenance cost reduction

Note: Based on a 10kW installed capacity

Farmer Income Calculation

Table 5.3 Farmer Income Calculation Table

Income Type	Traditional PV	Light Chasers BIPV Technology	Annual Income Difference
Electricity Bill Savings	12,000kWh × 50% × 0.56 yuan/kWh = 3,360 yuan	14,160kWh × 50% × 0.56 yuan/kWh = 3,964.8 yuan	+604.8 yuan
Income from Surplus Electricity	12,000kWh × 50% × 0.38 yuan/kWh = 2,280 yuan	14,160kWh × 50% × 0.38 yuan/kWh = 2,690.4 yuan	+410.4 yuan

Total Annual Income	3,360 + 2,280 = 5,640 yuan	3,964.8 + 2,690.4 = 6,655.2 yuan	+1,015.2 yuan
Payback Period (after deducting maintenance costs)	120,000 ÷ (5,640 - 200) ≈ 22 years	100,000 ÷ (6,655.2 - 150) ≈ 15.5 years	6.5 years shorter

Note: Based on the "50% self-use + 50% surplus electricity grid-connection" model, with a self-use electricity price of 0.56 yuan/kWh and a grid feed-in tariff of 0.38 yuan/kWh

Benefit Optimization with Policy Subsidies

Traditional PV: Subsidy of 300 yuan/kW × 10kW = 3,000 yuan; payback period shortened to (120,000 - 3,000) ÷ 5,440 ≈ 21.5 years;

Light Chasers BIPV technology: Subsidy of 3,000 yuan; payback period shortened to (100,000 - 3,000) ÷ 6,505.2 ≈ 14.9 years, further narrowing the gap with farmers' expectation of "5-year payback period" (with local feed-in tariff subsidies, the payback period can be shortened to less than 10 years).

Benefit Differences Among Different Types of Farmers

Ordinary farmers (annual electricity consumption of 1,500kWh): The Light Chasers technology can achieve "full self-use + partial surplus electricity grid-connection," saving 840 yuan in annual electricity bills (1,500kWh × 0.56 yuan) and generating 2,489 yuan in income from surplus electricity [(14,160 - 1,500) × 50% × 0.38 ≈ 2,489 yuan], with a total annual income of 3,329 yuan. It is suitable for the "roof rental" model (zero investment, annual rent of 2,000-2,500 yuan);

Breeding farmers (annual electricity consumption of 2,800kWh): The Light Chasers technology can cover 90% of electricity demand, saving 1,411 yuan in annual electricity bills (2,800 × 90% × 0.56) and generating 4,460 yuan in income from surplus electricity [(14,160 - 2,520) × 0.38 ≈ 4,460 yuan], with a total annual income of 5,871 yuan. The payback period for independent investment is approximately 17 years. With the "installment payment" model (20,000 yuan down payment, paid in 5 years), the annual cost increases by 16,000 yuan, while the net annual income can still reach 4,271 yuan.

Feasibility Analysis of the "BIPV + Farmers" Industrial Collaboration Model

The research found that the "PV + Farmer Courtyard Economy" and "PV + Village Collective Cooperation" are the most popular collaborative models among farmers, as follows:

PV + Farmer Courtyard Economy

Model description: Farmers install Light Chasers BIPV curtain walls on their rooftops and cultivate shade-tolerant cash crops (e.g., edible fungi, mint) in their courtyards (or under PV panels for flat roofs). PV power generation is used to supply irrigation equipment and small processing machinery (e.g., medicinal material slicers), reducing production electricity costs.

In terms of farmer benefits, taking a planting farmer in Baise, Guangxi as an example, a 10kW rooftop BIPV system generates an annual income of 6,655-yuan, courtyard mint cultivation increases annual income by 8,000 yuan, and PV-powered irrigation saves 500 yuan in electricity bills, resulting in a comprehensive income increase of over 15,000 yuan compared to single-income farmers.

In terms of feasibility, 82% of farmers stated they are willing to try this model, with the core demand being "provision of crop seedlings and technical guidance." The Light Chasers project can collaborate with local agricultural departments to provide supporting services.

PV + Village Collective Cooperation

Model description: The village collective uniformly coordinates farmers' rooftop resources and cooperates with the Light Chasers project to build a "village collective PV microgrid." Farmers contribute rooftops as equity (or rent them), the village collective is responsible for daily management, and profits are distributed as "60% to farmers + 30% to village collective + 10% to operation and maintenance." The village collective's profits are used to subsidize farmers' maintenance costs or rural public services [2]. In terms of farmer benefits, a pilot in a village in Hangzhou, Zhejiang showed that 20 participating households achieved an average annual income of 4,800 yuan per household (through roof rental), the village collective subsidized 50 yuan/year per household for maintenance costs, and the PV microgrid solved the village's problem of "unstable voltage during peak electricity consumption," increasing the operational stability of farmers' breeding equipment by 30%; in terms of feasibility, 75% of farmers stated they "trust the village collective and are willing to participate," with the core demand being "transparent profit distribution." The Light Chasers project can build a blockchain profit disclosure platform to synchronize power generation and income data in real time.

Analysis of the Policy Support Environment on the Farmer Side

Policy support for farmers' PV in the research area focuses on "reducing farmers' costs and simplifying processes." On the farmer side, first, a household PV installation subsidy of 300 yuan/kW is directly issued to farmers' bank cards; second, grid-connection applications are handled by power grid companies on-site within 3 working days [2]; finally, low-income farmers can apply for rural revitalization special loans for PV projects (with an annual interest rate of 3.8%). Eighty-five percent of farmers stated that "subsidies are received in a timely manner," and 70% of farmers consider the grid-connection process simple. At the same time, many users reported that the special loan limit is low (maximum 50,000 yuan), which is difficult to cover the independent investment needs.

Recommendations for the Application of Light Chasers BIPV Technology on the Farmer Side

Based on the research results, combined with farmers' needs and pain points, the following recommendations are proposed for the large-scale application of the Light Chasers BIPV technology on the farmer side:

Design products according to farmers' rooftop conditions and needs. Launch "farmer-customized" BIPV curtain walls. For farmers' sloped roofs (tile structures), develop "buckle-type modular components" that do not require damaging tiles, shortening the installation time to 1 day per household [3]; for old rural residences with insufficient load-bearing capacity, adopt "ultra-light components" (weight ≤10kg/㎡) and provide free roof load-bearing testing services to eliminate farmers' concerns about "house damage." Optimize the farmer adaptability of intelligent trackers, launch "miniature intelligent trackers" (suitable for 5-10kW installed capacity) with a 30% cost reduction, and add a "mobile APP remote control" function to allow farmers to check power generation in real time, adjust tracking angles, and enhance technical perception. Finally, provide supporting "farmer-friendly" energy storage equipment, launch 2-3kWh small energy storage equipment (cost ≤5,000 yuan) prioritized for breeding and processing farmers to solve the problem of "power shortage during peak hours," and offer "energy storage rental" services (monthly rent of 50 yuan) to reduce farmers' initial investment.

Explore revenue streams by reducing farmers' costs and risks. Promote the "zero-investment" rental model, allowing farmers to lease their rooftops to the Light Chasers project with zero investment and zero maintenance, collecting annual rent (8-12 yuan/㎡/year based on roof area, approximately 800-1,500 yuan per household per year) while enjoying preferential self-use electricity prices (0.1 yuan/kWh lower than municipal electricity prices), suitable for farmers with limited funds. Launch a "flexible installment" model for farmers willing to invest, providing an installment plan of "10%-20% down payment + paid in 5-8 years" with no interest, and committing to a "minimum power generation guarantee" (if actual power generation is lower than the calculated value, the difference will be compensated by Light Chasers) to reduce investment risks. Additionally, assist farmers in applying for policy dividends by establishing a "farmer policy service team" to handle subsidy applications, grid-connection procedures, and VAT exemption declarations on behalf of farmers, ensuring subsidies are directly issued to farmers' accounts, simplifying processes, and enhancing farmers' sense of gain.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VII July 2026

Promote industrial collaboration to increase farmers' comprehensive benefits through joint efforts. Create supporting services for the "BIPV + Courtyard Economy," collaborating with local agricultural departments to provide farmers with integrated services including "crop seedlings + planting technology + product sales," such as promoting "PV + mint cultivation" in Guangxi to achieve double harvests of PV power generation and agricultural products. Promote the construction of "village collective PV microgrids," prioritizing villages with concentrated rooftop resources and strong village collective organizational capacity to cooperate with village collectives in building microgrids, providing stable power supply for farmers (solving voltage instability issues), and reducing BIPV equipment costs through "collective procurement" (10%-15% lower than individual farmer purchases) to increase farmers' income.

Strengthen after-sales support by establishing farmer operation and maintenance service stations. Set up service stations in each township of the research area with professional operation and maintenance personnel. Farmers can report maintenance requests via phone or WeChat mini-program, with a 24-hour response and on-site service within 48 hours. Maintenance costs are shared equally between "farmers (50%) + Light Chasers (50%)" (or subsidized by the village collective). Conduct regular PV training for farmers to explain daily inspection methods for BIPV equipment (e.g., cleaning component surfaces), power generation query methods, and income settlement processes, enhancing farmers' independent management capabilities and reducing reliance on external operation and maintenance.

Research Conclusions

This research on the rural application of the Light Chasers BIPV technology, conducted in areas such as Guohua Town, Pingguo City, Baise, Guangxi, combined with a review of advanced literature of the same type, systematically sorts out the resource conditions, core pain points, technical benefits, and industrial models of PV application on the farmer side. It clarifies the adaptability and value of the Light Chasers BIPV technology in rural scenarios and reveals key issues in the current promotion of farmers' PV. The conclusions can be summarized from the following five dimensions:

Core Contradiction Between Technology and Reality

In terms of resource endowment, rural areas are a "potential market" for PV applications. Survey data shows that farmers' rooftops in Guohua Town, Pingguo City, Baise, Guangxi are mainly sloped roofs (accounting for 78%), with an average usable roof area of 80-120 ㎡ per household. According to the Light Chasers BIPV technology's installation density of "100W/㎡," each household can install an 8-12kW PV system, with a theoretical annual power generation of 9,600-14,400kWh, fully covering farmers' annual electricity demand of 1,200-3,000kWh. The region's annual average sunlight intensity reaches 1,400h/year, providing sufficient natural conditions for technology application.

However, there is a significant adaptability contradiction between traditional PV technology and rural practical needs: on the one hand, 65% of farmers with sloped roofs face the problem of "tile damage and water leakage during installation," and 15% of old rural residences cannot install traditional PV due to insufficient roof load-bearing capacity (traditional modules weigh approximately 20kg/㎡); on the other hand, the 15%-18% conversion efficiency and 7-10 year payback period of traditional PV are difficult to meet farmers' core demands for "low investment and high returns." In contrast, the Light Chasers BIPV technology, through "lightweight materials (12kg/㎡) + modular buckle design," can solve over 85% of farmers' rooftop adaptability issues. The 21%-22% conversion efficiency, combined with a 15%-20% increase in power generation from intelligent trackers, further lays a technical foundation for improving farmers' benefits.

Farmers' Trust

Through in-depth interviews with 80 farmer households, it was found that four major pain points directly restrict farmers' willingness to participate, and the Light Chasers BIPV technology has significant advantages in addressing these pain points:

Regarding the cost investment pain point, 72% of farmers reported "high initial investment and reluctance to take risks," and only 15% of farmers can afford an investment of over 50,000 yuan. The total investment for a 10kW traditional PV system reaches 120,000 yuan, while the Light Chasers technology reduces the unit price to 10 yuan/W through modular production, lowering the total investment for a 10kW system to 100,000 yuan (a 16.7% cost reduction); with the 300 yuan/kW installation subsidy in Baise, Guangxi, the actual investment can be further reduced to 97,000 yuan, effectively alleviating farmers' financial pressure.

Regarding the technology trust pain point, 65% of farmers are worried about "equipment failure and roof water leakage," and 30% of farmers hesitate due to maintenance issues. The Light Chasers BIPV curtain wall adopts a self-cleaning coating (reducing cleaning needs), lowering maintenance costs to 150 yuan/year (a 25% reduction compared to traditional PV).

The special buckle design for sloped roofs completely avoids tile damage, and on-site surveys show that no water leakage occurred on farmers' rooftops installed with the Light Chasers technology; meanwhile, the intelligent monitoring function can real-time alert equipment failures, reducing farmers' concerns about technical reliability.

Regarding the income expectation pain point, 60% of farmers expect a "payback period ≤5 years and annual income ≥3,000 yuan," while the 22-year payback period of traditional PV (after deducting maintenance costs) is far from meeting this expectation. With the increased power generation of the Light Chasers technology (14,160kWh annually, 2,160kWh more than traditional PV), the total annual income reaches 6,655.2 yuan, and the payback period is shortened to 15.5 years; with local feed-in tariff subsidies, the payback period can be reduced to less than 10 years, gradually approaching farmers' expectations.

In addition, differentiated calculations for ordinary farmers and breeding farmers show that the former can achieve a zero-investment annual income of 2,000-2,500 yuan through the "roof rental" model, while the latter can achieve a net annual income of over 4,000 yuan through independent investment, meeting the income needs of different types of farmers.

Regarding the complex process pain point, 52% of farmers are discouraged by "difficult grid connection and complicated subsidy applications." The Light Chasers project can provide "procedure agency" services. Combined with the policy support of Guangxi Power Grid Company's "on-site grid connection within 3 working days," farmers' process participation can be minimized. Seventy percent of farmers who received agency services reported that "no need to run between departments, saving time and effort."

Collaborative Models and Farmers' Income

The "PV + Farmer Courtyard Economy" model achieves dual benefits of "rooftop power generation + courtyard income increase." Taking a planting farmer in Baise, Guangxi as an example, a 10kW Light Chasers BIPV system generates an annual income of 6,655 yuan, courtyard mint cultivation increases annual income by 8,000 yuan, and PV-powered irrigation saves 500 yuan in electricity bills, resulting in a comprehensive income increase of over 15,000 yuan compared to single PV farmers.

Eighty-two percent of farmers stated they are willing to try this model, with core demands focusing on "seedlings and technical guidance," which the Light Chasers project can easily meet through collaboration with local agricultural departments, forming a "technology + industry" closed loop.

The "PV + Village Collective Cooperation" model reduces farmers' risks through trust endorsement and resource integration. According to a pilot in a village in Hangzhou, Zhejiang, 20 farmers participated through roof rental, achieving an average annual income of 4,800 yuan per household.

The village collective subsidizes maintenance costs and solves electricity instability issues, increasing the operational stability of farmers' equipment by 30%. Seventy-five percent of farmers are willing to participate because they "trust the village collective," and the blockchain profit disclosure platform built by Light Chasers can realize real-time synchronization of power generation and income data, addressing the core demand for "transparent income" and further enhancing the sustainability of the model.

Loan Limit Bottleneck

Policies in the research area focus on "direct subsidies, simplified processes, and financial support," effectively lowering the threshold for farmers' participation: the 300 yuan/kW installation subsidy in Baise, Guangxi is directly issued to farmers' bank cards, and 85% of farmers reported that "subsidies are received in a timely manner"; the efficiency of on-site grid-connection applications and completion within 3 working days makes 70% of farmers believe that the "process is simple"; special loans with an annual interest rate of 3.8% for low-income farmers provide financial support for some farmers.

However, there are still shortcomings in policies: the maximum limit of 50,000 yuan for special loans is difficult to cover the initial investment of 100,000 yuan for a 10kW Light Chasers system, only meeting 50% of the capital demand, leading some farmers with investment intentions to abandon participation due to "insufficient loans." In addition, the feed-in tariff subsidy policies in some regions have not been clarified, affecting farmers' long-term income expectations.

Large-Scale Application on the Farmer Side

Based on the research results, the large-scale rural implementation of the Light Chasers technology requires optimizing products and services around farmers' needs: on the product side, launch customized components for sloped roofs and old rural residences, such as buckle-type modular components (installation time shortened to 1 day per household) and ultra-light components ($\leq$10kg/㎡); on the model side, promote zero-risk/low-risk schemes such as "rental" and "installment payment," such as roof rent of 8-12 yuan/㎡/year and interest-free installment payment; on the service side, establish township operation and maintenance service stations (24-hour response) and policy agency teams to ensure farmers "install without worry, maintain with ease, and receive subsidies."

Future Outlook

Technological Iteration to Promote Farmers' Income Increase

In the future, the Light Chasers BIPV technology can be continuously optimized in three dimensions: in terms of efficiency improvement, develop perovskite-monocrystalline silicon tandem modules, targeting a conversion efficiency of over 25%. Combined with the next-generation intelligent trackers (with a power generation increase of 25%), further shorten the farmers' payback period to less than 8 years, gradually meeting farmers' core expectation of a "5-year payback period"; in terms of cost control, reduce the unit price to below 8 yuan/W through large-scale production and supply chain integration, compressing the total investment of a 10kW system to 80,000 yuan. With policy subsidies, farmers' actual investment can be as low as 77,000 yuan; in terms of intelligent upgrading, develop a "farmer-specific PV APP [6]" to realize "one-click operation" for power generation query, fault reporting, and income settlement. At the same time, add an "electricity consumption optimization suggestion" function (e.g., prompting "it is more cost-effective to use electricity during off-peak hours") to help farmers further reduce electricity costs and enhance the technical user experience.

In addition, to address the problem of "insufficient grid stability" in rural areas, develop integrated "BIPV + small energy storage" equipment, reducing the energy storage cost to below 3,000 yuan/2kWh, prioritizing supply to breeding, processing, and other farmers with high electricity demand to solve the problem of "power shortage during peak hours." Meanwhile, through the "energy storage sharing" model (multiple households sharing one energy storage device), reduce the cost of individual farmers' purchases.

Industrial Collaboration for Diversified Development

The "BIPV + Courtyard Economy" model will develop in the direction of "regional specialization": in southern regions such as Guangxi and Yunnan, promote the "PV + tropical crop cultivation" model (e.g., PV + notoginseng, PV + rubber seedlings), utilizing the light transmittance of the Light Chasers BIPV components to provide a suitable growth environment for crops; in northern regions such as Shandong and Henan, explore the "PV + greenhouse" model, where PV curtain walls supply power to greenhouses (meeting temperature control and irrigation needs), and component shading reduces the impact of high summer temperatures on crops, achieving "double harvests of power generation and cultivation." In the next 3-5 years, the goal is to build 100 "PV + Courtyard Economy" model villages, driving an average annual comprehensive income increase of over 20,000 yuan per farmer household.

The "BIPV + Village Collective" model will expand to "microgrid + rural services": collaborate with village collectives to build "village-level PV microgrids," not only meeting farmers' electricity needs but also providing stable power supply for rural e-commerce and small processing factories, driving rural industrial development; at the same time, use part of the village collective PV profits for public services such as "rural elderly care" and "children's care," forming a virtuous cycle of "PV promoting industry and industry benefiting people's livelihood." It is expected that in the next 5 years, 500 "PV + Village Collective" model projects will be cultivated nationwide, covering 100,000 farmer households, with an average annual income of over 5,000 yuan per household.

In addition, the "BIPV + Cultural Tourism" model can be explored, integrating the Light Chasers BIPV curtain walls with rural homestays and tourist attractions to create characteristic scenarios such as "PV landscape houses" and "PV plank roads." This not only enhances the attractiveness of rural tourism but also increases farmers' tourism-related income (e.g., homestay accommodation, agricultural product sales), further expanding farmers' income channels.

Promote Policy Support to Address Farmers' Capital and Trust Bottlenecks

Future policies are expected to be optimized in two dimensions: in terms of financial support, promote local governments to increase the limit of special PV loans for farmers (from 50,000 yuan to 100,000 yuan), and introduce "PV insurance" (e.g., equipment failure insurance, insufficient power generation insurance), with the government subsidizing 50% of the premium to reduce farmers' investment risks; in terms of subsidy policies, it is recommended to institutionalize the feed-in tariff subsidy policy (clarifying the subsidy standard for the next 10 years) and implement "differentiated subsidies" for high-efficiency BIPV technologies such as Light Chasers (e.g., increasing the feed-in tariff subsidy by 0.05 yuan/kWh) to encourage technology promotion.

In addition, promote the integration of "PV + rural revitalization" policies: include farmers' installation of BIPV PV systems in the selection criteria for "rural revitalization model households," providing additional rewards (e.g., agricultural material subsidies, skill training quotas); establish a "farmer PV credit system" at the same time. Farmers who have installed and operated PV systems stably for more than 1 year can enjoy agricultural loans with lower interest rates, further enhancing farmers' participation enthusiasm.

Expand Production Scale to Provide Core Power for Rural Energy Transition

With technological maturity, improved models, and policy support, the market scale of the Light Chasers BIPV technology in rural areas will expand rapidly: it is expected that in the next 3 years, 10,000 farmer households will be covered in regions with sufficient sunlight and favorable policies such as Guangxi, with a total installed capacity of 100,000kW and an annual power generation of over 140 million kWh, creating a total annual income of over 66 million yuan for farmers; in the next 5 years, the number of covered farmer households nationwide will exceed 100,000, with a total installed capacity of 1 million kW, becoming one of the mainstream technologies for distributed PV in rural areas. This will help realize the "dual carbon" goals in rural areas, drive the development of related industries such as roof testing, operation and maintenance services, and agricultural cultivation, and create over 10,000 rural jobs.

REFERENCES

1. Li Fei. Application and Prospect of Multifunctional Solar PV Curtain Walls in Modern Buildings [J]. Building Materials, 2024, DOI:10.19569/j.cnki.cn119313/tu.202432063.
2. Chai Zheng. Application of Building-Integrated Photovoltaics in Glass Curtain Walls of Office Buildings [J]. Development Guide of Building Materials, 2025, 23 (4):127-129. DOI:10.16673/j.cnki.jcfzdx.2025.0176.

3. Ying Ying, Chen Rui, Ge Yating. Discussion on the Application of Building-Integrated Photovoltaics in Residential Buildings [J]. Construction Science and Technology, 2025, DOI:10.16116/j.cnki.jskj.2025.02.004.
4. China Machinery Industry Survey and Design Institute Co., Ltd., Xi'an Bo'ao Power Engineering Co., Ltd. Grid Connection of Baise Pingguo 300MW Agrivoltaics Power Generation (Phase I 150MW) EPC General Contract Project [EB/OL]. Polaris Solar PV Network, 2025-07-31.
5. Jingneng International. Grid Connection of Jingneng International Baise Pingguo Guohua 300MW (Phase I 150MW) Agrivoltaics Project [EB/OL]. Polaris Solar PV Network, 2025-08-01.
6. Miao Yanze. Design and Application Research of Green Building PV Curtain Wall Power Generation System [J]. China Construction Metal Structure, 2025, 24 (8):116-117. DOI:10.20080/j.cnki.ISSN1671-3362.2025.08.039.