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Fishery–Photovoltaic Power Generation System Integration Under Dual-Carbon Goals: Accounting Decision Support Framework Design and Practice

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ABSTRACT: Under the backdrop of the "dual carbon" goal promotion and the integration of energy and agriculture, fishpond photovoltaic power generation, as an integrated and compound renewable energy system combining "power generation on water and farming under water", has both economic benefits and ecological emission reduction value. Its unique characteristics such as special assets, complex costs, and diverse revenues make it difficult for the traditional accounting system to adapt. Currently, the project has problems such as no unified standard for shared costs allocation, non-standard measurement and depreciation of special assets on the water surface, lack of carbon asset accounting and disclosure, and lagging accounting treatment of government subsidies in response to policy changes. These issues cannot support the project's "system integration, business coordination, and sustainable design". To solve these problems, this paper, guided by the concepts of "integrated system design, decision support, and sustainable value manifestation", uses methods of literature research, case analysis, and summary to construct an "integrated accounting and decision support framework" covering the entire life cycle. The framework is designed from four dimensions: collaborative cost allocation, full life cycle management of special fixed assets, dual value measurement of carbon emission reduction and aquaculture carbon sink, compliant handling of subsidies and risk prevention. It forms standardized accounting processes and control mechanisms. Research shows that this framework can achieve collaborative accounting of power generation and aquaculture business, dynamic management of special assets, financial manifestation of carbon value, and full-process compliance control of subsidies, significantly improving accounting information quality and decision support capabilities, and effectively serving the project's "system integration, business coordination, and sustainable development". The research results can provide guidance for practical operations of energy enterprises, offer references for the formulation of industry accounting standards and policy improvement, and help the fishpond photovoltaic industry achieve high-quality development.

KEYWORDS: Fishpond photovoltaic power generation; Energy enterprise accounting; Integrated accounting and financial reporting; Decision framework design; Sustainable value

INTRODUCTION

1. 1 research background

Under the backdrop of global energy transition, photovoltaic power generation, due to its renewability and environmental friendliness, has become an important path to achieve the "dual carbon" goals. China's photovoltaic industry is at the global leading level. In 2023, the newly installed capacity of photovoltaic power accounted for more than 40% of the total increase in renewable energy. It is gradually moving towards large-scale, base-based, and composite development[1]. Fishpond photovoltaic power generation is a new model of "energy-agriculture" integration. It adopts the "water surface power generation and underwater farming" mode, which not only solves the land occupation problem of traditional photovoltaic power stations, but also improves the farming environment by shading provided by the photovoltaic panels, achieving a "win-win situation for both fish and power"[2]. The data shows that a 1MW photovoltaic power station in a fishpond only requires 20-30 acres of water area. It can save approximately 350 tons of standard coal annually, reduce carbon emissions by about 1,000 tons, and also lower the water temperature in the fishpond by 3-5 degrees Celsius, reduce fish diseases, and increase fish production by 10%-15%[3]. The combined characteristics of fishpond photovoltaic power generation make its accounting treatment significantly different from that of other projects. Such projects require an investment of over 100 million yuan, have a construction period of 1-2 years, have a high degree of technical integration, involve multiple types of assets, and the accounting process needs to take into account both the power generation and fish farming sectors, as well as handle complex tasks such as cost allocation and measurement of special assets[4]. The accounting system of traditional energy enterprises is based on a single energy scenario and has deficiencies in adapting to complex scenarios, accounting for special assets, and supporting project system integration, business collaboration, and sustainable design. It is unable to accurately and completely reflect the economic and environmental benefits of the projects[5].

1. 2 Research Significance

1. 1. 1 Theoretical Significance

Most of the current research focuses on the technical optimization, economic evaluation and environmental impact analysis of fishpond photovoltaic projects. There are relatively few studies specifically dedicated to accounting, and there are issues such as scattered research and insufficient depth of innovation. So far, there has not yet been a complete accounting system that can cover the entire life cycle of the project and be suitable for complex business scenarios[6]. Based on this, this paper, after reviewing relevant studies at home and abroad, based on the core characteristics of fishpond photovoltaic system integration, business collaboration, and sustainable development, constructs a "cost - asset - carbon value - subsidy" four-dimensional integrated accounting framework that is oriented towards supporting system integration, strengthening business coordination, and serving sustainable design. It deeply combines financial accounting with system integrated management, cross-business collaborative control, and sustainable value manifestation, filling the theoretical gap in accounting for composite energy projects, and providing theoretical references and methodological support for the accounting innovation of similar "energy + agriculture" integrated projects.

1. 1. 2 Practical Significance

Fishpond photovoltaic power generation is an important direction for the large-scale development of China's photovoltaic industry. Whether the accounting of this sector is standardized and accurate directly affects the quality of enterprise financial management and the effectiveness of business decisions. The accounting system constructed in this paper can effectively serve the construction of the project system integration, the collaborative operation of power generation and breeding businesses, and the sustainable design and decision-making. It can truly solve practical problems such as inaccurate cost allocation, difficulty in managing special assets, and non-standard carbon asset accounting . It helps enterprises improve the quality of accounting information and control financial risks. The related achievements can not only provide practical references for energy enterprises to carry out accounting work for composite photovoltaic projects, but also provide support for the formulation of industry accounting standards and policy improvement, helping the photovoltaic industry to continue to develop healthily.

1. 1. 3 Research Content and Framework

This paper focuses on the innovative accounting for fishpond photovoltaic power generation systems, with the core objective being to establish an accounting decision support framework that supports system integration, business coordination, and sustainable design.

As shown in Fig. 1:

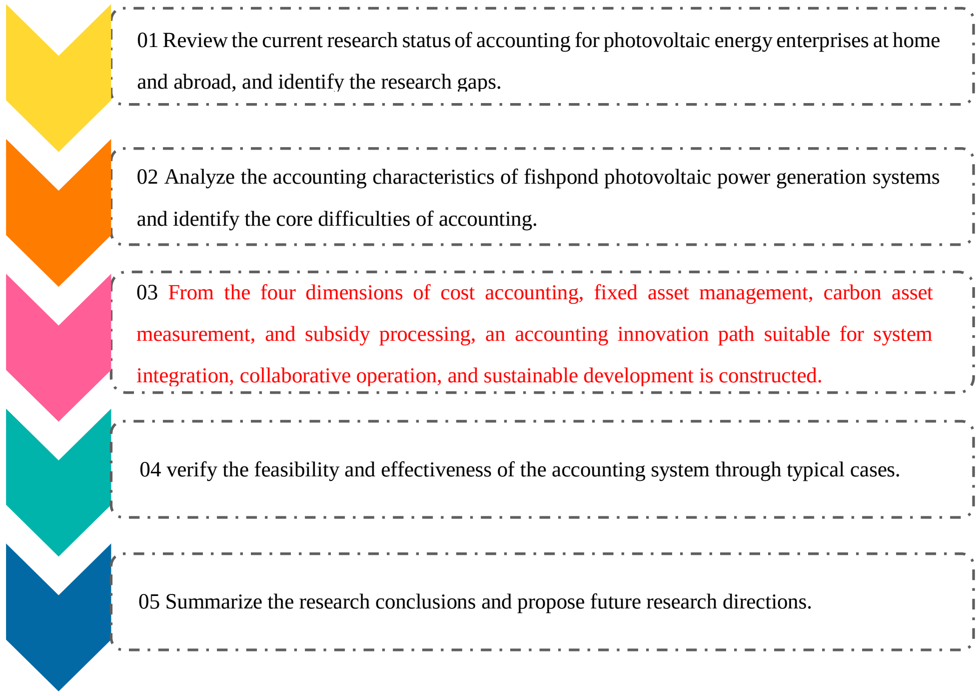

Fig. 1. research framework

1. Current Research Status at Home and Abroad

2. 1 status quo of overseas research

Research on the accounting of photovoltaic energy enterprises abroad started earlier and has formed a relatively mature theoretical system and practical norms. The related research mainly focuses on cost accounting, carbon accounting, subsidy handling, etc.

In terms of cost accounting for photovoltaic projects, Zhang et al. (2026) based on Activity-Based Costing (ABC), proposed to finely aggregate the costs of photovoltaic projects by dimensions such as power generation units, operation and maintenance links, and technological research and development. By identifying the cost drivers of each operation center, they achieved precise allocation and control of costs, providing a scientific method for the cost management of photovoltaic enterprises[7]. Zhang et al. (2026) conducted a study on the corrosion protection cost measurement and allocation methods for water-based photovoltaic projects, proposing a calculation model that adjusts the depreciation rate based on the risk coefficient of the asset's usage environment. By establishing a corrosion risk assessment model, they dynamically adjusted the asset depreciation policy to make the depreciation accrual more in line with the actual wear and tear of the assets[8]. Lu et al. (2026) emphasized that the cost accounting for new energy projects should focus on a full life cycle perspective, including all aspects such as equipment procurement, construction, operation and maintenance, and scrapping, and incorporating the costs of each link into the accounting scope to ensure the completeness and accuracy of the cost information[9].

In the field of carbon accounting and green value measurement, Lan et al. (2025) published the “Renewable Energy Accounting Guidelines”, which clearly defined the accounting standards and disclosure requirements for carbon emission reduction in photovoltaic projects, and proposed to calculate carbon emissions using the “emission factor method”, providing an international reference for carbon asset measurement[10]. Tan et al. (2025) took the fishery-solar power complementation project as the research object and constructed a dual carbon value accounting model of “electricity generation emission reduction + fishery carbon sink”. By separately calculating the carbon emission reduction volume in the photovoltaic power generation process and the carbon sink volume in the fishery cultivation process, they achieved the comprehensive measurement of the environmental value of the project[11]. Shen et al. (2025) pointed out that new energy enterprises should establish a standardized carbon accounting system, standardizing the calculation and disclosure of information such as carbon emissions, carbon reduction, and carbon asset value, to meet the information needs of stakeholders[12].

In terms of the accounting treatment of government subsidies, Jensen (2025) compared the differences in accounting treatment of renewable energy subsidies in European and American countries, proposed the principle of classifying accounting based on the nature of subsidies, and classified subsidies related to assets as deferred income, which is recognized over the asset's useful life in installments. Subsidies related to income were directly recognized in the current profit and loss, ensuring the compliance and rationality of subsidy treatment[13]. He (2025) emphasized the

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criteria for confirming government subsidies, requiring enterprises to recognize subsidy income only when they meet the conditions of "having a high probability of receiving the subsidy" and "meeting the subsidy criteria", in order to avoid distortion of financial data caused by premature or delayed recognition[14].

Overall, foreign research has established a complete framework covering cost accounting, carbon accounting, and subsidy handling. However, accounting research specifically for such complex projects as fishpond photovoltaic systems is still rather scattered, lacking systematic adaptation plans. Particularly in aspects such as cost allocation between power generation and aquaculture operations, and the management of special waterborne assets, there are no unified accounting standards yet.

2.2 status quo of domestic research

Domestic research focuses on the practical issues of accounting in photovoltaic energy enterprises, and has made certain progress in policy adaptation and practical innovation. Most of the related studies are combined with the actual development of China's photovoltaic industry and are highly targeted.

In the field of cost accounting, Du (2024) compared the cost differences between the traditional photovoltaic system and the "photovoltaic + conventional grid" hybrid system for the fishpond photovoltaic oxygenation system, proposed the idea of allocating common costs based on power generation efficiency, and provided a reference for cost allocation of composite projects[15]. Hu (2025) focused on the grounding system of photovoltaic supports in fish ponds, studied the cost composition and accounting methods of special assets, and proposed to incorporate the construction costs of the end plates of pipe piles and the reinforcing bars inside the piles into the fixed asset accounting. The depreciation rate was adjusted according to the corrosion rate, thereby improving the accuracy of the cost accounting for special assets[16]. Li (2025) pointed out the problems existing in the accounting internal control of power supply enterprises and proposed a cost control strategy of refining budget standards and tracking execution situations. This strategy has reference significance for the cost management of fishpond photovoltaic projects[17].

In the field of fixed asset management, Ji (2026) analyzed the core difficulties in converting construction in progress of new energy projects into fixed assets, and proposed a determination standard for conversion based on technical milestones. By taking "technical grid connection acceptance passing" and "grid connection safety assessment qualified" as the core conversion nodes, it has guiding significance for the divisional conversion of fishpond photovoltaic projects[18]. Zhou (2025) in the environmental impact assessment of the fishery and photovoltaic complementary project, addressed the issues of lifespan assessment and impairment testing of special assets. He proposed to assess the corrosion risk of waterborne assets based on hydrological environmental characteristics, providing practical experience for the impairment testing of fixed assets[19]. Yang (2025) pointed out that the proportion of fixed assets in power grid enterprises exceeds 70%, and it is necessary to strengthen the full life cycle management. This viewpoint has an enlightening effect on the fixed asset management of fishpond photovoltaic projects[20].

In the field of carbon accounting and subsidy processing, Li (2025) has developed an energy enterprise carbon accounting information management system, integrating technologies such as blockchain and big data to achieve automatic calculation and disclosure of carbon emissions and carbon reduction volumes, providing technical support for the measurement of carbon assets in photovoltaic projects[21]. Zhang (2025) addressed the accounting challenges of renewable energy subsidies and proposed a three-dimensional framework of "standardization of recognition - optimization of cost allocation - tax and accounting synergy", which standardized the classification, recognition and measurement processes of subsidies[22]. He (2025) in the research on the application of energy enterprise management accounting under the "dual carbon" context emphasizes that carbon costs should be incorporated into the management accounting system to achieve precise measurement of green value[23].

Although domestic research is in line with the actual operational characteristics of fishpond photovoltaic projects, it has problems such as fragmented research and insufficient innovation depth. Most existing research focuses on a single accounting process (such as cost allocation, determination of the time point for fixed asset recognition), lacking systematic research on the full life cycle accounting of the project; at the same time, there are no unified norms for cost allocation standards for the combined business of power generation and aquaculture, classification and depreciation policies for special waterborne assets, and coordinated measurement of carbon sinks and carbon reduction, making it difficult to meet the needs of energy enterprises for refined management.

2. 3 Comparative analysis of domestic and foreign research

To clearly illustrate the differences and complementarities between domestic and international research, Table 1 is constructed as follows:

Tab. 1 Comparative Table of Accounting Research on Fish Pond Photovoltaic Projects at Home and Abroad

Research Dimension	Foreign Research Characteristics	Domestic Research Characteristics	Research Gaps
Cost accounting	Focus on the application of activity-based costing, emphasizing the adjustment of environmental risk coefficients	Focus on the composition of special asset costs, explore the functional coefficient allocation method	Lack of unified standards for allocating costs of complex business operations
Fixed asset management	Emphasize the compatibility of depreciation policies with the environment, and the maturity of technology	Pay attention to the fixed asset conversion node and impairment testing, aligning with project realities	Inconsistencies in the classification of water assets and depreciation standards
Carbon accounting	Formulate international accounting norms, and improve the carbon asset measurement system	Build a carbon accounting information system, explore dual carbon value accounting	The absence of a coordinated measurement mechanism for carbon sinks and emission reduction
Subsidy processing	Account for subsidies based on their nature, and pay attention to the matching of cycles	Concentrate on policy adaptation and tax-accounting coordination, standardize processing procedures	Insufficient accounting strategies for responding to subsidy reduction
Research Focus	Primarily focused on general photovoltaic projects, with scattered research on composite scenarios	Focused on the fishery-photovoltaic complementary scenario, with highly targeted research.	Lack of a comprehensive life cycle system accounting framework.

Through comparative analysis, it can be seen that domestic and foreign research has achieved certain results in the field of accounting for photovoltaic energy enterprises. However, for the complex scenario of fishpond photovoltaic power generation systems, there are still significant research gaps: Firstly, there is a lack of a full life cycle accounting system that is suitable for complex business scenarios. Secondly, the accounting standards for core issues such as cost allocation of composite business, measurement of special assets, and carbon asset accounting are not unified. Thirdly, the application depth of digital technology in accounting is insufficient, making it difficult to meet the needs of enterprises for refined management. Based on these research gaps, this paper conducts an innovative research on the accounting of energy enterprises for fishpond photovoltaic power generation systems.

2. CORE CHALLENGES IN ACCOUNTING FOR FISHPOND PHOTOVOLTAIC POWER GENERATION SYSTEM

3. 1 Accounting characteristics

3. 1. 1 Specialized asset structure

The assets of the fishpond photovoltaic project are mainly fixed assets, accounting for over 70%, and cover various types of specialized assets. From the perspective of asset composition, it mainly includes three categories: photovoltaic power generation equipment, water-related specialized facilities, and aquaculture supporting facilities[24]. Among them, the facilities specifically designed for water use are affected by the hydrological environment and are prone to corrosion, making the assessment of their lifespan and the testing for impairment more challenging; the supporting facilities for aquaculture and the photovoltaic power generation equipment have functional interconnections, and the boundary of the assets is unclear, which brings inconvenience to accounting. At the same time, the project assets are distributed across different regions and are exposed to the outdoors for a long time, resulting in high operation and maintenance costs. The depreciation accrual and impairment testing need to be comprehensively judged based on the asset usage environment and technical characteristics.

3. 1. 2 Complexification of cost composition

The cost of the fishpond photovoltaic project covers various aspects such as equipment procurement, engineering construction, operation management, technological research and development, and fish farming operations. As shown in Fig. 2, from the perspective of cost nature, it can be divided into single business costs and common costs. Single business costs correspond to a single process such as power generation or fish farming, while common costs include expenses for water-based support structures, public operation and maintenance, and project management, which need to be allocated between the two major businesses[25]. At present, there is no unified standard for the allocation of common costs. For instance, the construction and maintenance costs of the floating supports, which not only support the photovoltaic modules but also provide shading for aquaculture, are difficult to precisely determine the proportion of the costs. In the public operation and maintenance costs, the labor and material consumption for equipment maintenance and fishpond management are difficult to clearly distinguish, resulting in insufficient accuracy in cost accounting. Moreover, issues such as the allocation of research and development expenses and government subsidies have further increased the complexity of cost accounting.

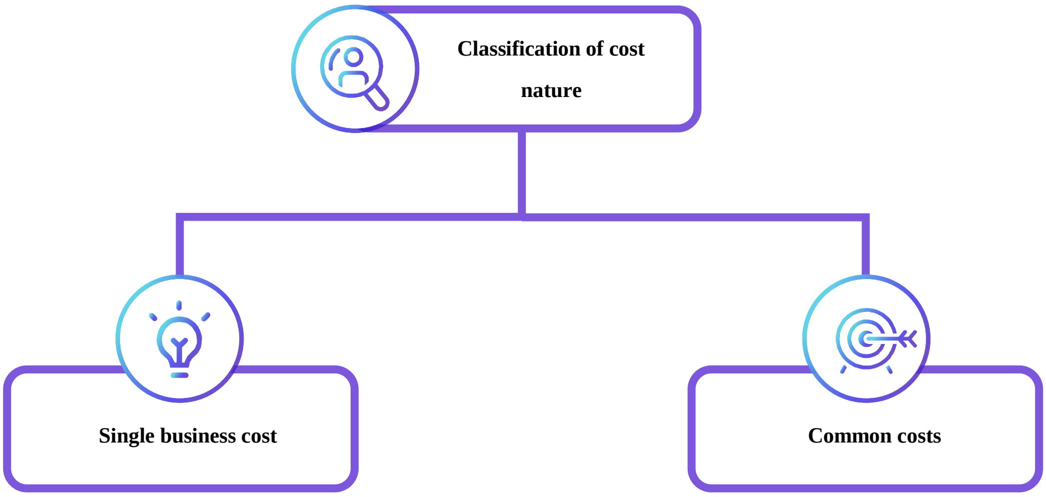

Fig. 2. Cost allocation

3. 1. 3 Enhanced policy integration

The income of the fishpond photovoltaic project relies on multiple policy supports, including renewable energy electricity price subsidies, investment subsidies, and carbon trading revenues, etc[26]. The accounting treatment methods for different policies vary: The electricity price subsidy is a government grant related to income, which should be recognized according to the accrual basis. The investment subsidy is a government grant related to assets, which should be recorded as deferred income and amortized over time; the carbon trading income is a non-recurring profit, which needs to be accounted for and disclosed separately. The uncertainty of policy dynamic adjustment and the long recovery period of subsidy funds not only increase the difficulty of accounting but also enhance the pressure of financial risk prevention and control.

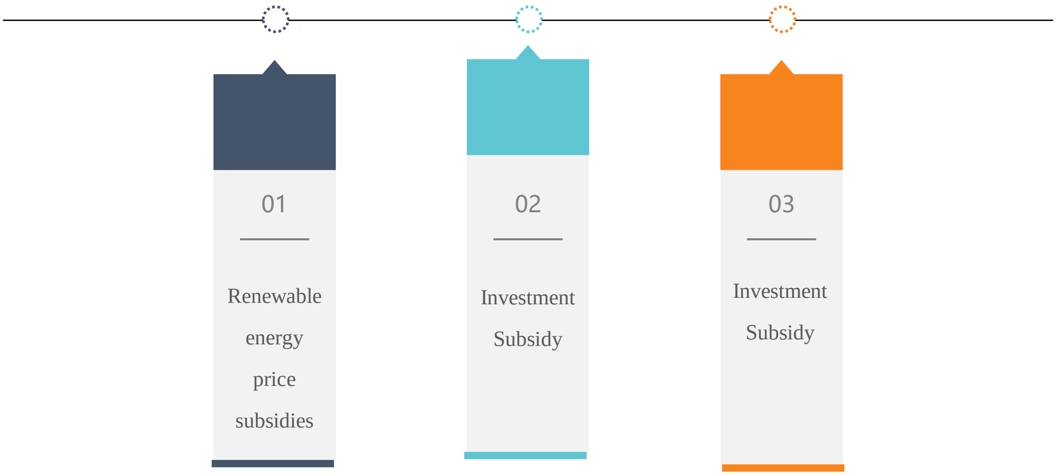

Fig. 3. The income of the fishpond photovoltaic project depends on policies

3. 1. 4 Explicitation of environmental value

The fishpond photovoltaic project has dual environmental values of both power generation and carbon emission reduction as well as carbon sequestration from fish farming. According to calculations, a 1MW project can reduce approximately 1,000 tons of carbon annually. The shading provided by the photovoltaic panels can inhibit the growth of algae and improve the water quality of the fishpond. The photosynthesis of aquatic plants in the fish farming process can absorb carbon dioxide, forming a carbon sink[27]. Incorporating environmental value into accounting and achieving the financial visibility of green value is an important aspect of project accounting. However, the current accounting system has not yet established a unified standard for measuring environmental value, and there is a lack of clear guidance on the confirmation, measurement and disclosure of carbon assets, which makes it difficult to effectively reflect environmental value through financial statements.

3. 2 The core difficulty

3. 2. 1 Inadequate adaptability of the cost accounting system

The insufficiency of cost accounting adaptability is the main difficulty in the accounting of fishpond photovoltaic projects. On one hand, there is a lack of a unified standard for the allocation of common costs. Expenses such as water support structures, public maintenance, and project management are used for both power generation and aquaculture. Traditional methods like based on installed capacity or average allocation cannot accurately reflect the cost and revenue ratio[28]. For instance, if the construction cost of the floating support structure is allocated based on the proportion of installed capacity, its functional value of providing shade for aquaculture will be overlooked; if the public operation and maintenance cost is allocated according to the proportion of labor hours, it is difficult to distinguish the consumption differences between equipment maintenance and fishpond management. On the other hand, special matters such as anti-corrosion of waterborne assets, research and development amortization, and cross-period cost recognition lack clear accounting norms. The handling methods of enterprises vary, and the cost information lacks comparability. Moreover, the project is constructed in batches and put into production in parts, and the public facilities cost is allocated among various power generation units in a complex manner, which further affects the accuracy of cost accounting.

3. 2. 2 The management of special fixed assets is very challenging

The special asset management issues in fishpond photovoltaic projects are quite prominent. Firstly, the classification and initial measurement of assets are not standardized. For example, special assets such as water-based supports and underwater cables are sometimes recorded as “fixed assets - general equipment” by some enterprises, while others record them as “construction in progress” and leave them on the books for a long time, resulting in chaotic asset classification. During the initial measurement, some enterprises did not include costs such as anti-corrosion and installation and commissioning in the asset cost, leading to an underestimation of the value. Secondly, the depreciation policy does not match the actual wear and tear. Water-based assets are prone to corrosion and have a shorter lifespan, but the 25-30-year depreciation period for land-based photovoltaic is still used, resulting in insufficient depreciation accrual and inflated asset value[29];The corrosion rate of underwater cables and other assets is affected by factors such as water quality and water temperature, making it difficult to dynamically adjust the depreciation rate. Thirdly, there is a lack of unified standards for the timing of fixed asset recognition and impairment testing, and the inconsistency between project acceptance and operation leads to deviations in the timing of fixed asset recognition, which affects the asset value and depreciation accrual. The impairment testing of fixed assets needs to take into account factors such as corrosion risk and technological iteration, and the impairment assessment lacks a scientific model, resulting in insufficient impairment provisions being made.

3. 2. 3 Inconsistent carbon asset measurement and disclosure practices

There are obvious irregularities in carbon asset accounting and disclosure. Firstly, the scope and methods of carbon accounting are not unified. Some enterprises only calculate the emission reduction volume from power generation but do not include the carbon sink volume from livestock farming. The accounting methods include emission factor method, measurement method, material balance method, etc. The accounting results of different methods vary greatly, resulting in a lack of comparability in the value of carbon assets. Secondly, there are no clear guidelines for the confirmation and measurement of carbon assets. Carbon assets are a new type of asset, and their confirmation conditions, measurement attributes (historical cost method, fair value method), etc. lack unified regulations. Some enterprises include carbon trading income in “other income”, while some include it in “non-operating income”. The accounting methods are inconsistent[30]. Thirdly, the carbon information disclosure is incomplete. Most enterprises merely provide a brief description of their emissions or transaction revenues in the notes to the financial reports, without systematically explaining the calculation methods, asset values, emission reduction targets and related risks. This makes it difficult to meet the information needs of stakeholders.

3. 2. 4 The lag in the accounting treatment of subsidies and policy adaptation

The accounting treatment of subsidies lags behind the current policies. Firstly, the classification and timing of subsidy recognition are not standardized. Electricity prices, investment, and environmental protection subsidies are not categorized according to their nature. Asset-related subsidies are directly recorded in the current profit and loss, resulting in excessive fluctuations in profits[31]. The confirmation timing mixes accrual basis and cash basis accounting. Some enterprises recognize revenue when receiving subsidy funds, ignoring the matching relationship between subsidies and related costs and expenses. Secondly, the amortization methods for cross-period subsidies are not unified, and the handling of tax and accounting differences is not standardized. There is controversy over the choice between the straight-line method and the output method; the application of tax preferential policies is not in place, and the compatibility of policies such as VAT immediate refund and income tax additional deduction is insufficient, leading to compliance risks. Thirdly, the risk prevention mechanisms for subsidy reduction and fund recovery are not complete. The renewable energy subsidy reduction policy leads to changes in enterprises' expected revenue, and the existing accounting system lacks coping strategies. The recovery period of subsidy funds is long (the recovery period of some subsidies exceeds 3 years), and the impairment testing and risk prevention of accounts receivable lack scientific methods, resulting in an increase in bad debt risks.

3. INNOVATIVE ACCOUNTING CALCULATION PATH FOR FISH POND PHOTOVOLTAIC POWER GENERATION SYSTEM

4. 1 Optimize the composite cost accounting

4. 1. 1 Establish a three-dimensional cost aggregation framework

Based on the requirements of the project's full life cycle management, a three-dimensional cost aggregation framework of "power generation - breeding - supporting facilities" was established. All expenditures were classified into five major categories according to their business attributes: The cost of photovoltaic equipment covers the procurement, transportation, installation and commissioning expenses of core equipment such as photovoltaic modules, inverters, and transformers; the cost of breeding facilities includes the construction and procurement expenses of specialized facilities such as aeration pumps, breeding water tanks, and water circulation systems; the cost of shared assets involves the construction and maintenance expenses of common facilities such as floating supports, pipe piles grounding systems, and public roads; the operation and maintenance cost includes operational expenses such as equipment maintenance, daily management of fish ponds, and safety monitoring; the research and development cost is related expenses such as collaborative research and development of photovoltaic and breeding technologies, equipment modification, and patent applications[32].

This classification method not only clearly defines the accounting boundary for individual business costs, but also facilitates the precise allocation of shared costs. For shared asset costs, the "functional coefficient method" is used for allocation. The allocation weight is determined based on the actual proportion of photovoltaic installation capacity and breeding area, taking into account the functional contributions of both the power generation and breeding businesses. For example, the floating support structure simultaneously serves as a support for photovoltaic modules and a shading cover for breeding, and the costs can be allocated at a ratio of 60% for the installation capacity and 40% for the breeding area, ensuring that the cost allocation is in line with the functional contributions.

4. 1. 2 Standardize the handling methods for special costs

Regarding the cost of corrosion protection for waterborne assets, the actual expenditure on protection should be recorded as current period expenses or capitalized. The capitalized portion should be amortized over the remaining useful life of the asset in installments. Research expenses are divided into the research stage and the development stage. Expenditures during the development stage that meet the capitalization criteria should be included in intangible assets and amortized over the benefit period[33]. By leveraging big data technology, a dynamic cost monitoring platform is constructed, integrating equipment operation data, breeding output data, and environmental monitoring data, to achieve cost traceability and anomaly warning.

4. 1. 3 Cost accounting process standardization

Establish an operational specification for cost accounting for fishpond photovoltaic projects, clearly defining the process, methods, and responsibility division of cost accounting. The cost accounting process mainly includes. First, cost data collection, which is carried out collaboratively by the engineering department, operation department, and finance department, collecting original vouchers such as equipment purchase invoices, engineering settlement forms, operation records, and breeding output data. Second, cost classification and aggregation, the finance department classifies and aggregates the cost data according to the three-dimensional framework of "power generation - breeding - supporting facilities", and assigns them to corresponding cost accounts. Third, common cost allocation, using the "functional coefficient method" to allocate shared asset costs and public operation and maintenance costs; Fourth, cost transfer and accounting, at the end of the period, transfer the costs to the corresponding assets or profit and loss accounts, and prepare a cost analysis report; Fifth, cost review and supervision, the internal audit department regularly reviews the accuracy and compliance of cost accounting to ensure the authenticity and reliability of cost information[34].

4. 2 Improve the special fixed asset management mechanism

4. 2. 1 Initial measurement and classification norms

In accordance with the requirements of "Accounting Standards for Enterprises No. 4 - Fixed Assets", the fixed assets of the fishpond photovoltaic project are classified and accounted for. A new subcategory "Special Equipment for Waterborne Photovoltaic" is added, covering special assets such as flexible supports, pipe piles grounding systems, underwater cables, etc. (as shown in Table 2). At the initial measurement, all necessary expenditures before reaching the predetermined usable state are included in the asset cost, including equipment purchase price, installation fees, anti-corrosion treatment fees, etc.

For projects constructed in batches and put into production in parts, fixed assets are confirmed separately for each independent power generation unit or breeding area. The cost of public facilities is reasonably allocated according to the proportion of each unit's installed capacity or breeding area. For example, a 100MW fishpond photovoltaic project is constructed in two phases. The 50MW unit reaches the usable state first, and can be separately confirmed as fixed assets. The cost of the substation and other public facilities is allocated to the first phase project according to the proportion of installed capacity.

Tab. 2 Classification Table of Fixed Assets for Fish Pond Photovoltaic Project

Asset category	Specific asset item	Initial measurement scope	Depreciation method	Expected useful life (years)
Photovoltaic power generation equipment	Photovoltaic modules, inverters, transformers, etc.	Purchase price, transportation cost, installation fee, commissioning fee	Straight-line depreciation method	25
Specialized equipment for water-based photovoltaics	Flexible supports, pipe pile grounding systems, underwater cables, etc.	Construction cost, installation fee, anti-corrosion treatment fee, inspection fee	Accelerated depreciation method	20
Aquaculture facilities	Oxygenating pumps, fish farming tanks, water circulation systems, etc.	Purchase price, construction cost, installation fee, commissioning fee	Straight-line depreciation method	15
Supporting facilities	Public roads, distribution rooms, office buildings, etc.	Construction cost, decoration cost, equipment purchase cost	Straight-line depreciation method	30

4. 2. 2 Optimization of Depreciation and Impairment Testing

Based on the usage environment and technical characteristics of the assets, differentiated depreciation policies are implemented: Land-based general equipment such as photovoltaic modules and transformers adopt the straight-line depreciation method for depreciation calculation; Waterborne specialized equipment such as flexible supports and pipe pile grounding systems, considering the higher corrosion risk, adopt accelerated depreciation methods such as double-declining balance method, with an estimated useful life set at 20 years; Farming facilities and supporting facilities are depreciated using the straight-line depreciation method, with estimated useful lives set at 15 years and 30 years respectively.

Establish a full life cycle monitoring mechanism for fixed assets, conducting impairment tests regularly each year. Pay close attention to factors such as the corrosion status of waterborne assets, the technical iteration risks of photovoltaic equipment, and the functional wear and tear of farming facilities. For assets with impairment indications, impairment provisions are made based on the difference between the present value of expected future cash flows and the book value. During the impairment test process, combine multiple aspects of information such as hydrological environment monitoring data, equipment operation parameters, and market technology update trends to ensure the scientificity and accuracy of the impairment judgment.

4. 2. 3 Clarify the criteria for determining the time point of asset conversion to fixed assets

Establish a cross-departmental working group consisting of finance, engineering and operations. Develop the “Judgment Criteria for Project Conversion to Fixed Assets” based on the core criteria of “successful technical grid connection acceptance”, “compliance with grid safety assessment”, and “completion of equipment debugging and meeting the designed power generation capacity”. For projects that have been independently put into operation by the division, determine the conversion to fixed assets based on separate power generation units. When a certain unit meets all the above requirements, it can be separately recognized as fixed assets to avoid delays in conversion due to the overall project not being completed.

During the conversion process, meticulously record the acceptance documents, test reports and other supporting materials for each node as the basis for fixed asset recognition. At the same time, establish a post-conversion tracking mechanism to continuously monitor the operation status and depreciation accrual of the converted assets to ensure the accuracy and completeness of asset measurement.

4. 3 Establish a carbon asset measurement and disclosure system

4. 3. 1 Unifying the scope and methods of carbon accounting

Based on the “Greenhouse Gas Accounting System” and relevant domestic carbon trading regulations, the carbon accounting scope is clearly defined to cover direct and indirect emissions from the photovoltaic power generation process, as well as carbon sequestration volumes from the fishery farming process. The carbon emissions are calculated using the “emission factor method”, and the carbon emission reduction in the power generation process is calculated by combining actual power generation volume, power supply coal consumption, emission factors, etc. The carbon sequestration volume in the fishery farming process is calculated based on information such as the type of breeding, breeding area, and coverage of aquatic plants, and finally, the net carbon emission reduction of the project is determined.

Establish a carbon accounting data collection mechanism to regularly collect basic information such as power generation volume, energy consumption data, and breeding output data to ensure the authenticity and completeness of the carbon accounting data. At the same time, unify the accounting parameter standards and adopt the emission factors and carbon sequestration coefficients published by the national competent authorities to ensure the comparability of carbon accounting results for different projects and different periods.

4. 3. 2 Standardize the confirmation and measurement of carbon assets

The carbon credits corresponding to the net carbon emission reduction of the project shall be recognized as “carbon emission rights assets” and be listed separately in the balance sheet. At the initial recognition, they shall be measured at the actual cost of obtaining the carbon assets; for subsequent measurement, the fair value model shall be adopted, and the book value of the carbon assets shall be adjusted regularly based on the carbon trading market price. The fair value changes shall be included in the current profit and loss. The income and expenses generated from carbon trading shall be accounted for separately and recorded in the “Other Income - Carbon Trading Income and Expenses” account to ensure a clear reflection of the changes in the value of carbon assets and the trading income. At the end of the period, an impairment test shall be conducted on the carbon assets. When there are indications of impairment such as a continuous decline in carbon prices or inability to achieve the expected benefits from carbon emission reduction, impairment provisions shall be made based on the difference between the book value and the recoverable amount. Once impairment provisions are made, they cannot be reversed, ensuring the prudence of accounting information.

4. 3. 3 Improve the content of carbon information disclosure

In the notes to the financial report, comprehensive carbon accounting information is systematically disclosed, including carbon emissions, carbon sinks, net carbon reduction, carbon asset value, carbon trading income and expenditure, accounting methods, selection of emission factors, and other key contents. An independent environmental, social and governance (ESG) report is compiled to detail information on carbon reduction targets, carbon asset management systems, environmental benefits achieved, and carbon market risks faced, meeting the information needs of investors, regulatory agencies and other stakeholders.

Carbon information disclosure should follow the principles of authenticity, completeness and comparability, and adopt a combination of quantitative and qualitative methods. It should not only present specific data indicators but also explain carbon asset management policies and measures. For uncertain factors in the carbon accounting process, such as adjustment of emission factors and fluctuations in carbon market prices, they should be explained in the disclosure to enhance the transparency of information disclosure.

4. 4 Standardize accounting treatment of subsidies and risk prevention measures

4. 4. 1 Clarify the classification of subsidies and the confirmation time point

Distinguish between government subsidies related to assets and those related to income. Subsidies related to assets are recorded in “deferred income” and are recognized in the current profit and loss over the asset’s useful life. Subsidies related to income are recognized in accordance with the accrual basis principle to ensure matching with the relevant costs and expenses.

Strictly follow the accrual basis principle to recognize subsidy income. Subsidies related to income are recognized when the subsidy conditions are met and the relevant costs and expenses occur, without relying on the actual arrival time of the subsidy funds. Subsidies related to assets are evenly allocated over the asset’s useful life after the asset reaches the predetermined usable state to ensure that the subsidy income is matched with the asset’s usage efficiency.

4. 4. 2 Standardize subsidy allocation and coordinate with tax processing

For cross-period subsidies, they are amortized using the straight-line method or the output method based on the period during which the benefits are received. The straight-line method is applicable to subsidy projects with uniform benefit periods, while the output method is suitable for subsidy projects directly related to electricity generation or breeding output. Establish a tax and accounting difference ledger for subsidy-related matters, detailing the tax and accounting differences under policies such as immediate tax refund for value-added tax and additional tax deduction for income tax. Make timely tax adjustments in accordance with tax laws to ensure the compliance of tax treatment.

For new businesses such as green power certificate trading and carbon asset trading, clearly define the accounting treatment and tax application rules for related revenues to avoid accounting chaos caused by unclear policies. Strengthen communication and coordination with the tax department, promptly grasp changes in tax policies, and ensure the accuracy of subsidy-related tax treatment.

4. 4. 3 Establish a risk prevention mechanism for subsidies

Establish a dynamic tracking mechanism for subsidy policies, assign dedicated personnel to monitor changes in renewable energy subsidy policies, carbon trading policies, and other related policies, analyze the impact of policy adjustments on enterprise profits, and formulate response strategies in advance. In response to the problem of long recovery periods for subsidy funds, calculate bad debt provisions based on the aging account method, initiate special collection procedures for subsidies overdue for more than one year, enhance communication and coordination with subsidy distribution departments, and ensure timely recovery of funds.

Utilize blockchain technology to build a subsidy fund traceability system, achieve transparent management of the entire process of subsidy application, review, disbursement, and usage, and ensure that subsidy funds are used exclusively for their intended purposes. Incorporate subsidy accounting processing into the enterprise’s internal control system, conduct regular compliance audits of subsidy accounting, and prevent compliance risks such as incorrect classification of subsidies and improper confirmation times.

To compare the differences between traditional processing and innovative processing, the following Table 2 is constructed.

Tab. 3 Comparison Table of Traditional and Innovative Accounting Models for Subsidies

Processing stage	Traditional model characteristics	Innovative model characteristics	Advantages demonstrated
Subsidy classification	The classification criteria are vague and the boundaries are unclear.	Strictly classified by assets/earnings	Unified accounting standards, reducing subjective judgment
Confirmation time point	It mostly adopts the cash basis for recognition.	Precisely confirmed based on accrual basis	Matching of revenue and expenses, improving information quality
Measurement method	It measures with a single amount and lacks dynamic adjustment.	Measured by fair value, regularly reviewed	Reflecting the true value of assets, reducing risks
Funds traceability	Manual ledger records make it difficult to trace.	Enforced by blockchain technology, with all processes traceable	Enhancing transparency, preventing fraud risks
Risk prevention and control	There is a lack of special mechanisms and it responds passively.	Established early warning system, for proactive prevention and control	Reducing bad debt risks, ensuring fund security

4. CASE ANALYSIS

5. 1 Case Background

A 100MW fishpond photovoltaic power generation project covers an area of approximately 2,000 acres. It installs 222,000 single-crystal silicon photovoltaic modules and is equipped with a flexible support system, pipe pile grounding system, inverter room, and fishery breeding facilities. The total investment of the project is 580 million yuan. The project adopts the “full grid connection” model and enjoys renewable energy electricity price subsidies. At the same time, it achieves green income through carbon trading. The accounting calculation involves multiple complex businesses such as special asset measurement, cost allocation, and subsidy processing. During the project construction process, issues such as unclear classification of water assets, significant disputes over shared costs, and no standard for carbon asset accounting were encountered, which affected the quality of accounting information and the efficiency of financial management.

5. 2 Accounting Innovation Practice

5. 2. 1 Cost accounting optimization

The “functional coefficient method” was adopted to allocate the cost of shared assets. The total cost of the floating support structure was allocated to the photovoltaic assets and the aquaculture assets according to the proportion of power generation and aquaculture functions. In the operation and maintenance costs, the equipment maintenance expenses were included in the power generation cost, the fishpond management expenses were included in the aquaculture cost, and the common labor costs were allocated based on the proportion of working hours. By establishing a cost dynamic monitoring platform, real-time tracking and abnormal warning of data such as equipment energy consumption and maintenance expenses were achieved, effectively reducing the calculation errors, and the accuracy of cost accounting has significantly improved compared to before.

5. 2. 2 fixed-assets management

Classify special assets such as flexible supports and pipe pile grounding systems as “special equipment for water-based photovoltaics”. During the initial measurement, fully include necessary expenditures such as anti-corrosion treatment costs. Adopt differentiated depreciation policies based on the characteristics of the assets. The flexible supports adopt the accelerated depreciation method, and the grounding system adjusts the depreciation rate based on the corrosion monitoring data to ensure that the depreciation accrual is in line with the actual wear and tear of the assets.

The project is transferred to fixed assets in two phases, and fixed assets are confirmed based on independent power generation units. The cost of public facilities is reasonably allocated according to the proportion of installed capacity.

5. 2. 3 Carbon asset accounting

Calculate the carbon emission reduction volume in the power generation process and the carbon sink volume in the breeding process according to the unified standards, determine the value of the carbon assets corresponding to the net carbon emission reduction volume, and standardize the confirmation and measurement. The carbon trading income achieved in the current year shall be included in the current period's income in accordance with relevant standards.

5. 2. 4 Subsidy accounting treatment

The received electricity price subsidy funds are classified and accounted for according to their revenue-related nature. Revenue is recognized based on the accrual basis to ensure matching with related costs and expenses. The blockchain system is used to achieve the linkage and traceability of the subsidy funds flow and the power generation data, ensuring the compliance of subsidy processing.

5. 3 Practical results

Through innovative accounting practices, the quality of accounting information for this project has significantly improved. The accuracy of cost accounting and the compatibility of fixed asset depreciation have been greatly enhanced. The value of carbon assets has been effectively reflected, fully demonstrating the composite revenue characteristics of the project "power generation + breeding + carbon trading". At the same time, the standardization of the accounting system has reduced financial risks, ensuring the safe recovery and compliant use of subsidy funds, and providing solid financial support for the project's subsequent operation and expansion.

To quantitatively demonstrate the effectiveness of the innovation, Table 4 is constructed as follows:

Tab. 4 Comparison Table of Key Indicators Before and After the Innovation of Project Accounting Methods

Evaluation indicators	Before innovation	After innovation	Improvement features
Cost accounting accuracy	Lower, more disputes to be settled	Higher, with uniform diameter	Standardization of shared asset cost allocation
Standardization of fixed asset management	Unclear classification, poor depreciation adaptation	Clear classification, actual depreciation	Full lifecycle management of special assets
Realization of carbon asset value	Not included in the accounting system	Standardized confirmation of measurement and disclosure	Explicitization of green value in finance
Compliance rate of subsidy processing	Lower, with inter-period issues	100% compliant	Matching of rights and responsibilities, with full traceability throughout the process
Decision support for accounting information	Limited, unable to reflect composite value	Higher, comprehensive multi-dimensional information	Supporting full-cycle decision-making for projects
Level of financial risk control	Weak, risk warning lagging	Strong, proactive prevention and control	Establishment of a full-process risk prevention mechanism

5. CONCLUSION AND OUTLOOK

The "energy-agriculture" integrated characteristic of the fishpond photovoltaic power generation system determines that its accounting needs to break through the framework limitations of traditional energy enterprise'' accounting and establish an innovative system with system integration, business collaboration, and sustainable design as its core positioning. Based on this new positioning, this article systematically reviews the current research status at home and abroad, accurately identifies key problems such as the lack of a unified standard for shared cost allocation, the non-standard management of special fixed assets, the absence of carbon asset measurement, and the lag in the processing of subsidies and policy integration. It then constructs a full life cycle integrated accounting and decision support framework from four dimensions: collaborative cost allocation, full life cycle management of special assets, dual value measurement of carbon reduction and breeding carbon sequestration, and compliant processing of subsidies and risk prevention. The framework has been verified through case studies and demonstrates good feasibility and practicality.

Research shows that this framework is deeply adapted to the integrated operation logic of fishponds and photovoltaic power generation, effectively supporting the construction of the project system integration, the cross-business coordination of power generation and aquaculture, the realization of sustainable value and the optimization of solutions. It can accurately reflect the economic value and environmental benefits of the fishpond photovoltaic project, and enhance the financial management level and decision-making scientificity of the enterprise . Future research can further deepen the application of digital technology in accounting, build an intelligent accounting platform based on artificial intelligence, and realize the automated processing of cost allocation, depreciation accrual, carbon asset measurement, and subsidy processing; at the same time, strengthen international comparison research and draw on advanced foreign experience to promote the standardization and internationalization of accounting for fishpond photovoltaic projects. With the deepening of the "carbon neutrality" goal, the fishpond photovoltaic power generation system will have greater development space, and the accounting system needs to be continuously optimized to provide a solid financial guarantee for the high-quality development of the industry.

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