# Compliance Practice Manual on Biodiversity Risk Identification for Photovoltaic Power Stations

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PECC

Under of the implementation of the Paris Agreement and the launch of China's 15th Five-Year Plan, the Photovoltaic (PV) Industry has become a key pillar of the energy transition driven by declining costs and technological progress. At the same time, as the industry continues to expand, the relationship between Photovoltaic Project development and biodiversity conservation has increasingly become a focus of international attention. Both international and domestic policy frameworks are strengthening the integration of biodiversity protection into energy planning and infrastructure development. The ecological compatibility of PV projects is no longer optional, it has become a fundamental requirement. Although China is a global leader in the PV industry, some projects may still cause potential impacts on ecosystems during site selection, construction, and operation, particularly in areas with important ecological functions and unclear regulatory boundaries. The ecological risks associated with PV projects are not limited to a single stage but run throughout the entire project life cycle. In this context, Green Jiangnan will systematically review the potential biodiversity impact scenarios that may arise during the full life cycle of the PV power station and develops a clear, practical, and operational framework for risk identification and compliance assessment. The goal is to support the transition of the PV industry from "scale expansion" to "quality improvement" and to promote the integration of energy security, ecological security, and development benefits, assisting the PV industry in achieving green, sustainable, high-quality development

From the perspective of project types, centralized PV power stations are the primary focus of biodiversity risk assessment. Due to their large-scale electricity generation needs, such projects often require vast areas of contiguous land. This can fundamentally change land-use patterns and even disrupt the integrity of existing ecosystems, leading to habitat loss, reduced species populations, simplified community structures and overall biodiversity decline. In the well-known environmental public interest litigation case brought by Friends of Nature against Wenzhou Hengtai New Energy Development Co., Ltd., PV panel arrays and related infrastructure covered and occupied tidal wetlands, causing significant habitat loss and fragmentation. This affected waterbirds' ability to recognize and use the remaining tidal habitats. Moreover, the shading effect of PV panels reduced sunlight penetration, altering the composition and diversity of benthic organisms that serve as food for waterbirds, thereby undermining the ecological function of tidal flats as feeding grounds.

In recent years, the rapid development of "Photovoltaic Plus" integrated models, such as Agrophotovoltaics, fishing-PV complementary, forest-PV complementary, and grass-PV complementary, has aimed to promote intensive land use and ecological synergy. However, as the number and scale of these projects have expanded, irregular

land use and biodiversity impacts have become increasingly visible. Although cases directly linking PV projects to biodiversity damage remain relatively limited, negative examples of failing to fulfill biodiversity protection obligations throughout the project life cycle are common. For example, on November 14, 2023, Huaneng (Danzhou) Solar Power Co., Ltd. occupied land in Yaxing Town, Danzhou City without legal approval to construct a booster station for an integrated agro-forest-fishing-PV complementary project.

Different types of integrated projects involve different ecological risks. Offshore and tidal flat PV projects may affect migratory bird routes; forest-PV complementary projects may alter vegetation coverage, and fishing-PV complementary projects may disrupt wetland hydrological balance. These differences mean that risk identification and regulatory oversight cannot rely on a single uniform model but must adopt targeted management approaches. In response, Ministry of Natural Resources, National Forestry and Grassland Administration, and the National Energy Administration jointly issued a notice 'Standardizing Land Use Management to Support PV Industry Development'. Subsequently, additional guideline 'Regulate the Use of Grasslands for PV Projects' were released. In recent years, provincial authorities have also conducted focused inspections and introduced local regulatory measures for integrated PV projects.

From a temporal perspective, biodiversity impacts occur throughout the entire life cycle of a PV station, from planning and site selection to construction, operation, and decommissioning. During the planning and site selection stage, comprehensive ecological baseline surveys and biodiversity assessments should be conducted. Based on the environmental impact assessment reports as required by law, project owners should carry out scientific identification of species distribution, habitat conditions, ecosystem types, ecological sensitivity and suitability, minimizing ecological conflicts with avoidance measures. However, in practice, there have been cases of inadequate biodiversity assessment, insufficient ecological avoidance and even unauthorized project construction. For instance, the Tiangang Lake PV project in Sihong County, Jiangsu Province, was launched without approval from the Huai River Water Resources Commission, causing serious damage to bird habitats and stopover sites. In project design, developers should adhere to the principle of ecological priority and avoid large-scale terrain alteration, thereby protecting rare species and critical habitats. For integrated projects such as Agrophotovoltaics, fishing-PV complementary projects, relevant technical standards and management requirements must be strictly complied. Large-scale land occupation is a significant feature of centralized PV power station projects during the development and construction stage, and changes in land use are one of the direct drivers of biodiversity loss. A typical example is the case of the Hancheng Longchi 100MW PV project, which illegally occupied grassland. After obtaining land use rights and completing the project feasibility study, the project owner must further commission a qualified third party to conduct an environmental impact

assessment, so that potential environmental risks can be identified and addressed at an early stage，otherwise it may result in the absence of assessment of environment impact. A representative case is the 60MW agro-forestry integrated PV Complementary project in Lingshui Li Autonomous County, which began construction without prior approval and was subsequently subject to administrative penalties by the county's comprehensive law enforcement authority. This case demonstrate that, despite strengthened environmental awareness campaigns and increasingly strict supervision, enterprises still face shortcomings or weaknesses in ecological and environmental compliance. To enhance biodiversity protection in PV project management, companies should take at key measures such as ecological assessment of site selection plans, species surveys, habitat evaluation, ecosystem identification, and other essential compliance actions.

Entering the construction phase, ecological risks are mainly reflected in five aspects. First of all, there is the risk of habitat destruction and soil erosion. Activities such as site clearing, foundation excavation, and road construction may damage vegetation structures, leading to soil erosion and habitat fragmentation. Secondly, noise and vibration generated by construction machinery may disturb wildlife behavior. Thirdly, if wastewater, dust, and solid waste are not properly managed, they may contaminate surrounding water bodies and soil. Fourth, construction equipment and externally sourced materials may act as carriers for invasive species, increasing the risk of ecological invasion. Finally, if ecological restoration is not carried out promptly after construction, exposed land may face long-term degradation, reducing the recovery capacity of local ecosystems. Therefore, it is recommended that personnel shall be appointed for environmental management during the construction stage, establishing a clear environmental responsibility system, and designating responsible persons for environmental protection at each construction step.

During the operational stage, large-scale panel arrays may block wildlife migration routes if sufficient ecological space are not reserved, thereby intensifying habitat fragmentation. Continuous low-frequency noise generated by equipment may, over time, affect wildlife behavior patterns. If improper cleaning agents are used during panel washing and no wastewater collection system is installed, water and soil pollution may occur. During a soil and water conservation inspection conducted by the Songyang County Water Resources Bureau, it was found that the owner of a PV project had failed to complete rectification within the required time limit. The project site showed serious deficiencies in soil and water conservation measures, extensive vegetation damage, significant soil erosion and impaired ecosystem service functions. In addition, under extreme weather conditions, damaged panels that are not promptly repaired or properly disposed of may also pose potential environmental risks.

The decommissioning stage should likewise not be overlooked. PV power stations typically operate for more than twenty years. When entering the dismantling phase, large-scale machinery operations, if not planned and managed well, may cause secondary disturbance to ecosystems that have already begun to recover. If dismantling

and transportation processes are not properly regulated, pollutants may be exposed and carried by rainfall into soil and groundwater, resulting in long-term contamination. This may threaten the survival of nearby birds, small mammals, and aquatic species. Furthermore, if landform reshaping and systematic ecological restoration are not conducted after decommissioning, natural vegetation succession and the recovery of soil ecological functions may be hindered, further affecting soil microbial communities and plant growth.

Overall, Chinese PV industry has entered a stage of high-quality development, and the tension between project expansion and ecological protection has become increasingly evident. There is an urgent need to establish a biodiversity risk prevention and control system that covers the entire life cycle of PV projects, starting from early-stage design concepts and compliance management frameworks. In this regard, Green Jiangnan offers recommendations from multiple perspectives: Firstly, from the perspective of strengthening life-cycle risk management within industry enterprises, companies are encouraged to enhance their awareness of biodiversity conservation and adopt sustainable development strategies. This includes integrating stricter biodiversity protection measures into corporate compliance management systems. For enterprises with legacy compliance issues in existing projects, it is advisable to establish mechanisms for ecological risk assessment and rectification of historical projects. Second, at the national regulatory level, authorities should refine the criteria for recognizing integrated PV projects and require projects that fail to achieve genuine synergy, such as Agrophotovoltaics or pastoral-PV models, to undergo rectification within a specified time frame or exit the market. Prudential access control should be implemented in ecologically sensitive areas. Even outside officially designated ecological redline zones, baseline biodiversity surveys should be conducted and differentiated development controls applied. Finally, from the perspective of industry self-regulation, it is recommended to establish decommissioning reserves and emergency funds, and to require project operators to assume long-term responsibility for ecological restoration and pollution prevention.

In conclusion, only by embedding biodiversity protection into the institutional foundation of PV development, and by applying a rule-of-law approach throughout the entire process, from planning and construction to operation and decommissioning, can we truly achieve harmonious coexistence between clean energy and natural ecosystems, and contribute a distinctly Chinese model of ecological governance to the global renewable energy transition.