Proceedings of CONF-MCEE 2026 Symposium: Advances in Sustainable Aviation and Aerospace Vehicle Automation
DOI: 10.54254/2755-2721/2026.KA29712

Construction of Environmental Impact Assessment System for Offshore Wind Power Projects

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Abstract. As the installed capacity of new energy sources in our country exceeds that of thermal power, new energy has become the primary means of ensuring future incremental power supply, with offshore wind power being particularly notable due to its numerous advantages, thus becoming the focus of new energy development in the future. Nevertheless, the implementation of offshore wind power projects may have ramifications for the marine ecology, hydro-logical dynamics and surrounding communities, from the selection of the site to the commencement of operations. The question that arises is how to strike a balance between the two. The construction of a scientific and systematic environmental impact assessment system has become the core proposition for the sustainable development of offshore wind power. The present paper is divided into three chapters, the first of which provides a concise overview of the current development background of offshore wind power projects. The second chapter analyses the relevant foreign systems, and the third and final chapter plans to build a set of feasible and practical visualization models. Firstly, the development process of offshore wind power projects in China is described, and the existing environmental problems are analyzed. The following section summarizes the successful experiences of mature environmental impact review systems in the United States and elsewhere. The paper then integrates the relevant provisions of the existing offshore wind power project environmental impact assessment in our country, and proposes an offshore wind power project environmental impact assessment system that truly conforms to our country's characteristics.

Keywords: Environmental impact assessment, Offshore wind power, Pressure-State-Response; Environmental-Social-Governance

1. Development history and environmental problems of offshore wind power in China

1.1. Developments

As asserted by the China Wind Energy Association and the World Wide Fund for Nature, the offshore wind energy reserves of China are located within 100 kilometers of the coast and 100 meters in height, with wind speeds that exceed 7 meters per second [1]. The average annual potential generating capacity of these reserves is estimated to be 110*1012 kw. Nevertheless, the development

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of offshore wind power in our country is relatively underdeveloped. After the 16th National Congress of the Party, the country increased its support for the wind power industry, leading to a significant expansion in the development of wind power on a large scale.

As reported by the National Energy Administration, China's wind energy capacity increased by 79.82 gigawatts in 2024, representing a 6% annual growth rate [2]. This expansion encompasses 75.79 gigawatts of onshore wind and 4.04 gigawatts of offshore wind power.

On 9 February 2025, the National Development and Reform Commission and the National Energy Administration jointly issued a notice on deepening the marketization reform of the on-grid electricity price of new energy and promoting the high-quality development of new energy. This move was intended to clarify the path of comprehensive market-oriented reform of new energy feed-in tariffs, thereby marking the transition from a 'policy-driven' to a 'market-driven' approach.

The primary challenge confronting renewable energy is anticipated to be the transition to a market-based electricity pricing structure, as subsidies are projected to decline and internal revenue is expected to decrease. In the future, the energy sector is expected to experience heightened levels of competition. Offshore wind power, however, is poised to emerge as a distinct and prominent energy source due to its abundance of resources, consistent wind speed, minimal environmental impact, distance from the coast, low noise and visual disturbance, substantial stand-alone capacity, high annual utilization hours, and the absence of land occupation. These attributes position offshore wind power as a pivotal catalyst for the advancement of new energy technologies, both nationally and globally.

1.2. Environmental issues

Compared with onshore wind power, offshore wind power has less impact on the environment, and large-scale projects will inevitably have a certain impact on the biological ecology and hydrogeological conditions of the engineering sea area.

From a biological and ecological point of view, the first two problems are migratory birds and marine fishery resources. In terms of migratory birds, one is the possible destruction of bird habitats on shallow tidal flats, which is gradually being solved with the development of offshore wind power projects like deep sea areas; the other is the operation of wind turbines, including the disturbance of leaf movement and noise to birds. From the perspective of hydrogeology, it is faced with two major challenges: natural landscape and electromagnetic radiation. In terms of natural landscape, as a new planning content, offshore wind power projects have formed a special landscape in some areas. However, in Europe, where it has developed for a long time, a large number of individuals and groups have argued that its extensive construction has destroyed the character of different sea areas and resulted in a similar landscape. In terms of electromagnetic radiation, the radiation of wind farms mainly comes from generators, motors, substations and transmission lines. At present, most of the projects under development are through strict restrictions on wind turbine design standards and laying multi-conductor cable systems under the sea, to prevent the generation of a strong magnetic field to overcome this problem.

The Environmental Impact Assessment System is the last line of defence for environmental protection, and reviewing these issues before offshore wind projects are built is undoubtedly an important solution to reducing environmental pollution, how to build a mature and feasible environmental review mechanism to ensure the clean and safe development of offshore wind power has become the focus of academic attention.

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2. New energy environmental impact assessment system outside Hong Kong

The UK is committed to the sustainability of its power system and aims to meet its more ambitious 2050 carbon reduction commitments through the use of renewable energy in the power system [3]. As a traditional powerhouse, the UK had 16.9 GW of offshore wind capacity at 2024, or 16% of its total, and plans to expand to 50 GW by 2030, it accounts for 41 per cent of Europe's offshore wind capacity and 19 per cent of the world's. And the newly established contracts for difference, and in the project management has established a complete set of review process, especially in the core of environmental law.

2.1. Legal system

The UK has Environmental impact Assessment legislation covering the Environmental aspects of Offshore wind power. The Infrastructure Planning Act 2009 sets out an environmental impact assessment (EIA -RRB - process, which is the result of translating EUeEIA eia directive iUKo UK domestic law. Section 25 of the Offshore Marine Conservation Regulations 2007 provides for Habitat Regulation Assessment or Appropriate Assessment, the offshore Marine Conservation Regulation 2007 is also the result of the domestication of the EU habitat protection directive and the Wild Birds Protection Directive. It stipulates that the authority, when granting a permit for marine works, must take appropriate measures to assess the possible impact of marine works on nature reserves established by the European Union. This assessment is known as the assessment of habitat regulations. Environmental Impact Assessment and habitat regulation assessment are important environmental legal documents for offshore wind power project permit application. The regulation on Environmental Assessment of Plans and programs 2004 sets out a system for Strategic Environmental Assessment of plans and projects to be undertaken in specific energy sectors, environmental interventions such as offshore wind power in the early stages of planning [4].

“Marine Coastal Zone access law 2009”, “Planning Act 2008”, “Marine policy statement” and the regional “Marine planning” under their framework are the main legal basis for the authority to grant or refuse permission for offshore wind power projects, these include a host of environmental considerations, such as noise, electromagnetic interference, bird and fish populations, the ecology of the ocean floor, sediments, and ocean landscape vision. These regulations constitute the UK offshore wind power environmental review management allocation, assessment procedures and review basis.

2.2. Department of audit

In the UK, the Department for Commerce, Energy and Industrial Strategy (DECIS) is the main authority on offshore wind regulation, but it is delegated to marine management bodies and the Planning Inspectorate [5].

MSO is a Non-Departmental Public Body established under the Marine Coastal Zone Access Act 2009, with licensing powers for ocean affairs granted by the relevant minister, any construction or landfilling of an offshore power plant requires a Deemed Marine License. The Planning Inspectorate is an executive body set up with support from the Department for Community and Local Government and the Welsh Government. The Localism Act 2012 amended the Planning Act 2008 to enable the Planning Inspectorate to Review National Priority Projects for development permits under the Planning Act 2008.

The Department of Energy and Climate Change began in 2000 to conduct an environmental review of the draft licensing scheme for the energy sector, a process known as a strategic

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environmental assessment. It started with gas and oil but has since expanded to offshore wind, tidal power and carbon storage. Since 2016, the Department of Energy and Climate Change and the Department of Commerce, Innovation and skills have been merged to form the Department of Commerce, Energy and industrial strategy, the Ministry of Commerce, Energy and Industrial Strategy is therefore responsible for the strategic environmental assessment of the proposed licensing scheme in the energy sector mentioned above. The Ministry of Commerce, Energy and Industrial Strategy is the main authority on offshore wind power, and both the Maritime Organization and the Planning Inspectorate have mandates to manage offshore wind power.

3. Environmental impact assessment system of offshore wind power in our country

3.1. Influence index system of offshore wind power project evaluation based on P-S-R model

The PSR model is a causal chain-based system analysis framework widely used in environmental science, ecological management and sustainable development [6]. By analyzing the current situation and changes of ecological environment and resources, this model can trace back the causes of their changes, so as to grasp the occurrence and development of environmental problems as a whole, and can effectively reflect the mutual feedback mechanism between various evaluation indicators.

In the construction environmental impact assessment of offshore wind power projects based on the PSR model, the calculation order of index weight in the criterion layer is state, pressure and response. The state index directly reflects the results of environmental impact, is the direct embodiment of environmental change, and is also the final yardstick for evaluating the impact of construction, so the weight accounts for the largest proportion. The pressure index is the key to the control of pollution sources and the driving factor of environmental degradation, which reflects the load imposed by offshore wind power projects on the marine environment, and the weight ratio is lower than the state index. The response index reflects the measures taken by human beings to mitigate or adapt to the environmental impact, and the effect of the measures is lagging behind. The effect of the response measures needs to be indirectly reflected through the state index, and the weight proportion is the smallest.

The state layer includes water body, sediment, marine biological community status and bird ecological status, etc. . The marine biological community is the premise of other indicators, which is related to the biodiversity of the seabed and the self-restoration ability of the environment, the weight proportion is the highest, and the ecological status of birds is low because only the migration period will be affected, and the migration route is difficult to confirm. In the pressure layer, the environmental target avoidance rate has the highest weight, such as coral reefs, large fishing grounds, and important environmental protection areas. Once violated, the project will be fundamentally unfeasible, however, the weight of indicators such as waste sewage treatment and air pollution prevention and control is relatively low, because they can be improved through standardized operation, technical improvement and other ways, that is, the important factors in the response layer can be improved and calculated comprehensively.

3.2. The construction of legal system

3.2.1. Existing laws

The environmental impact assessment work of our country's offshore wind power project, it is mainly based on the Environment in the People's Republic of China Protection Law, the Marine

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Environmental Protection Law of the People's Republic of China, the Environment in the People's Republic of China Impact Assessment Law, the regulations on the prevention and control of pollution and damage to the marine environment from marine engineering construction projects, the regulations on the environmental protection management of construction projects, the technical guidelines for Marine Engineering Environmental Impact Assessment, and the technical specifications for Environmental Impact Assessment of offshore wind power projects [7].

According to the technical code for Offshore Wind Power Environmental Impact Assessment and the technical guidelines for offshore wind power environmental impact assessment, the environmental impact assessment for offshore wind power projects shall include the following: Marine water quality environment; second, marine sediment environment, including sediment disturbance, sediment quality changes, etc. ; third, marine biological ecology; fourthly, bird ecology; fifthly, marine hydrological and dynamic environment, sixth, marine topography and environment of erosion and deposition: evaluate the impact of the project construction and operation on the marine topography and environment of erosion and deposition. Seventh, the acoustic environment, including the construction period and operation of the noise source; eighth, the electromagnetic environment, including electromagnetic radiation, electromagnetic interference and so on. Ninth, environmental risks, including natural disasters, equipment failures, accidents and so on. Tenth, landscape and cultural relics, including visual impact, cultural impact and so on.

In addition, our country participates in the international organization stipulation to the Offshore Wind Power Project Construction also has certain request. The IEC International Electrotechnical Commission emphasizes the impact of electromagnetic (EM) on marine wind power development, and requires project owners to take effective measures to reduce the impact of EM radiation on marine life during project design and operation. Standards such as the IEC technical code for Electromagnetic Environmental Impact Assessment for offshore wind power projects (IEC 61400-21) provide technical guidance on electromagnetic environmental impact assessment for offshore wind power projects, these standards and China's “Electromagnetic environment control limits”(GB 8702) and other national standards echo [8].

Article 192 of the United Nations Convention on the Law of the Sea law of the sea (UNCLOS) , one of the core documents of the international law of the sea, clearly sets out the obligations of coastal states to protect and preserve the marine environment within their Exclusive Economic Zone and continental shelves. Under this provision, coastal states are required to take precautionary measures to avoid pollution or damage to the marine environment when carrying out activities for the exploitation of resources. In addition, articles 205 and 206 of UNCLOS require coastal states to conduct an environmental impact assessment and communicate the results to the international community if planned activities are likely to have a significant impact on the marine environment.

3.2.2. The censorship model

A mature offshore wind environmental impact assessment system should not only comprehensively investigate and evaluate the construction and operation of existing offshore wind farms, but also strengthen the assessment of the impact of offshore wind power on the marine environment, during the construction period, it is necessary to strengthen the evaluation of the environmental quality of the sea area and the environmental impact of wind power construction in the planning and site selection stage of the offshore wind farm, and establish a long-term monitoring mechanism during the operation and maintenance period of the project, timely restoration and compensation of ecological damage and environmental pollution caused by offshore wind power development.

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According to the above analysis results, the environmental impact assessment system of offshore wind power projects in our country can be divided into five main stages for systematic review.

The first stage is a pre-procedure, in which the competent authority can use a systematic analysis framework, including the PSR model, combined with accurate sea area data, to regularly and clearly issue construction standards for targeted sea area projects, while the developer submits the application for development permit to the regulatory authorities, the regulatory authorities should also arrange consultation meetings on its application. As offshore wind power projects are large-scale projects that affect people's livelihoods, making public the results of the environmental impact assessment is a necessary step. In advance, developers can be required to release preliminary environmental information to the public, it can not only save the time cost of the follow-up formula, but also monitor the link in advance to ensure that stakeholders fully investigate and listen to public opinions.

The second stage is the pre-examination stage, in which the regulatory authority is mainly responsible for the formal review of the qualification documents submitted by developers, such as whether to provide complete and necessary information in accordance with the prescribed format and content; Members of the public may submit written comments to the competent authorities and are entitled to participate in hearings at the review stage.

The third stage is the review stage, which should be the longest stage in the whole process. The Competent Department should establish a review team according to the project situation and organize and carry out hearings. In addition, the review team may conduct site visits to the project site or select non-interested professionals to provide written advice to prevent fraud or technical errors from the EIA body.

The fourth stage is the decision-making stage, the review team should review the stage formed by all the views and conclusions of the review, by the responsible department within the specified time to make a decision.

The fifth stage is the litigation stage, after the competent authority has made a decision on the application project, a reasonable period of time should still be reserved for environmental protection organizations and stakeholders to file lawsuits and take judicial remedies. This type of preventive environmental litigation is different from the current “Harm first, Sue later” model, the aim is to prevent huge economic losses and irreversible potential environmental pollution once large-scale offshore wind power projects are suspended.

4. Conclusion

Offshore wind power is key to China’s sustainable energy transition due to its vast resources and lower environmental impact than onshore options. However, challenges persist, notably environmental risks to marine ecosystems and local communities. This paper highlights the necessity of a tailored, scientific environmental impact assessment (EIA) system for China’s offshore wind projects. By examining domestic development, legal frameworks, and the UK’s advanced EIA practices, we propose a framework integrating the Pressure-State-Response (P-S-R) model and international standards. The system includes five stages: pre-procedure, pre-examination, review, decision-making, and litigation, ensuring rigorous, transparent evaluation. Through stakeholder involvement and long-term monitoring, it balances offshore wind expansion with marine conservation, supporting clean, safe growth. In conclusion, a robust EIA system is critical for China’s offshore wind sector to thrive sustainably while reducing ecological harm.

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References

[1] Feng Zeshen, Zhao Zenghai, Guo Yanheng, Ai Lin, Qiu Chen: "The Current Status and Prospects of China's Wind Power Development in 2021", published in Hydropower, Vol. 48, No.10, pp. 1-8.
[2] National Energy Administration: Renewable Energy Grid Operation in 2024, January 27, 2025, https: //www.nea.gov.cn.
[3] The figures come from the Department for Energy Security and Net Zero Emissions (DESNZ)'s latest energy trends report.
[4] The renewable energy quota system was closed to offshore wind projects in 2017.
[5] Zhou Chang and Li Huapei: Environmental Review Mechanism of Offshore Wind Power in the UK, published in Proceedings of the 2017 National Symposium on Environmental and Resource Law.
[6] Wang D, Li Y, Yang X: Evaluating urban ecological civilization and its obstacle factors based on integrated model of PSR-EVW-TOPSIS: A case study of 13 cities in Jiangsu Province, China, Ecological Indicators, 2021, 133: 1-15.
[7] Yang Haitao, Xu Wei, Si Geyang: Environmental Impact Assessment Index System and Model Construction during Offshore Wind Power Construction Period, Journal of Tianjin University of Technology, July 23, 2025.
[8] Wu Shanshan, Wang Shuang, Peng Hongbing, Li Feng: "Development Ideas and Countermeasures for China's Offshore Wind Power Industry", Economic Horizons, No.1, 2017, pp. 68-73.