The Asian Infrastructure Investment Bank's Role in Promoting Sustainable Hydropower Projects: A Comparative Analysis of the Mangdechhu and Punatsangchhu-I Projects

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Abstract. This study compares the Asian Infrastructure Investment Bank (AIIB)-led Mangdechhu Hydroelectric Project with the World Bank-supported Punatsangchhu-I Hydroelectric Project. By comparing the approval and implementation process, multilateral and regional cooperation, sustainable development factors, and challenges and coping strategies of these two hydropower projects, it is concluded that AIIB has a clear advantage in promoting sustainable energy projects. AIIB has demonstrated an efficient project approval and implementation process, as well as close multilateral and regional partnerships. In addition, AIIB has systematically focused on the environmental, social and economic impacts of the project, so that sustainable development can be balanced in the progress of energy projects. However, the agency's pressing issues include technical difficulties, environmental protection, and population resettlement. In order to meet these challenges, AIIB needs to strengthen the learning of experience, optimize the project strategy, and expand the scope of cooperation. The findings of this study have guiding value for policymakers and academia. In future energy cooperation and investment, governments, multilateral development banks and relevant institutions should learn from the practical experience of AIIB and formulate more effective and targeted policies and plans. By tackling challenges together, we will contribute to solving global energy problems and promoting sustainable development.

Keywords: Asian Infrastructure Investment Bank, Sustainable Development, Mangdechhu Project, Punatsangchhu-I Project.

1. Introduction

The core questions of this study focus on are the role of the Asian Infrastructure Investment Bank (AIIB) in promoting sustainable energy development, and the practices and challenges faced in this process. Through the analysis of the energy development projects supported by AIIB, this article will deeply explore the characteristics of sustainable energy investment strategies, project implementation and evaluation, investment strategies and challenges in line with sustainable development goals. This will contribute to a better understanding of AIIB's effectiveness and problems in promoting sustainable energy development, and provide a reference for other multilateral or bilateral development agencies to invest in the energy sector.

Existing studies have shown that hydropower projects have significant environmental advantages as a renewable energy source. Many scholars believe that hydropower projects are an effective way to reduce dependence on fossil fuels and reduce greenhouse gas emissions [1, 2]. At the same time, the successful implementation of hydropower projects can improve energy security and support regional integration and cooperation [3, 4].

In this article, we will take the AIIB-supported Mangdechhu Hydroelectric Project (Bhutan) as an example to provide an in-depth analysis of its role in sustainable energy development. To further demonstrate the strengths of AIIB in energy project enablement, this article compares another World Bank-backed 1200 MW Punatsangchhu-I Hydroelectric Project (PIP, Bhutan). Building on the experience of other multilateral development banks, such as the World Bank, in promoting sustainable energy projects, this article will delve into the similarities and differences between AIIB and other multilateral development banks in promoting hydropower projects [5, 6].

Humphreys and Liu's research point to the efficiency of AIIB's project approval and execution process as one of its significant advantages in facilitating such projects. Therefore, this article will focus on how AIIB can promote the rapid development of hydropower projects by improving the efficiency of project approval and execution [7, 8]. At the same time, this study will also analyze how AIIB can leverage its strengths in multilateral and regional cooperation to achieve inter-regional linkages and sharing of resources, experiences and technologies [9, 10]. Finally, this article will focus on the challenges facing current sustainable energy investment strategies and the measures taken by AIIB and other multilateral development banks to address these issues to provide guidance for achieving the SDGs in the future [11, 12].

This study will provide valuable experience and enlightenment for academics and policymakers, and governments, multilateral development banks and relevant institutions should focus on drawing on the practical experience of AIIB to formulate more targeted policies and plans in future energy cooperation and investment. In addition, the role of AIIB and other multilateral development banks in sustainable energy projects needs to be further studied by the academic community in order to provide more precise policy recommendations and decision-making guidance.

In addition, future research needs to explore the social responsibility of AIIB in sustainable energy projects and its impact on the countries and regions involved. This study focuses on the role of AIIB at the project level, and its contribution to the operational mechanism, national strategy, and regional master planning can be further studied in the future. Such expansion will help to identify new strengths and further achieve sustainable global energy development by improving the core competencies of multilateral development banks. At the same time, in practice, it is necessary to pay attention to the implementation of corporate social responsibility, and pay attention to the impact of the project on the employment, life and health of local residents, so as to ensure the harmony and unity of energy construction and sustainable social development.

Combined with the comparative analysis of the Mangdechhu case and the PIP case, this study finds that AIIB has obvious advantages in promoting hydropower projects. These advantages can help it stand out from international competition and provide strong support for the development of global sustainable energy and green economy. However, academics and policymakers should remain vigilant and identify, solve and respond to potential challenges in a timely manner in the process of fully drawing on and summarizing these advantages, so as to ensure the successful implementation of sustainable energy projects and make greater contributions to global sustainable development.

2. Mangdechhu Hydroelectric Project

The Mangdechhu Hydroelectric Project is a large-scale hydropower project located in Bhutan with an installed capacity of 720 MW. The project is located on the Mangdechhu River in the Trongsa region. The total investment is about US$1.3 billion, mainly supported by government subscriptions, the Asian Infrastructure Investment Bank (AIIB) and other multilateral development banks. The project was launched in 2010 and officially put into operation in 2019.

The Mangdechhu hydropower plant transmits electricity to India via cross-border transmission lines, giving a strong impetus to energy interaction and regional integration. The project will reduce the dependence on fossil fuels for energy imports, reduce greenhouse gas emissions, and improve energy security. At the same time, the construction of hydropower stations and the transmission of electricity generate revenues, which contribute to Bhutan's domestic economic growth. During the construction of the project, a large number of jobs will be provided for the two regions, of which about 20,000 people will be employed.

In the process of implementation, the Mangdechhu project has been supported by AIIB loans, government grants and other relevant institutions. This funding structure helps to reduce financing costs and increase the financing flexibility of projects. In addition, AIIB provides technical support and human resources for the project by strengthening cooperation with other relevant institutions,

local governments, etc. This will facilitate cross-border cooperation and policy collaboration to jointly promote regional sustainable energy development strategies.

However, there are many challenges in the process of the project, especially in terms of environmental protection and population relocation. In response to these challenges, AIIB has taken a number of measures. First of all, at the technical level, the project adopts new environmental protection technologies and designs, which brings a lower scale of reservoir construction and a smaller ecological impact. Secondly, in terms of ecology, the habitats of animals and plants around the reservoir should be restored and restored, and ecological channels should be set up to ensure the stability of the ecological environment in the reservoir area. In addition, in terms of population resettlement, the relevant initiators provide appropriate compensation for the migrants involved in the project, and pay full attention to the resettlement issues of migrants' life and employment. At the same time, in order to strengthen the continuous monitoring procedures to protect the ecological environment of the reservoir, the relevant initiators have set up a management committee dedicated to environmental protection.

3. Punatsangchhu-I Hydroelectric Project

The Punatsangchhu-I Hydroelectric Project (PIP) is another major hydropower project located in Bhutan with an installed capacity of 1200 MW. The project is located in the Punatsangchhu River basin on Bhutan's border with India, with a total investment of about US$1.5 billion. The project is mainly funded by the World Bank, the National Hydropower Corporation of India and the Government of Bhutan. The project was launched in 2008, but the construction process has been postponed several times due to technical difficulties and geological conditions.

Similar to the Mangdechhu Project, the PIP Hydropower Project also delivers electricity to India to provide clean energy. The project will help reduce the region's dependence on fossil fuels, slow greenhouse gas emissions, and increase the security of energy supply. At the same time, the project is expected to create a large number of jobs for Bhutan, and boost its fiscal revenue and economic development.

However, PIP hydropower projects also face many challenges during implementation. First of all, the geological conditions of the project are complex and the construction is difficult. In order to cope with this problem, the project executor introduced advanced technology, strengthened geological exploration, and continuously adjusted the plan to the site conditions during the construction process. Second, climate change causes fluctuations in water flows, which in turn affect hydropower generation. Meteorological and hydrological data analysis and climate model forecasting were used to predict water flow fluctuations and optimize design options. In addition, the Punatsangchhu-I project faces challenges of environmental protection and social responsibility. In order to ensure the sustainability of the project, a series of environmental protection measures have been adopted, such as ecological environment monitoring, soil and water conservation, wildlife habitat protection and planting compensation.

Despite this, the progress of the PIP project has been delayed and delayed several times. This contrasts with the Mangdechhu project and reveals the limitations of the World Bank and other multilateral development institutions in terms of project facilitation. This is mainly reflected in the low efficiency of the project approval and implementation process, as well as the need to improve the resilience to geological, technical and environmental challenges.

4. Comparison

This section will compare and analyze the Mangdechhu Hydroelectric Project and the Punatsangchhu-I Hydroelectric Project from various perspectives to highlight the similarities and differences between AIIB and other multilateral development banks in promoting hydropower projects.

4.1. Project Approval and Execution Efficiency

The Mangdechhu Project demonstrated high efficiency in the approval and execution process. This is due to AIIB's unique operating model, which allows it to quickly mobilize funds and simplify procedures when projects are approved. In addition, AIIB has demonstrated strong supervision capabilities during the implementation of the project, so as to effectively ensure the progress and quality of the project. In contrast, the World Bank-supported PIP Hydropower Project is subject to the World Bank's cumbersome system in the approval and implementation process, and the progress is significantly delayed. As a result, AIIB's efficiency in advancing the project reflects one of its advantages over other multilateral development banks.

4.2. Multilateral and Regional Cooperation

AIIB has demonstrated close cooperation with multilateral and regional partners in promoting the Mangdechhu Hydropower Project. Taking the Mangdechhu project as an example, AIIB not only cooperated with the Bhutanese government, but also took the lead in establishing cooperative relations with local institutions such as India to jointly provide financial support for the project. This deepening of multilateral and regional cooperation will help foster a sound political and economic atmosphere, promote inter-regional communication, resource sharing, mutual learning of experience and technology transfer, and promote the sustainable development of the region as a whole.

In contrast, in the PIP project, the World Bank's interaction with the project team is more traditional, focusing on financial support and regulatory interaction. Although the World Bank has provided financial support and technical guidance for the project, the penetration of cooperation with regional stakeholders is relatively limited, and the advantages of international cooperation and coordinated development have not been fully utilized.

4.3. Project Sustainability Factors

In the process of advancing hydropower projects, AIIB pays more attention to the comprehensive consideration of the environmental, social and economic impacts of the projects, aiming to achieve the sustainable development goals. Taking the Mangdechhu project as an example, AIIB adopted innovative environmental protection technologies during the project implementation phase to minimize the project's impact on the ecological environment. In addition, the AIIB has formed a dedicated management committee for ongoing environmental monitoring procedures aimed at protecting the reservoir ecosystem. On a broader level, from the preparation to the implementation stage, AIIB fully considers various factors such as environmental protection, ecosystem balance, and social well-being in all aspects. These factors minimize the potential negative impacts as the project progresses.

In contrast, the World Bank is also very concerned about the sustainable development of its projects. In the PIP hydropower project, the World Bank provided a rigorous environmental and social impact assessment to ensure that the project adheres to sustainable development principles. However, compared with AIIB, the World Bank may not have fully utilized its environmental, ecological and social influence in the actual implementation process. These differences show that AIIB is unique from other multilateral development banks in its focus on sustainable development factors.

4.4. Challenges and Responses

Although AIIB has many advantages in promoting hydropower projects, it still faces some challenges in practice, such as technical difficulties, environmental protection, population resettlement, water resources management and other issues. In response to these challenges, AIIB has taken practical measures to address them. Taking the Mangdechhu project as an example, in terms of technical problems, AIIB introduced new technologies and adjusted the project design to solve them, in terms of environmental protection, through innovative environmental protection technologies and restoration of ecological facilities to achieve sustainable development of the project, and in terms of

population resettlement, it mitigated the impact of the project on the regional society through appropriate compensation measures. In terms of water resource management, AIIB pays special attention to the impact of climate change on water resources, and applies relevant data analysis and model prediction techniques to make projects more adaptable.

In addition, AIIB is constantly learning from the experience of other multilateral development banks, learning lessons and further improving its capabilities in the process of promoting energy projects. These initiatives are important to address the challenges of current sustainable energy investment strategies and help provide more effective guidance for achieving the Sustainable Development Goals in the future.

At the same time, the World Bank has demonstrated relatively strong resilience in addressing challenges such as the PIP hydropower project. In terms of technical challenges, the World Bank provided technical support and consulting services to help the project achieve breakthroughs in complex geological conditions. In terms of environmental protection, the World Bank requires projects to conduct a detailed assessment of ecological and environmental risks to ensure sustainable management. In the area of climate change and water management, the World Bank is also concerned about the impact of climate factors and is driving progress in climate adaptation and adaptation.

4.5. Financing Structure and Risk Management

In the process of promoting hydropower projects, AIIB and the World Bank also show different characteristics in terms of financing structure and risk management.

For the Mangdechhu project, AIIB adopted a blended financing model, with financial support from the government, the Asian Infrastructure Investment Bank, and other multilateral development banks. This financing structure helps to reduce the cost of financing and increase the financing flexibility of the project. At the same time, by strengthening cooperation with other relevant institutions and local governments, AIIB can effectively identify and manage potential risks. For example, for the Mangdechhu project, AIIB actively carried out geological exploration and design optimization through its partners to minimize and respond to potential geological risks.

However, in the case of the PIP Hydropower Project, the World Bank has supported the construction of the project mainly through loans. Although this model provides security in terms of funding, it also reduces the diversity and flexibility of the financing structure to a certain extent. At the same time, the World Bank has taken a more conservative approach to risk management. Although the World Bank has mobilized some financial and technical resources to conduct risk assessment and corresponding planning and design in the PIP project, the World Bank's response strategy to potential risks arising during the implementation of the project is relatively lagging behind.

4.6. Project Delay and Cost Control

Hydropower project delays and cost containment are key criteria for assessing the success of multinational hydropower projects. In this regard, the AIIB and the World Bank also show significant differences.

Taking the Mangdechhu project as an example, although the project started in 2010, it was officially put into operation in 2019, and the whole construction period is relatively tight. AIIB effectively controlled project delays and cost increases by adjusting schedules in a timely manner, introducing new technologies, and strictly monitoring construction quality. This successful experience is further proof of the efficiency of AIIB in the project execution process.

However, in the case of the PIP Hydropower Project, its construction process was repeatedly delayed due to technical difficulties and geological problems. Since its inception in 2008, the project has remained unfinished. While the World Bank has provided financial support and technical assistance to the project, it has been relatively inadequate in dealing with delays and cost containment. To some extent, this exposes the World Bank's limitations in project schedule control and cost management when promoting large-scale hydropower projects.

4.7. Post-Project Operation and Maintenance

For hydropower projects, in addition to focusing on the construction process of the project, the later operation and maintenance are also crucial. In this regard, the AIIB and the World Bank also present different characteristics.

In the promotion of the Mangdechhu project, AIIB not only paid attention to the project construction, but also fully considered the operation and maintenance work in the later stage of the project. AIIB has laid the foundation for later operation and maintenance by introducing technology, setting up monitoring systems, providing training, and other measures. After the completion of the project, it will be put into operation, which will have a positive impact on the regional power cooperation and development between Bhutan and India.

In the PIP Hydropower Project, although the World Bank also considered the post-operation and maintenance issues at the project initiation stage, the actual effect of the post-operation and maintenance has yet to be verified and evaluated due to the repeated delays in the construction process of the project. This also reveals that the balance between the World Bank's promotion of such projects and the operation and maintenance needs to be further optimized.

By analyzing the comparison of these seven aspects, we can see the similarities and differences between AIIB and the World Bank in promoting hydropower projects. Overall, AIIB has demonstrated its unique advantages in terms of project approval and implementation efficiency, deepening multilateral and regional cooperation, sustainable project development, financing structure and risk management, project extension and cost control, and post-operation and maintenance. These advantages will help AIIB better promote sustainable energy projects and provide strong support for global sustainable energy development and green economy development.

In contrast, the World Bank has some experience in promoting hydropower projects, but it is lagging behind in these areas. However, in dealing with natural risks such as technical difficulties and geological problems, the World Bank has relied on its extensive experience and technical expertise to provide important support for the construction of the project. This also provides AIIB with lessons to learn from.

In the future of energy cooperation and investment, governments, multilateral development banks and relevant institutions should learn from the achievements and shortcomings of AIIB and the World Bank, and formulate more targeted and effective policies and plans to fundamentally address the challenges faced in the process of promoting sustainable energy projects. This will give rise to sustainable energy development and international cooperation, which will play a vital role in addressing global energy and climate challenges.

5. Conclusion

This study compares the role and practice of AIIB in the Mangdechhu Hydroelectric Project and the World Bank-supported Punatsangchhu-I Hydroelectric Project. After in-depth discussions, it can be concluded that AIIB has clear advantages in promoting hydropower projects and achieving sustainable energy development. AIIB has demonstrated high efficiency in the project approval and execution process, which helps to improve the speed of the project. At the same time, the agency demonstrates a comprehensive consideration of environmental, social and economic impacts in practice, taking into account sustainable development factors in the promotion of energy projects. In addition, AIIB maintains close cooperation with multilateral and regional partners, which helps to strengthen international trade, financial investment and technical cooperation, and support the sustainable development of the entire region.

However, AIIB still faces some challenges in the process of promoting sustainable energy development, such as technical difficulties, environmental protection, and population resettlement. In order to solve these problems, AIIB needs to further summarize lessons learned, strengthen cooperation and exchanges with all parties, and strive to optimize project implementation strategies. Academics and policymakers can draw useful insights from research to better support sustainable

development in the energy sector. In future energy cooperation and investment, governments, multilateral development banks and relevant institutions should learn from the successful practices of AIIB, formulate more effective and targeted policies and plans, jointly overcome challenges, and contribute more to solving global energy problems and achieving sustainable development.

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