

**QUESTIONING WHAT HAS
ALREADY BEEN DECIDED:
A Critical Examination
of the Environmental Impact
Assessment (EIA/AMDAL) Process
for Batam's Floating Solar Project**



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**Transparency Internasional Indonesia
September 2026**

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Page Size : 20 x 28 cm
Amount of Pages : cover + vi + 100 Halaman
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Editor : Bagus Pradana
Design & Layout : Taqi

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Supported by:



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This publication was published with funding assistance from the Waverley St Foundation under Transparency International's Climate Governance Integrity Program (CGIP). The content of this publication is the responsibility of Transparency International Indonesia and does not necessarily reflect the views of the Waverley St Foundation.

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FOREWORD

The transition to renewable energy has become an important part of efforts to reduce emissions while promoting more sustainable economic growth. Yet amid the many expectations attached to the energy transition, one question must not be overlooked: is the development of cleaner energy also being pursued through a just process?

This question is one of the foundations of this study, which traces the development process of floating solar photovoltaic (PV) projects at the Duriangkang and Tembesi Reservoirs in Batam. Both reservoirs play an important role in meeting Batam's water needs and sustaining the lives of its communities. They are now also part of renewable energy development plans linked to investment interests and electricity-trading cooperation between Indonesia and Singapore.

The floating solar PV projects illustrate how a single space can serve multiple functions and interests at once. On the one hand, reservoirs are seen as potential sites for generating clean energy. On the other, they are part of water-supply and environmental systems whose sustainability must be safeguarded. These two interests need not be mutually contradictory, but they require a decision-making process capable of balancing them.

Through a review of policy documents, particularly an analysis of the Environmental Impact Assessment (AMDAL/EIA) documents, together with field research at Duriangkang and Tembesi, this study seeks to understand how decisions on the development of floating solar PV at the two reservoirs were shaped. Particular attention is given to the extent to which environmental considerations, community interests, and development alternatives were given space in the decision-making process, especially before the project locations, capacities, and designs were determined.

The study finds that the principal issue in the development of Batam's floating solar PV projects is not an absence of policy or environmental management instruments. Rather, it lies in vulnerabilities to conflicts of interest and the risk of regulatory capture, particularly when investment commitments and project-development decisions are formed before a comprehensive environmental assessment is undertaken. These risks require attention so that EIA does not shift into merely a document that justifies development decisions, but remains an instrument capable of testing, correcting, and influencing the direction of a project.

The findings in this study are not intended to set renewable energy development against environmental protection. On the contrary, the study proceeds from the view that the two must advance together. Cleaner energy is essential for the future, but the way it is achieved must also reflect the principles of sustainability, openness, and justice.

We hope this study can provide useful input for BP Batam, government agencies, developers, environmental authorities, and other parties involved in renewable energy development. Ultimately, the energy transition is not only about replacing the sources of energy we use; it is also about improving the way development is planned and carried out.

Jakarta, September 2026

Research Team
Transparency International Indonesia



CHAPTER I. INTRODUCTION

1.1. Background

"In nature nothing exists alone."

Rachel Carson, Silent Spring (1962).

More than six decades ago, Rachel Carson reminded us that human life and nature are never truly separate. What humans do to nature ultimately shapes the future of human life itself. This message is increasingly relevant amid the climate crisis, which is changing how the world understands development, including how energy is produced, traded, and used.

Over the past decade, the discourse on energy transition has evolved from a narrow emissions-reduction agenda into an economic development strategy that shapes investment, international trade, and national competitiveness. Renewable energy is no longer positioned merely as an alternative energy source; it has moved beyond being an alternative to become a foundation for green growth and low-carbon industry. One consequence of this shift is the expansion of cross-border electricity trade, which has become part of energy-integration strategies in many regions.

In Southeast Asia, Indonesia has sought to keep pace with this transformation in outlook. Commitments to achieve Net Zero Emissions, increase the share of new and renewable energy, and implement national policies such as the National Energy General Plan (RUEN), the Electricity Supply Business Plan (RUPTL), and the Just Energy Transition Partnership (JETP) mark a shift in Indonesia's development trajectory toward a purportedly low-carbon energy system. At the same time, energy cooperation between Indonesia and Singapore reflects a broader reorientation of energy policy. Renewable energy is now positioned as part of a green-economy development strategy in Southeast Asia, with the potential to drive investment and open opportunities for cross-border electricity trade, even as domestic energy security continues to face significant gaps.

Against this backdrop of expanding regional energy cooperation, Batam has emerged as a highly strategic focal point. As a Free Trade Zone (FTZ) directly adjacent to Singapore, Batam has developed into an internationally oriented business and investment hub. Its geographic proximity to a regional energy hub gives Batam an advantage as a priority location for green-energy infrastructure development compared with many other parts of Indonesia.

The direction of energy cooperation in Southeast Asia, particularly cooperation oriented toward renewable energy development projects, has become increasingly concrete alongside recent policy developments. At the Indonesia-Singapore Leaders' Retreat, the two governments agreed to expand renewable energy cooperation as part of strengthening bilateral economic relations. The President of the Republic of Indonesia subsequently appointed the Daya Anagata Nusantara Investment Management Agency (Danantara) to lead implementation of green-electricity trading cooperation with Singapore. To support this plan, Indonesia is to develop solar PV power plants in Batam, Bintan, and Karimun with a total capacity of 3.4 GW to serve electricity exports (Kompas, 2026).

Two infrastructure projects supporting this agenda are the development of floating solar PV projects at the Duriangkang and Tembesi Reservoirs. These two reservoir-based projects in Batam City were also included in Transparency International Indonesia's 2024 research repository as part of its mapping of large-scale solar PV projects in the Riau Islands intended to support the cross-border electricity export programme pursued by the Indonesian government with Singapore through the Energy Market Authority (EMA) since 2023. The research recorded plans for a 720 MW floating solar PV project by PT Adaro Energi Indonesia and a 120 MW project by PT Batam Sarana Surya at Duriangkang Reservoir. At Tembesi Reservoir, plans included a 333 MW floating solar PV project by PT Toba Bara Energi and a 42 MW solar PV project, later confirmed at 46 MW, involving a consortium of PT TBS Energi Utama, PT PLN Batam, and PT PLN Nusantara Power. From an energy-transition perspective, these projects can be presented as part of efforts to decarbonise Batam's power system. Technically, however, they also introduce more complex ecological vulnerabilities because both reservoirs selected for floating solar PV are major raw-water sources for the people of Batam City.

From a broader perspective, the development of floating solar PV to meet electricity-export commitments to Singapore stands in sharp contrast to conditions in several parts of Indonesia that still experience recurring power outages. One recent example was the widespread blackout across Sumatra for two days, from 22 to 23 May 2026, which left large parts of Aceh, North Sumatra, West Sumatra, Riau, and Jambi without electricity (Kompas, 2026). This contrast raises a fundamental question about the direction of policy and who ultimately benefits most from Indonesia's energy-transition agenda. Electricity exports can, in principle, form part of promising regional cooperation and can open new investment opportunities for renewable energy development. However, an export orientation should not cause the government to neglect its continuing obligation to ensure adequate domestic electricity supply.

For Transparency International Indonesia, the issue is not simply whether Indonesia should be allowed to export electricity to another country, but how decisions are made to allocate public resources and energy capacity. When large-scale projects use reservoirs or other strategic areas under the control of public bodies, those decisions must be open to scrutiny on the basis of the public interest, rather than judged solely on investment feasibility or potential economic returns.

This issue is particularly relevant because large-scale energy infrastructure development invariably carries governance risks. Large investment values, the granting of concessions, and infrastructure procurement and construction create numerous points of interaction between public authority and business interests. Without adequate transparency, these grey areas can create opportunities for conflicts of interest, regulatory capture, and other forms of corruption.

The success of the energy transition cannot ultimately be measured only by how many megawatts of renewable energy are built or how much electricity can be exported. The integrity of the decision-making process must itself form part of the measure of success. This is especially important when an energy project is designated strategic or involves international interests: its decision-making process must uphold the principle of meaningful participation, including by ensuring that environmental considerations, community interests, and sustainability principles are given adequate weight in the project's go/no-go decision.

From a climate-justice perspective, the energy transition should not create new forms of injustice for local communities. Renewable energy infrastructure development must ensure that community interests and the sustainability of ecosystems around project sites are not sacrificed in pursuit of energy-transition targets. This is especially important for communities whose living spaces directly intersect with a project. They should not be treated merely as recipients of development impacts, but as participants in decision-making, with their rights to access information, express views and objections, and help determine the future of their own living environment guaranteed.

In this context, Environmental Impact Assessment (AMDAL/EIA) plays a highly strategic role. EIA is fundamentally intended to ensure that environmental considerations are brought into the process before project decisions are made. However, the growing complexity of energy-transition projects requires EIA to do more than merely satisfy permitting requirements. "The more strategic an energy-transition project, the greater the need to improve the quality of its environmental governance." EIA must therefore be positioned as a governance instrument capable of balancing accelerated investment, environmental protection, the public interest, and principles of justice in development.

1.2. Problem Identification

Batam's transformation into one of the region's green-energy hubs brings new consequences. Its economic value is increasing, but so too are demands for higher-quality environmental governance. The government has consistently promoted accelerated renewable energy investment, expanded green-electricity trade with Singapore, and strengthened Indonesia's position in the region's clean-energy supply chain.

The central issue lies in the position of EIA within the overall decision-making process for strategic projects. At the regulatory level, EIA is designed to provide a basis for government to assess a project's environmental feasibility before a development decision is made. Yet for projects involving high investment values and forming part of a national strategic agenda, to what extent does EIA genuinely have room to influence those decisions? Or does its role largely emerge only after policy and investment directions have already been set? This question matters because the quality of environmental governance is heavily determined by when and how environmental considerations begin to be integrated into the development process.

The challenge is more complex because Batam's floating solar PV development is taking place at the Duriangkang and Tembesi Reservoirs, two major raw-water sources for Batam's communities and industrial areas. At the same time, these reservoirs have been selected as sites for floating solar PV generation. Bringing two strategic functions together in the same area requires planning and decision-making processes capable of balancing energy needs, water-resource protection, and community interests.

Green-energy development also raises an increasingly relevant climate-justice dimension. Efforts to reduce carbon emissions at the global level must not overlook how benefits and risks are distributed locally. Questions about who benefits from green-energy investment, who bears potential environmental impacts, and how far communities are involved in decision-making are part of evaluating the quality of sustainable-development governance.

These issues point to a fundamental need. This study views the development of Batam's floating solar PV projects as an appropriate moment to evaluate how the EIA system operates in the context of energy-transition projects with national and regional strategic significance. The study does not assess the quality of EIA documents as final products. Rather, it seeks to understand how policy, institutional, and procedural frameworks shape the quality of environmental decision-making.

1.3. Research Questions

The transition toward a low-carbon energy system is changing the position of renewable energy projects in Indonesia. Such projects are no longer viewed solely as energy-supply projects, but also as part of green-investment strategies and regional economic cooperation. Batam's floating solar PV projects provide an instructive example of a strategic development where multiple interests converge at once: accelerating the energy transition, strengthening national economic competitiveness, cross-border green-electricity trade, water-resource management, and environmental protection. As a result, decision-making for energy-transition projects can no longer be understood merely as a technical matter of infrastructure development; it is a governance process that must sustainably balance a range of public interests.

In principle, EIA is designed to ensure that environmental considerations are introduced before development decisions are made. Yet for projects of high strategic value, it is necessary to understand how the EIA system works in practice. This study takes the view that EIA quality cannot be judged by the documents alone. Equally important is how policy, institutions, and procedures shape the decision-making process. In other words, the core issue is not merely whether an EIA has been prepared in accordance with regulatory requirements, but whether the underlying system can perform its substantive function as an instrument of environmental governance.

The relevance of this issue is particularly clear in Batam. As a free-trade zone, an international maritime gateway, and a hub for green-energy investment, Batam faces strong pressure to accelerate strategic infrastructure development. At the same time, the area has ecologically sensitive characteristics because floating solar PV projects are being developed on reservoirs that serve as major raw-water sources for communities and industrial areas. This situation demands a decision-making process that can integrate economic-development interests, protection of ecological functions, and communities' social rights in a balanced manner.

These issues lead to one central requirement: a more comprehensive evaluation of the EIA development process through three main dimensions—the policy framework, the institutional framework, and the procedural framework. These dimensions are interrelated elements that determine the EIA system's ability to integrate environmental considerations into strategic decision-making. The evaluation of all three dimensions must then be confirmed through empirical field findings to provide a picture of how the system operates in practice. On this basis, the study is structured around four research questions.

1. To what extent has the policy framework underpinning the development of Batam's floating solar PV projects integrated sustainability principles and environmental considerations into strategic decision-making before EIA preparation?
2. How does the institutional framework underpinning the development of Batam's floating solar PV projects facilitate cross-sector coordination, clarity of roles and responsibilities, and accountability so that environmental considerations can be effectively integrated into the EIA process?
3. How does the EIA process for Batam's floating solar PV projects integrate environmental considerations through alternatives assessment, cumulative-impact assessment, adaptive assessment methods, and meaningful public participation in decision-making?
4. How do empirical field findings reflect the effectiveness of the policy, institutional, and procedural frameworks in producing an EIA process capable of supporting environmental decision-making for strategic energy-transition projects?

1.4. Objectives and Benefits

This study aims to evaluate how Indonesia's Environmental Impact Assessment (AMDAL/EIA) system supports environmental decision-making for strategic energy-transition projects, using the development of Batam's floating solar PV projects as the case study. The evaluation examines the relationships among the policy, institutional, and procedural frameworks that shape the EIA process and confirms their implementation through empirical field findings.

Specifically, this study aims to:

1. Analyse the extent to which the policy framework underpinning the development of Batam's floating solar PV projects has integrated sustainability principles and environmental considerations into strategic decision-making before EIA preparation.
2. Evaluate how the institutional framework facilitates cross-sector coordination, clarity of roles and responsibilities, and accountability in integrating environmental considerations throughout the EIA process.
3. Analyse how the procedural framework for the EIA process for Batam's floating solar PV projects integrates environmental considerations through alternatives assessment, cumulative-impact assessment, adaptive assessment methods, and meaningful public participation.
4. Validate the relationship between the policy, institutional, and procedural frameworks and empirical field conditions in order to assess the effectiveness of the EIA system in supporting environmental decision-making for strategic energy-transition projects.

1.5. Scope

This study focuses on evaluating the capacity of Indonesia's Environmental Impact Assessment (AMDAL/EIA) system to support decision-making for strategic energy-transition projects, using the development of Batam's floating solar PV projects as a learning case. The analysis focuses on three principal dimensions that shape the quality of EIA implementation: the policy framework, institutional framework, and procedural framework, as developed through the Strategic Environmental Assessment (SEA) perspective. The question is not whether the Batam floating solar PV projects are feasible or should proceed, but whether the EIA system has been able to ensure that environmental considerations are genuinely integrated into decision-making. The study therefore examines the policies underpinning project development, relationships among actors and institutional coordination mechanisms, and the EIA process from scoping and alternatives assessment through impact assessment, public participation, and environmental decision-making.

This study does not evaluate the technical aspects of floating solar PV, such as plant design, technology, electricity generation, financial analysis, or direct measurement of environmental quality, including water quality, hydrology, and biodiversity. Nor is the study intended to conduct a legal-compliance audit of the EIA documents or to judge whether government decisions on project development are right or wrong. The Batam floating solar PV case is used as a learning vehicle for understanding how the EIA system operates when confronted with projects of national and regional strategic significance. Within these boundaries, the findings are expected to provide broader lessons for strengthening environmental governance in energy-transition projects across Indonesia, beyond any single project or research location.

CHAPTER II. CONCEPTUAL FOUNDATIONS

2.1. Energy Transition and the Sustainable Development Paradigm

Energy development has undergone fundamental change over recent decades. For much of the twentieth century, success in the energy sector was generally measured by its ability to provide sufficient supply to support economic growth, industrialisation, and improvements in public welfare. This paradigm placed security of supply, economic efficiency, and growth at the centre of energy policy. However, rising concentrations of greenhouse gases, climate change, environmental degradation, and inequalities in access to energy demonstrate that this approach is no longer adequate to address the development challenges of the twenty-first century. The issue is not merely how to produce sufficient energy, but how energy systems can be developed without increasing environmental risks or social inequality.

This shift in perspective has occurred alongside the development of the concept of sustainable development. The World Commission on Environment and Development's report *Our Common Future* (1987) introduced the idea that development should meet the needs of the present without compromising the ability of future generations to meet their own needs. The concept subsequently evolved into a global development framework emphasising the integration of economic, social, and environmental dimensions. From the 1992 Rio Conference to the 2030 Agenda and the Sustainable Development Goals, environmental issues have increasingly been understood not as constraints on development, but as prerequisites for development's long-term sustainability.

This change in the development paradigm has direct implications for how the energy sector is understood. Energy is part of a system that affects environmental quality, public health, food security, water security, and social stability. This shift in perspective changes the meaning of energy transition. The focus is no longer limited to replacing fossil fuels with renewable energy sources, but extends to a comprehensive transformation of how energy systems are designed, governed, and used. The Intergovernmental Panel on Climate Change (IPCC, 2022) explains that energy transition encompasses changes across multiple interconnected dimensions, including technology, institutions, policy, consumption patterns, investment, and development governance.

This perspective broadens the meaning of sustainable energy development. The International Energy Agency has long emphasised that energy policy must balance three principal dimensions of sustainable development: economic growth, environmental protection, and social well-being. As global policy has evolved, this balance has been translated into a range of interrelated objectives, including improved access to affordable energy, reduced carbon emissions, greater energy efficiency, stronger energy security, and protection for vulnerable groups.

This paradigm shift also changes the focus of energy-project evaluation. Project success has traditionally been measured using technical and economic indicators such as installed capacity, generation costs, or return on investment. The question is now broader: does the project genuinely support sustainable development? Addressing that question requires attention to areas that previously received less emphasis, including protection of ecosystem functions, natural-resource management, distribution of development benefits, the quality of public participation, and accountability in decision-making.

These developments are highly relevant to Indonesia. Commitments to achieve Net Zero Emissions, implement the 2030 Agenda, formulate energy-transition policy, and expand investment in renewable energy indicate that national energy development is moving toward a more sustainable paradigm. At the same time, this shift shows that the principal challenge is no longer confined to technology development or financing, but concerns the capacity of governance systems to integrate multiple development objectives that often interact and can generate trade-offs.

2.2. Justice in the Energy Transition

Accelerating the energy transition is often viewed as a principal solution for reducing greenhouse-gas emissions and meeting low-carbon development targets. Experience across countries, however, shows that changing the energy mix is only one part of this process. Many renewable energy projects continue to face social resistance, land- and space-use conflicts, and environmental problems even when they succeed in reducing carbon emissions. Attention to the justice dimension increased as research showed that climate-change mitigation policies can produce uneven consequences. In many countries, renewable energy infrastructure has reduced carbon emissions while simultaneously generating new problems, including changes in land and space use, natural-resource conflict, community relocation, and unequal distribution of economic benefits. The energy transition can therefore create new forms of injustice if it focuses only on emissions targets without considering how the costs and benefits of development are distributed locally. Sustainable-development literature has consequently taken a more normative direction, treating justice as a prerequisite for a successful energy transition rather than merely a desired outcome.

These developments gave rise to the concept of a just transition, which originated in North American labour movements in the 1980s in response to the social impacts of environmental policies on fossil-fuel-based industries. As concern over climate change grew, the meaning of just transition expanded. The International Labour Organization (ILO) defines it as a transformation toward a low-carbon economy that can create decent work, reduce inequality, protect vulnerable groups, and ensure that development benefits are shared more equitably (ILO, 2015). Over time, just transition has come to mean more than labour protection; it is a principle for ensuring that the entire energy-transition process is inclusive, participatory, and just. Newell and Mulvaney (2013) emphasise that energy transition is not merely a technological shift from fossil fuels to renewable energy. Behind every transition policy are political and economic processes that determine who benefits, who bears the costs, and how risks are distributed.

One approach that subsequently developed is climate justice. This concept begins from the view that climate change is not only an environmental issue, but also an issue of power distribution, access to resources, and human rights. Schlosberg (2007) argues that environmental justice cannot be understood solely through the distribution of development benefits and burdens. Justice also depends on recognition of affected communities, opportunities to participate in decision-making, and communities' ability to maintain the social and ecological functions of their living environments. This perspective became an important foundation for the development of climate justice in climate policy. Schlosberg and Collins (2014) further argue that climate justice places justice at the heart of climate policymaking through four principal dimensions: distributive justice, procedural justice, recognition justice, and, in later developments, restorative justice. This approach treats justice as an important measure of climate-policy quality. Emissions reduction remains a core objective, but the process of achieving it must also ensure that development benefits are shared more fairly, affected groups have opportunities to participate, diverse community interests are recognised, and remedies are available when policies cause harm.

The concept was later made more operational through energy justice. Sovacool and Dworkin (2015) and Jenkins et al. (2016) developed energy justice as an analytical framework for evaluating energy policies and projects. They argue that a just energy system should satisfy at least three core principles: distributive justice, procedural justice, and recognition justice. Distributive justice concerns how the benefits and burdens of energy development are shared proportionately. Procedural justice focuses on the quality of decision-making, particularly access to information, transparency, and public participation. Recognition justice emphasises the importance of recognising groups that are often marginalised in development processes.

Climate justice is also a recurring advocacy theme for Transparency International. For this international anti-corruption movement, climate justice is not limited to emissions reduction and environmental protection; it also requires climate governance to be fair, transparent, and free from corruption. Each year, Transparency International publishes the Corruption Perceptions Index (CPI), a global reference for assessing perceived levels of public-sector corruption across countries. Countries with higher CPI scores tend to have stronger environmental policies than countries with lower scores. Transparency International has illustrated this relationship by comparing CPI trends with the Environmental Performance Index (EPI) and the Notre Dame Global Adaptation Initiative (ND-GAIN) Index.



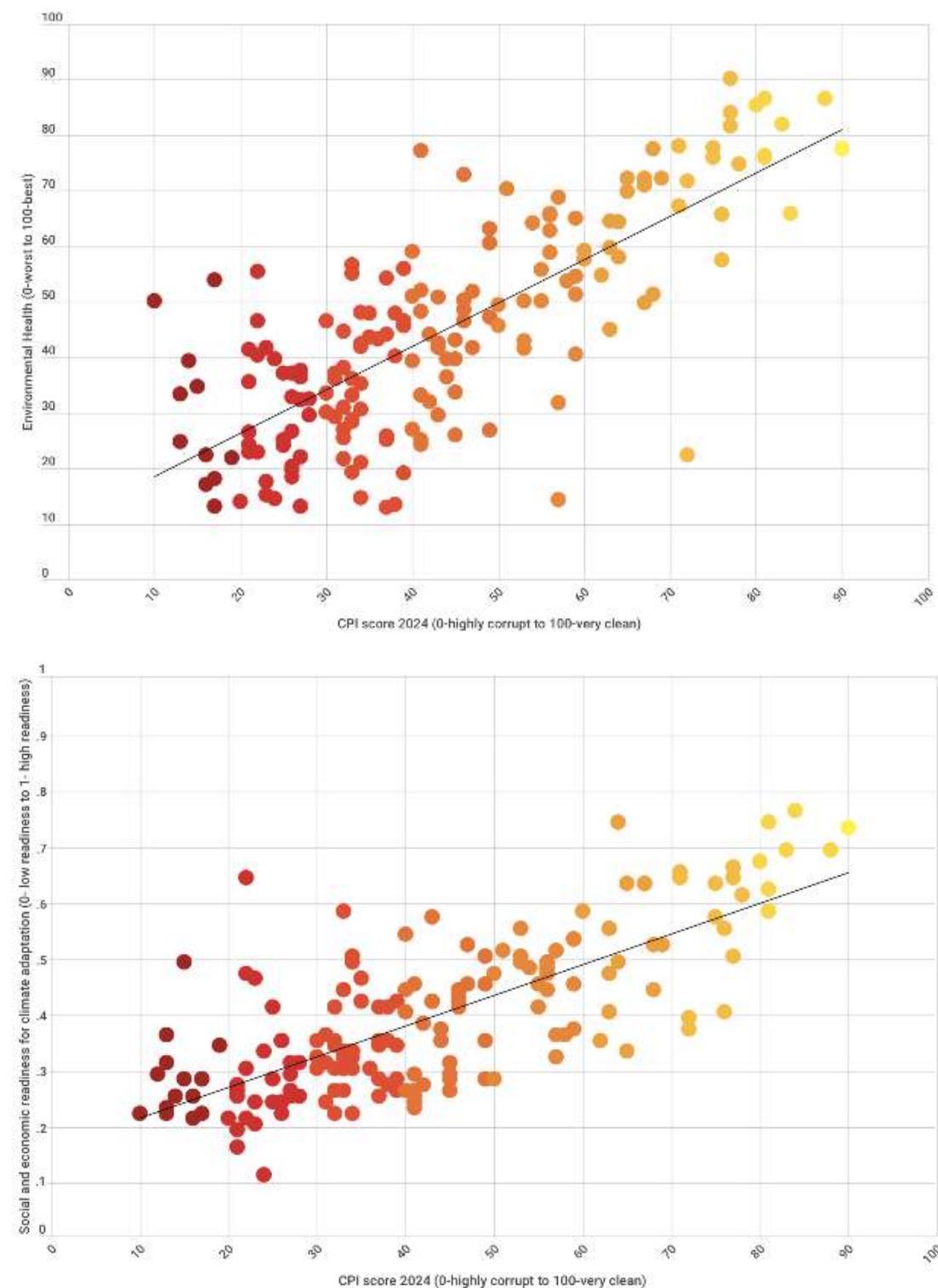


Figure 1. Comparison of 2024 CPI Scores with the EPI and ND-GAIN Indices

This correlation indicates that high levels of corruption can create space for the misuse of climate finance, illegal exploitation of natural resources, and domination of policymaking by environmentally destructive extractive-industry interests. These observed CPI trends underpin Transparency International's (2025) approach to climate justice, which is grounded in the central argument that corruption can weaken a country's capacity to respond to the climate crisis (Transparency International, 2025).

2.3. *Environmental Governance*

The shift in the development paradigm toward a sustainable energy transition shows that policy success can no longer be measured solely through technical or economic achievements, or reductions in carbon emissions. Experience across countries demonstrates that renewable energy projects can still generate social conflict, environmental degradation, or public distrust when decision-making is not transparent and accountable. The question therefore shifts from simply what is built to how development decisions are made. This shift has driven increasing attention to the concept of environmental governance.

The concept of environmental governance developed in response to the limitations of earlier environmental-management approaches that focused more heavily on pollution control and regulatory compliance. Lemos and Agrawal (2006) explain that environmental management can no longer be understood as the responsibility of government alone. Decisions with environmental consequences involve actors with diverse interests, including government, business, communities, financial institutions, and civil-society organisations.

This perspective represents a fundamental change in how environmental policy is understood. While conventional approaches focus on command-and-control instruments, environmental governance places greater emphasis on the quality of decision-making processes. Meadowcroft (2007) argues that the central challenge of sustainable development is not simply to formulate the right policies. More decisive is the ability of governance systems to manage decision-making in situations involving many actors, competing interests, and development objectives that often conflict. The capacity to establish cross-sector coordination, resolve conflicts of interest, create space for public participation, and operate accountability mechanisms is a crucial foundation for effective governance.

This perspective has received growing attention in the context of energy transition. The International Energy Agency (IEA), OECD, and United Nations Environment Programme (UNEP) have consistently emphasised that successful transition to clean energy depends not only on technological innovation and investment, but also on the quality of institutions governing the process of change. Policies that accelerate renewable energy investment can lose legitimacy if they neglect environmental protection, community rights, or transparent decision-making mechanisms. Conversely, credible governance can increase public trust, reduce conflict, and strengthen social acceptance of energy projects.

Environmental-governance literature suggests that governance quality is generally built on three interrelated components. First, the policy framework provides direction, objectives, and development principles. Policy should ensure that environmental issues are considered from the strategic-planning stage, rather than only when a project is about to be implemented. Second, the institutional framework governs the allocation of authority, inter-agency coordination, and accountability mechanisms in decision-making. Third, the procedural framework governs how decisions are made through processes that are transparent, evidence-based, adaptive, and open to public participation. These three components do not operate separately; weakness in any one can reduce the effectiveness of the governance system as a whole.

The relationship among these three components is also reflected in environmental-governance evaluation frameworks developed by the OECD and World Bank. Both organisations view governance quality as a system's capacity to ensure that policy, institutions, and decision-making processes work coherently toward sustainable-development objectives. Governance assessment therefore cannot be based solely on the existence of regulations or institutional structures. It must also consider policy coherence, the effectiveness of cross-sector coordination, institutional capacity, information transparency, public participation, and the ability to translate policy into consistent implementation (OECD, 2020; World Bank, 2017). This perspective underscores that the quality of environmental decisions results from the interaction of all these components, so evaluation of EIA should focus on the governance system shaping decision-making, not merely on the EIA documents produced.

2.4. *Strategic Environmental Assessment*

The development of environmental-governance thinking shows that the quality of environmental decision-making cannot be determined solely through project-level evaluation. Many decisions that affect environmental conditions are made long before a project is designed, for example through development policy or spatial planning. When environmental considerations are introduced only during EIA preparation, the scope for improving strategic decisions is often limited because the development direction has already been established. This condition drove the development of Strategic Environmental Assessment (SEA) as an approach that introduces environmental considerations earlier in the formulation of policies, plans, and programmes.

SEA began to develop in the late 1980s in response to the limitations of project-oriented Environmental Impact Assessment (EIA). Sadler and Verheem (1996) explain that EIA is effective at identifying the impacts of an activity but is less able to influence the strategic decisions from which the project itself emerges. As a result, important issues such as site selection, development scale, policy alternatives, and cumulative impacts are often decided before environmental assessment begins. SEA was developed to address this gap by extending assessment from the project level to the levels of policy, plan, and programme.

The development of SEA did not stop at broadening the object of assessment. Scholars increasingly questioned whether SEA should be understood as an additional procedure or as part of strategic decision-making itself. One of the most influential contributions came from Maria do Rosário Partidário, who shifted the understanding of SEA from a document-based approach toward a decision-centred approach. According to Partidário (1996; 2012), the principal purpose

of SEA is not to produce a more comprehensive environmental report, but to improve decision quality by integrating environmental considerations from the earliest stages of policy formulation and planning.

This perspective brought an important change to environmental-assessment practice. Partidário argues that SEA effectiveness is determined not by the quantity of information collected or the complexity of methods used, but by its capacity to influence decision-making while development options remain open. SEA should therefore function as a strategic thinking process that helps policymakers understand the environmental implications of different alternatives before decisions are made. This approach positions environmental assessment as part of a learning process, rather than simply as a mechanism for evaluating decisions that have already been taken.

Building on this thinking, Partidário developed a strategic framework that locates SEA effectiveness in three principal dimensions. First, the policy framework emphasises integrating sustainability objectives into development policy before projects are formulated. Attention is directed to policy coherence, clear environmental objectives, and the capacity of policy to compare different development alternatives. Second, the institutional framework emphasises cross-sector coordination, clarity in the allocation of authority, institutional capacity, and accountability mechanisms in decision-making. Third, the procedural framework emphasises process quality through alternatives assessment, consideration of cumulative impacts, adaptive assessment methods, information transparency, and meaningful public participation. These three dimensions are not treated as separate stages, but as an interconnected system shaping the quality of environmental decisions.

Partidário's approach is highly relevant to this study because it bridges environmental governance and EIA. The study does not seek to evaluate SEA as a formal instrument as regulated in various jurisdictions or through Indonesia's Strategic Environmental Assessment (Kajian Lingkungan Hidup Strategis/KLHS). Instead, the SEA framework is used as an analytical lens to assess whether the EIA process is supported by coherent policy, effective institutions, and procedures that allow environmental considerations to influence development decisions.

2.5. EIA as an Instrument for Environmental Decision-Making

Environmental Impact Assessment (Analisis Mengenai Dampak Lingkungan/AMDAL) is an instrument developed to ensure that environmental considerations form part of decision-making before an activity or project is implemented. The concept first developed through Environmental Impact Assessment (EIA) under the United States National Environmental Policy Act (NEPA) of 1969, and was subsequently adopted widely as a mechanism for anticipating environmental impacts from the planning stage. Over time, EIA has come to be understood not merely as a document containing impact predictions, but as a process that provides decision-makers with information on the environmental, social, and economic consequences of a proposed development (Glasson & Therivel, 2019; Morgan & Morgan, 2012).

In Indonesia, AMDAL has developed into a principal instrument within the environmental protection and management system. AMDAL is currently governed by Law No. 32 of 2009 on Environmental Protection and Management, as subsequently adjusted through Law No. 6 of 2023 on the Enactment of the Job Creation Government Regulation in Lieu of Law, together with implementing regulations including Government Regulation No. 22 of 2021. These regulations establish AMDAL as a basis for granting Environmental Approval to proposed businesses and/or activities expected to cause significant environmental impacts.

Nevertheless, numerous studies show that EIA effectiveness is not always determined by the quality of the documents produced. Morgan (2012) argues that the principal weakness of EIA in many countries lies not in impact-identification methods, but in the limited capacity of the instrument to influence decisions that have already taken shape. When project location, investment scale, or development direction has been determined before the EIA process begins, the space available for environmental considerations narrows. EIA then risks shifting from a decision-support tool into a decision-justification tool. This criticism is one reason SEA developed as an approach that introduces environmental considerations at the policy and planning levels.

This perspective demonstrates that EIA quality cannot be separated from the surrounding governance system. A technically well-prepared EIA document will not necessarily produce a high-quality environmental decision if the underlying policy is incoherent, institutional coordination is weak, or the process provides insufficient space for alternatives assessment and public participation. Conversely, EIA has greater potential to influence decisions when it is prepared within a system that integrates environmental considerations from the earliest stages of planning.

Literature on EIA evaluation identifies several aspects consistently used to assess the instrument's effectiveness. Cashmore et al. (2004) argue that EIA effectiveness cannot be judged solely by the accuracy of environmental-impact predictions. Effectiveness is also reflected in the extent to which EIA can influence decision-making, encourage policy improvement, strengthen institutional learning, and enhance the legitimacy of development in the eyes of stakeholders. Bond and Pope (2012) further argue that environmental-assessment evaluation should consider substantive, procedural, transactive, normative, and learning dimensions.

2.6. Theoretical Framework

The preceding sections show that research on EIA development in energy-transition projects cannot be explained through a single theoretical perspective. Each concept illuminates a different dimension of the same problem. The sustainable-development paradigm explains why development systems must move toward a low-carbon economy. The concepts of climate justice, energy justice, and just transition provide a normative foundation for how that transition should take place. Environmental governance explains the institutional mechanisms needed to translate those principles into public decision-making. Strategic Environmental Assessment (SEA), meanwhile, provides an operational framework connecting governance principles with policy formulation, while EIA is the project-level instrument through which these principles are applied.

This relationship shows that the study does not view EIA as a stand-alone instrument. EIA effectiveness is understood as the outcome of interactions among factors that operate before document preparation begins. Environmental considerations can influence project decisions where policy provides a clear sustainability direction, institutions can establish coordination and accountability, and procedures create space for alternatives assessment, cumulative-impact consideration, and public participation. Conversely, if any one of these components does not function effectively, EIA's capacity becomes more limited. This perspective treats the quality of EIA documents as a consequence of the quality of the system that produces them, rather than as the sole measure of successful environmental assessment.

This framework is particularly relevant to Batam's floating solar PV projects. The projects form part of the national energy-transition agenda, green-investment development, and cross-border electricity trade. At the same time, they are being developed on reservoirs with strategic functions as raw-water sources, ecological spaces, and social spaces for local communities. These interests converge in a single decision-making process that must balance economic-development objectives, environmental protection, and the public interest. The question is therefore not merely whether the EIA has been prepared in accordance with applicable requirements, but whether the entire system underpinning it can integrate these interests transparently, accountably, and justly.

On this basis, the study uses the Strategic Environmental Assessment framework developed by Partidário as its principal analytical framework. It was selected because it connects environmental-governance principles with decision-making through three interrelated dimensions: the policy framework, institutional framework, and procedural framework. These dimensions are treated as prerequisites for ensuring that environmental considerations enter decision-making from an early stage, rather than being evaluated only after the development direction has been established. In this study, the three dimensions are not treated as independent variables, but as components that collectively shape the capacity of the EIA system to support environmental decision-making.

The conceptual framework is then applied to evaluate the EIA process for Batam's floating solar PV projects. The evaluation proceeds through four interrelated stages of analysis. The first examines the extent to which the policy framework integrated sustainability principles and environmental considerations before EIA preparation. The second evaluates institutional capacity to establish coordination, allocate roles, and ensure accountability during the EIA process. The third examines the quality of EIA procedures, particularly alternatives assessment, cumulative-impact assessment, assessment methods, and public participation. The final stage confirms these findings through empirical field evidence to understand how the EIA system operates in practice.

Under this framework, the capacity of the EIA system is the central focus of analysis. Capacity is measured not merely through administrative compliance or document completeness, but through the system's ability to integrate environmental considerations into decision-making for strategic energy-transition projects. This approach broadens the understanding of EIA from a permitting instrument to part of an environmental-governance system that shapes the quality of development decisions.

Conceptually, the relationship among the theories used in this study can be understood as a complementary hierarchy. The sustainable-development paradigm provides normative direction for transformation of the energy system. The concepts of just transition, climate justice, and energy justice explain the principles of justice that should guide that transformation. Environmental governance translates those principles into governance mechanisms, while SEA provides an operational framework for ensuring that environmental considerations are present at the policy, institutional, and procedural levels. EIA then serves as the project-level instrument through which those principles are implemented in decision-making. On this basis, the study advances the proposition that the stronger the integration of the policy, institutional, and procedural frameworks, the greater the capacity of the EIA system to produce transparent, accountable, and participatory environmental decision-making that supports a sustainable and just energy transition.

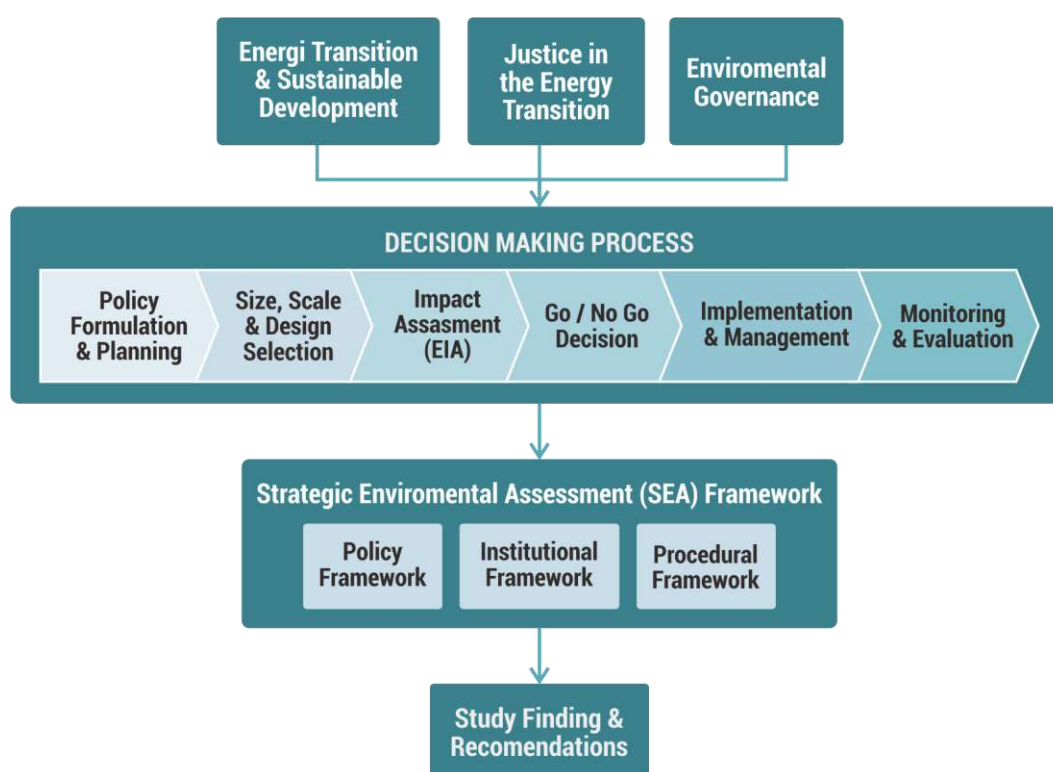


Figure 2. Conceptual Framework

3.1. Research Approach

This study uses a qualitative case-study design to evaluate the Environmental Impact Assessment (AMDAL/EIA) process for Batam's floating solar PV projects. This approach was selected because the research focuses on understanding environmental decision-making within complex policy, institutional, and procedural contexts. The analytical framework draws on the Strategic Environmental Assessment (SEA) approach developed by Partidário, particularly its three principal dimensions: the policy framework, institutional framework, and procedural framework. These dimensions are used as analytical lenses to evaluate the extent to which environmental considerations were integrated into the EIA process before development decisions were made.

The study combines document analysis, in-depth interviews, and field observation through source and method triangulation. This approach allows the evaluation to go beyond the content of EIA and policy documents by confirming findings through empirical evidence and the perspectives of stakeholders involved in project development. The study therefore seeks to provide a comprehensive picture of the capacity of the EIA system to support environmental governance in energy-transition projects.

3.2. Research Location and Period

The research was conducted in Batam City, Riau Islands Province, focusing on the Duriangkang and Tembesi Reservoir areas as sites for floating solar PV development. The areas were selected because they form part of strategic renewable energy projects supporting green-electricity trading cooperation between Indonesia and Singapore. In addition to serving as sites for energy infrastructure, both reservoirs perform vital functions as raw-water sources for Batam's communities and industrial areas. The convergence of these interests makes Batam a relevant case for evaluating how the EIA process integrates environmental considerations into decision-making for energy-transition projects.

Data collection was planned for the research period from July to August 2026. Activities included collecting and analysing policy and EIA documents, interviewing stakeholders, conducting field observations, and validating research findings. These stages were undertaken sequentially so that each finding could be compared and verified through triangulation.

3.3. Types and Sources of Data

The study uses qualitative data obtained from primary and secondary sources. Data were selected to support evaluation of the EIA process for Batam's floating solar PV projects, from the policy framework underpinning the projects and the institutional dynamics involved in EIA preparation to the conduct of the EIA process and empirical field conditions. Each type of data was therefore collected to answer the research questions and support analysis within the dimensions developed under the Strategic Environmental Assessment (SEA) framework.

Primary data were obtained through in-depth interviews with stakeholders directly or indirectly involved in the EIA process. Informants included government representatives, the area-management authority, technical agencies, project proponents, EIA consultants, academics, civil-society organisations, and communities around the Duriangkang and Tembesi Reservoirs. Primary data were also obtained through field observation to understand conditions in the research area and to confirm the consistency between information in the documents and actual field conditions.

Secondary data came from a range of documents related to the development of Batam's floating solar PV projects and EIA preparation. These included national and regional policies such as the National Energy General Plan (RUEN), Electricity Supply Business Plan (RUPTL), Regional Spatial Plan (RTRW), BP Batam policy documents, and regulations on environmental protection and management. The study also used AMDAL/EIA documents comprising the Terms of Reference for Environmental Impact Analysis (KA-ANDAL), Environmental Impact Analysis (ANDAL), Environmental Management Plan (RKL), and Environmental Monitoring Plan (RPL), together with minutes of public consultations, environmental monitoring reports, licensing documents, and relevant reports, scientific publications, and news coverage providing context on project development.

These data were used complementarily through triangulation. Policy documents provided the basis for evaluating the policy framework; institutional documents and interviews were used to understand the institutional framework; and EIA documents, public consultations, field observations, and interviews were used to assess the procedural framework and validate how the EIA system works in practice. This approach allows the study to develop a comprehensive picture of the EIA process as part of the environmental decision-making system.

3.4. Data Analysis Methods

Data analysis follows the research questions and conceptual framework used in this study. The analysis focuses on evaluating the EIA process through three principal dimensions—the policy framework, institutional framework, and procedural framework—as developed within Partidário's Strategic Environmental Assessment (SEA) framework. These dimensions are then confirmed through empirical field findings to show how the EIA system operates in practice.

The analytical method combines several complementary approaches. Policy Coherence Analysis, together with Directed Qualitative Content Analysis, is used to evaluate the policy framework underpinning the development of Batam's floating solar PV projects. Institutional Analysis is used to examine institutional structures, allocation of roles, coordination, and accountability among institutions involved in the EIA process. Procedural Review is then applied to evaluate the quality of EIA preparation, particularly alternatives assessment, consideration of cumulative impacts, assessment methods, and public participation. Findings from all three analyses are subsequently verified through triangulation using interviews, field observations, and supporting documents to produce a comprehensive understanding of the effectiveness of the EIA process.

Operationally, each analytical method is designed to address a different research objective while remaining part of an integrated analysis. The policy framework is analysed to determine the extent to which sustainability principles were integrated before EIA preparation. The institutional framework is used to evaluate institutional capacity to support decision-making. The procedural framework is used to assess the quality of EIA implementation as an environmental decision-making instrument. All findings are then interpreted together to explain how interactions among policy, institutions, and procedures influence the capacity of the EIA system to support environmental governance in energy-transition projects.

3.4.1. Policy Framework Analysis

The policy-framework analysis evaluates the extent to which policies underpinning the development of Batam's floating solar PV projects integrated sustainability principles and environmental considerations before EIA preparation. The analysis focuses on relationships among policies, consistency in development direction, and alignment between energy-transition objectives and policies on environmental protection, water-resource management, and spatial use. This approach is based on the view that the quality of environmental decision-making is strongly influenced by the policy framework shaping a project long before EIA documents are prepared.

The analysis combines Directed Qualitative Content Analysis (Hsieh & Shannon, 2005; Assarroudi, 2018) and Policy Coherence Analysis (Nilsson et al., 2012). Directed Qualitative Content Analysis is used to identify the substance of each policy document against categories derived from Partidário's Strategic Environmental Assessment (SEA) framework. The analytical categories include integration of sustainability objectives, environmental considerations in policy formulation, policy coherence, evaluation of development alternatives, protection of water resources, and attention to justice principles in the energy transition.

Coding results are then analysed using Policy Coherence Analysis to assess relationships among policy documents. The analysis identifies levels of coherence, potential overlap, policy gaps, and policy trade-offs associated with the development of Batam's floating solar PV projects. The assessment compares a range of project-related documents, including the National Energy General Plan (RUEN), Electricity Supply Business Plan (RUPTL), Regional Spatial Plan (RTRW), BP Batam reservoir-management policies, environmental protection and management regulations, and other policy documents relevant to the energy transition and green-electricity trade.

To improve analytical consistency, each indicator is assessed using an ordinal scale reflecting the level of policy coherence. A score of 3 indicates that an aspect is consistently integrated and mutually reinforcing across policy documents (high coherence); a score of 2 indicates general alignment but with inconsistencies in some documents (moderate coherence); a score of 1 indicates limited or inconsistent integration (low coherence); and a score of 0 indicates that the aspect has not been accommodated or that clear contradictions exist among policies (incoherent). The scoring is not intended as quantitative analysis, but as a tool to improve transparency in the evaluation process and facilitate interpretation. The results are then interpreted qualitatively, taking into account the context in which each policy was prepared and the relationships among policies in shaping decision-making. Interpretation also considers the degree of policy alignment and its relationship to the EIA process.



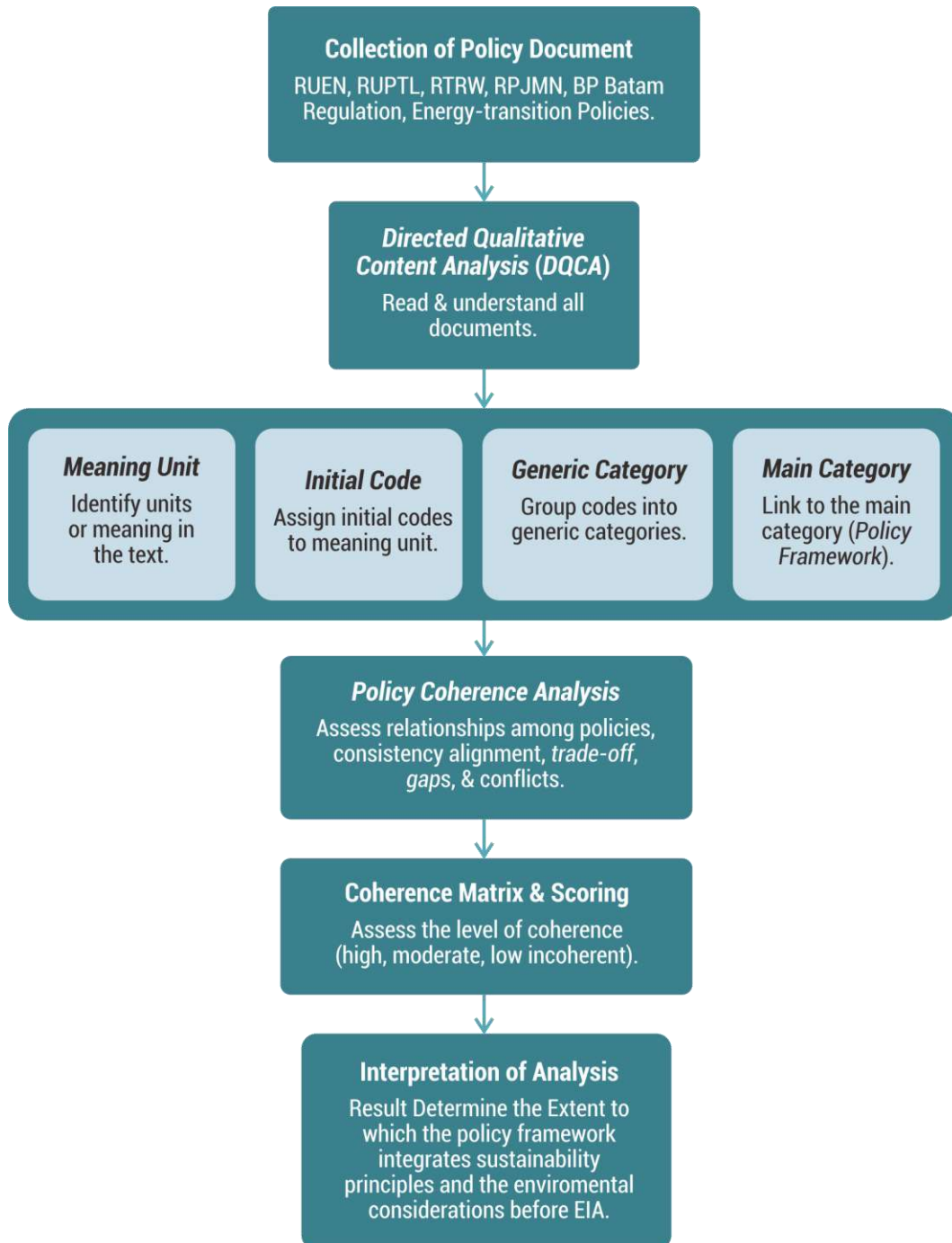


Figure 3. Stages of the Policy Framework Analysis
(adapted from Hsieh & Shannon, 2005; Assarroudi, 2018; Nilsson et al., 2012)

3.4.2. Institutional Framework Analysis

The institutional-framework analysis evaluates how the institutional structure underpinning Batam's floating solar PV development facilitates cross-sector coordination, allocation of roles and responsibilities, and accountability mechanisms in the EIA process. The approach used is Institutional Analysis, examining institutional structures, distribution of authority, coordination patterns, and accountability mechanisms that develop during the EIA process. The analytical framework refers to the Institutional Framework dimension of Partidário's Strategic Environmental Assessment (SEA), focusing on three principal aspects: cross-sector coordination, clarity of roles and responsibilities, and accountability in decision-making.

Data are analysed through coding using Directed Qualitative Content Analysis (DQCA) of institutional documents, meeting minutes, consultation records, regulations, interview findings, and other supporting documents. Analytical categories are developed deductively from the established theoretical framework and supplemented with new categories when institutional dynamics arise that are not fully explained by the theory. The identified material is then organised into an institutional-analysis matrix to map relationships among institutions, potential overlaps in authority, coordination gaps, and accountability mechanisms in decision-making. The analysis also considers how environmental considerations are communicated, negotiated, and accommodated among the actors involved, from project planning through preparation and review of EIA documents. Interpretation is qualitative and compares empirical findings with the institutional principles set out in the SEA framework.





Figure 4. Stages of the Institutional Framework Analysis

3.4.3 Procedural Framework Analysis

The procedural-framework analysis evaluates how the EIA process for Batam's floating solar PV projects integrates environmental considerations into decision-making. The analysis focuses on the stages of EIA implementation, from preparation of the terms of reference, impact identification and assessment, and alternatives assessment to public consultation and formulation of environmental management and monitoring plans. The research seeks to understand the extent to which this process can function as an instrument that materially affects development decisions.

The analysis uses a Procedural Review combined with Directed Qualitative Content Analysis (DQCA). The Procedural Review assesses the consistency of the EIA process with Strategic Environmental Assessment (SEA) principles, particularly early integration of environmental considerations into decision-making, evaluation of development alternatives, consideration of cumulative impacts, use of proportionate assessment methods, and meaningful public participation. Directed Qualitative Content Analysis is used to code EIA documents and interview results according to analytical categories established in the theoretical framework.

The units of analysis include the Terms of Reference for Environmental Impact Analysis (KA-ANDAL), Environmental Impact Analysis (ANDAL), Environmental Management Plan (RKL), Environmental Monitoring Plan (RPL), public-consultation records, supporting EIA documents, and stakeholder interviews. All documents are read systematically to identify meaning units, which are then coded into categories describing the quality of the EIA process.

Analytical categories are developed deductively from Partidário's Procedural Framework dimension and include integration of EIA into decision-making, alternatives assessment, consideration of cumulative impacts, assessment methods, and public participation. New categories may still be developed during analysis if procedural aspects are identified that are not fully explained by the theoretical framework. This approach allows empirical findings to enrich the analysis while maintaining consistency with the study's conceptual framework.

Coding results are then organised into a procedural-evaluation matrix showing the relationship between each stage of the EIA process and the principles used as assessment criteria. The matrix is used to identify strengths, weaknesses, process gaps, and aspects that may affect the effectiveness of EIA in supporting environmental decision-making. Interpretation is qualitative and links the results of document analysis, interviews, and field observations. The process seeks to explain how EIA procedures are implemented in practice and the extent to which they can integrate environmental considerations before development decisions are made.

3.4.4 Validation of Findings

Findings are validated by testing the consistency of policy, institutional, and procedural analysis against empirical field conditions. This is the final stage of analysis and is intended to ensure that interpretation is based not only on formal documents but also reflects practices occurring during the EIA process. It synthesises document-analysis results with stakeholder experiences and actual conditions at the research sites.

Validation uses both source triangulation and method triangulation. Source triangulation compares information from policy documents, EIA documents, interviews, and other supporting materials. Method triangulation combines document analysis, in-depth interviews, and field observation. This approach allows each finding to be tested from multiple perspectives, reducing the risk of interpretations that depend on a single type of data.



Validation focuses on several major issues emerging from the analysis, including integration of environmental considerations into policy, effectiveness of inter-agency coordination, implementation of public participation, evaluation of development alternatives, and management of potential impacts on reservoir areas. Each issue is traced across multiple data sources to identify consistency, differences, or contradictions requiring further explanation. Where information differs, interpretation considers the context in which documents were prepared, the position of informants, and empirical field conditions.

The final validation stage produces a synthesis integrating all research findings within a single analytical framework. This synthesis is used to answer the research question concerning the extent to which the policy, institutional, and procedural frameworks collectively shape the EIA process for Batam’s floating solar PV projects. In this way, the conclusions are built through a chain of evidence, allowing each interpretation to be traced back to its underlying data sources.

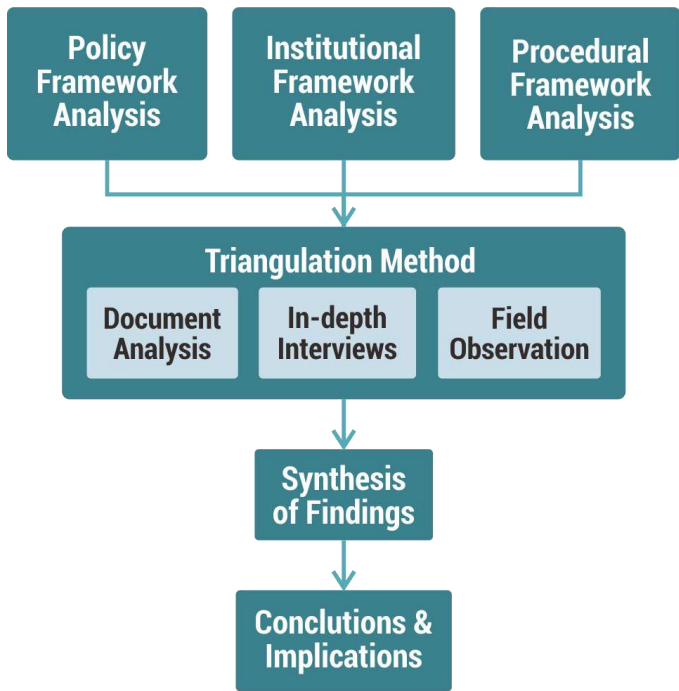


Figure 5. Tahapan Validasi

4.1. Policy Framework Study

4.1.1. Policy Framework and the Position of Environmental Considerations in the Development of Batam Floating Solar PV Projects

*"An educated person must also be fair,
first in thought and then, all the more, in action."*

Pramoedya Ananta Toer, This Earth of Mankind (1980).

Pramoedya's message reminds us that justice should be present from the moment a decision is first conceived, not considered only after the decision has been made. The same principle applies to decision-making in renewable energy projects, particularly after Indonesia has declared its commitment to the principle of a just transition. Good intentions to deliver renewable energy should go hand in hand with guarantees of justice for both the environment and communities.

In the context of Batam's floating solar PV development, the key question is no longer simply whether renewable energy has become a development priority. It is how far environmental considerations and community interests genuinely influence project decisions from the outset—from site selection, capacity, design and layout, and technology to how the project is constructed and operated.

This is where EIA should ideally—indeed, must—play a strategic role. It should not merely assess the impacts of a project that has already been planned, but also create space to question and revise the plan when environmental risks or community interests have not been adequately considered. A commitment to sustainability cannot end with policy documents; it must be visible in how development decisions are made, who is involved, and whose interests are ultimately heard.

The 2025–2034 RUPTL provides a reasonably strong basis for concluding that sustainability has been incorporated into power-sector planning. The RUPTL explicitly places environmental protection and emissions reduction within its sustainable-business principles. It also incorporates biodiversity and water-resource management into planning for generation, transmission, and distribution. On the social dimension, PLN adopts the principle that nobody is left behind and commits to community engagement, attention to vulnerable groups, gender equality, occupational health and safety, and labour rights.

However, the existence of these principles does not resolve more specific questions concerning Batam's floating solar PV projects. The RUPTL provides for 44.8 MW of solar PV development in the Riau Islands generation plan, including solar PV plus BESS and distributed solar PV. It also allows project locations to be determined based on system needs, reliability, and economic considerations.

This study finds that if environmental considerations enter only after project location and scale have been determined, EIA risks functioning primarily as an impact-control instrument for decisions that have already taken shape. Conversely, if environmental information is used while alternatives for location, technology, design, and scale remain open, EIA has a stronger position as part of decision-making. On this basis, policy integration is analysed through the following seven indicators.

1. Integration of Sustainability Objectives

The 2025–2034 RUPTL explicitly adopts sustainable-business principles through three main dimensions: affordability, sustainability, and reliability. The environmental dimension is clearly reflected in emissions-reduction targets, development of new and renewable energy, energy storage, the Green Super Grid, Smart Grid, and coal phase-down. The RUPTL also incorporates biodiversity protection and water-resource management into electricity-infrastructure planning.

From a policy-evaluation perspective, commitment to environmental objectives is a positive development. However, including environmental objectives in policy documents is not sufficient to demonstrate that environmental considerations genuinely form part of decision-making. A distinction must be made between merely stating that the environment is important and giving environmental considerations a real role in determining or changing development decisions. This distinction is important for Batam's floating solar PV plans. Solar energy is an important component of efforts to reduce carbon emissions, but floating solar PV also uses water-surface space that may serve other functions. Where the water body is part of a raw-water supply system, sustainability assessment cannot focus only on emissions-reduction benefits. Water quality, security of water supply, ecological functions, use of water space, and the interests of surrounding communities must also be considered in determining development feasibility.

Review of the RUPTL shows a reasonably clear direction for solar PV development in the Riau Islands. However, the document does not explain in detail how the conditions and characteristics of the Duriangkang and Tembesi Reservoirs were considered in determining project development. Sustainability integration is therefore clearer at the energy-policy level than at the level of project siting. This distinction is important in evaluating EIA. If sustainability objectives are used only as a general rationale for renewable energy development, EIA risks merely assessing the impacts of a development decision already made on the basis of the energy agenda. The question, then, is whether the EIA underpinning the solar PV projects at these two Batam reservoirs was genuinely given room to determine whether a project was environmentally feasible, or whether it functioned mainly to justify a decision taken from the outset

2. Timing of Environmental Considerations

Timing is a key indicator of EIA effectiveness. Environmental considerations can be described as strategically integrated when environmental information enters the process before major decisions become final. This differs from an approach that examines impacts only after the project, location, capacity, and design have effectively been determined. The RUPTL shows that environmental issues were considered during power-system planning. It uses the ARED scenario to accelerate renewable energy development and links this to emissions reduction. It also incorporates biodiversity protection and water-resource management into system planning.

The issue emerges when the analysis moves from system planning to the formation of Batam's floating solar PV projects. The RUPTL demonstrates the presence of environmental considerations at the power-sector policy level, but it does not provide a decision trace showing when the role of Duriangkang and Tembesi as raw-water sources began to be considered in site selection. The documents reviewed did not include meeting minutes, pre-project studies, site-planning documents, or inter-agency correspondence recording this process. The available evidence therefore does not allow the study to determine whether the raw-water function was considered before site decisions narrowed or only at a later stage.

This information gap is directly related to the position of EIA in decision-making. If the site had already been determined before raw-water issues were substantively discussed, EIA's capacity to influence the choice would be limited. It would then function more to determine how the project could proceed with acceptable impacts. **This is the fundamental concern: when development decisions precede environmental considerations, EIA risks losing its critical function and becoming an administrative formality that provides environmental legitimacy to investment interests.**

Table 1. Project Timeline

Year	Project milestone	Relevance to the timing indicator
2021	MoU between BP Batam and Sunseap for a floating solar PV project; Duriangkang was identified as an initial study location; the project was linked to electricity exports to Singapore. (BP Batam)	Indicates that the project concept and export orientation had already emerged before the formal process in 2022.
Sept. 2022	BP Batam and the Dam Safety Commission inspected Duriangkang and Tembesi to establish baseline conditions before the floating solar PV projects. Duriangkang's role as the backbone of Batam's clean-water supply was explicitly noted. (BP Batam)	The strongest evidence that dam safety and water considerations were already being addressed at an early stage.
Sept. 2022	BP Batam and the Ministry of Energy and Mineral Resources described the Duriangkang-Tembesi floating solar PV projects as large-scale/strategic developments, with initial planned capacities of 720 MW and 40 MW. (BP Batam)	Indicates that the project locations and scale had begun to narrow at a very early stage.
Nov. 2022	BP Batam reaffirmed the development direction for floating solar PV on the two reservoirs. (BP Batam)	Strengthens the indication that the two locations had become the preferred project sites by 2022.
Dec. 2022	BP Batam stated that the process had entered discussions on cooperation agreements, and that the selected partners for use of the Duriangkang and Tembesi reservoir areas had been determined. (BP Batam)	Marks the shift from exploration toward project commitment.
Dec. 2023	A 25-year cooperation agreement for development of the Duriangkang-Tembesi floating solar PV projects was signed. (BP Batam)	The commitment to the selected locations became more binding.
Dec. 2024	Second addendum on the provision of Duriangkang reservoir-area infrastructure. (BP Batam)	Indicates the continuation and strengthening of project commitments.
Feb. 2025	Third addendum to the Duriangkang Floating Solar PV cooperation agreement. (BP Batam)	Shows that the project had moved into a strengthening/implementation phase rather than remaining at the site-exploration stage.

3. Alternatives Assessment at the Policy Level

The RUPTL provides options at the power-system planning level. The RE Base and ARED scenarios are used to shape generation-development configurations, with options including solar PV, solar PV plus BESS, BESS, other generation technologies, and interconnection. For the Riau Islands, the RUPTL plans 44.8 MW of solar PV development and allows the addition of solar PV plus BESS or standalone BESS based on system needs, reliability, and economic considerations. It also does not require solar PV plus BESS to be concentrated at a single site. From an energy-planning perspective, this flexibility creates scope to identify configurations better suited to system characteristics and local conditions.

However, choice at the system level does not automatically mean that alternatives remain available at the site level. The more relevant question for Batam's floating solar PV projects is whether functionally viable alternative sites were still open when Duriangkang and Tembesi began to be considered. This question must be situated within Batam's water-resource governance, because reservoir and raw-water system management falls under BP Batam's authority. Inventories of raw-water sources maintained by BP Batam and the local government show that, in addition to Duriangkang and Tembesi, there are other impoundments, including Muka Kuning, Sei Ladi, Sei Harapan, Nongsa, Sei Baloi, Sei Rempang, and Sei Gong. The physical existence of these reservoirs, however, cannot be treated as evidence that all are equivalent site alternatives. Some already function as raw-water sources with different capacities, while others remain potential sources or are not yet integrated into the raw-water service system.

This distinction matters because Duriangkang and Tembesi occupy strategic positions in Batam's water-security configuration. Duriangkang is the raw-water source making the largest contribution to Batam's water-supply system and supports approximately 70% of the city's clean-water needs. Tembesi has also been incorporated into the strategy for increasing raw-water capacity and is linked to the water-supply system through transmission infrastructure from other sources. At the same time, projected raw-water demand continues to rise while existing sources face service pressure. BP Batam planning documents even direct the development of alternative sources, including new reservoirs and seawater reverse osmosis (SWRO), as part of a medium-term strategy to meet water demand. These conditions place water bodies serving as raw-water sources in a category of ecological space and infrastructure that is highly sensitive to additional intervention.

On this basis, the alternatives considered in this study need to be distinguished between those that are physically available and those that are substantively available within decision-making. Physical alternatives refer to other water bodies or locations that are geographically capable of accommodating solar PV. Substantive alternatives require more: sufficient capacity and function to permit such use, technical and economic feasibility, compatibility with the raw-water system, an acceptable level of water-security risk, and a genuine opportunity to be considered by decision-makers at the relevant time.

This distinction also clarifies the position of the RUPTL in the analysis. Choices among solar PV, solar PV plus BESS, BESS, interconnection, and other generation technologies are energy-system alternatives. Choices among Duriangkang, Tembesi, other reservoirs, land-based sites, or combinations of several sites are spatial alternatives. These two levels of choice have different environmental consequences and are not interchangeable. The RUPTL

can provide flexibility in technology and generation configuration, but it does not yet provide evidence of how the sensitivity of raw-water sources was used to screen and compare alternative solar PV sites in Batam.

This gap is particularly important because Batam differs from areas with numerous interchangeable raw-water sources. As an island region, Batam is highly dependent on rainfall impoundments for raw water. Concentrating supply in a limited number of reservoirs means that a change in the function of one strategic source can have system-wide consequences. In this context, solar PV site alternatives should be assessed not only on surface area, solar irradiation potential, proximity to the grid, or economic viability, but also on the strategic value of the water body for water security, the system's dependence on the reservoir, the reserve capacity of other sources, and the consequences if the raw-water function is disrupted.

Under this framework, the study does not seek to reach a conclusion about which alternative site should have been selected during planning. The available evidence instead shows that several water bodies and options for developing both energy and water sources existed. The unresolved issue is whether these alternatives were genuinely opened, compared, and eliminated through a documented decision-making process before Duriangkang and Tembesi narrowed into the selected floating solar PV sites. The absence of comparative site studies, pre-project studies, site-planning documents, meeting minutes, or inter-agency correspondence means that this alternatives-screening process cannot yet be adequately reconstructed.

This position is important for assessing strategic environmental integration. If Duriangkang and Tembesi had become relatively final choices before water-security concerns were substantively addressed, the range of alternatives available to the environmental process would have been significantly narrowed. When the site and development direction are determined first and EIA follows later, the question becomes whether environmental assessment still has meaningful room to change the decision.

In such circumstances, alternatives assessment risks losing its purpose. EIA may be directed primarily toward finding ways to make an already selected site workable, rather than testing whether the site is in fact the most appropriate option. This is where vulnerability to regulatory capture emerges.

4. Policy Coherence

Batam's floating solar PV projects did not emerge from a single policy or institutional decision. They sit at the intersection of multiple interests: the energy-transition agenda, environmental protection, spatial planning, water-resource management, development of Batam's industrial area, and electricity-trading cooperation between Indonesia and Singapore. Each brings different rules, authorities, and objectives that do not always move in the same direction. The key issue is therefore not merely whether these policies are mutually supportive on paper, but how differing interests are reconciled when development decisions must be made.

The Electricity Supply Business Plan (RUPTL) gives renewable energy development a relatively clear place. Through the Accelerated Renewable Energy Development (ARED) scenario, solar PV development in the Riau Islands forms part of efforts to accelerate the energy transition. The RUPTL also plans interconnection of the Sumatra power system with Batam-Bintan to strengthen electricity supply and support growth of green-energy-based industry. At the policy level, this direction suggests an intention to pursue energy and sustainability objectives together.

Alignment of objectives in policy documents, however, does not necessarily mean alignment in actual decision-making. Energy policy has its own measures of success, such as installed generation capacity, supply reliability, production costs, achievement of renewable-energy targets, and project-delivery speed. Reservoir management has different indicators: security of water supply, water quality, storage capacity, ecological functions, and continuity of public service. The problem arises when the same space—the reservoir—is required to serve both sets of interests at once.

Policy conflict becomes more visible when a single space is claimed by two different strategic interests. In Batam's floating solar PV development, the Duriangkang and Tembesi Reservoirs are no longer viewed only as parts of a water-supply system serving the public interest, but also as potential spaces for energy infrastructure and investment. Both interests are important, but they do not necessarily have equal standing or influence in decision-making. Renewable energy development is driven by capacity targets, investment, and the acceleration of the energy transition, while reservoir management must maintain ecological functions, water quality, and continuity of services for communities that depend on them.

The question is not merely whether the two functions can technically coexist, but which interest is first given the power to shape the future of the reservoir. When energy interests have already defined the site and development direction while environmental interests enter only through the EIA process, the relationship risks becoming imbalanced. Ultimately, the policy conflict is not only about competing uses of a reservoir, but also about who has the power to determine how the space will be used. If the reservoir is treated as an energy-investment asset, the public interests already embedded in it should not lose their standing in decision-making.

5. Protection of Raw-Water Functions

Protecting raw-water functions is an important indicator for assessing whether sustainability principles in floating solar PV planning have been applied contextually. The RUPTL includes water-resource management as an aspect of power-sector development. At the project level, public evidence also shows that water functions and dam safety received attention before solar PV development entered the formal cooperation stage. In September 2022, BP Batam and the Dam Safety Commission inspected Duriangkang and Tembesi to establish the initial condition of both dams before their use for floating solar PV. During the inspection, Duriangkang's condition was directly linked to the sustainability of Batam's clean-water supply, while dam-safety recommendations were identified as considerations in solar PV development. BP Batam also stated that Duriangkang is Batam's principal clean-water source.

The significance of this issue is evident from the reservoirs' position within Batam's water-supply system. BP Batam explains that the Batam Drinking Water Supply System (SPAM) uses reservoirs as raw-water sources for households, industry, and tourism, with production capacity continuing to be developed. Across six principal reservoirs, production capacity is recorded at 3,487 litres per second, while BP Batam's 2025–2029 Strategic Plan uses a broader scope, stating that clean-water services in the Batam Free Trade and Free Port Zone are supplied by eight reservoirs from Batam to Galang. Duriangkang occupies a dominant position: BP Batam records a catchment area of 7,259.10 hectares and states that the reservoir supports up to 70% of Batam residents' clean-water needs. Tembesi also serves a water-supply function. BP Batam is developing a water treatment plant (WTP) with a capacity of 230 litres per second at Tembesi, while Duriangkang is being developed with a 500-litre-per-second WTP. This means the reservoir surfaces being considered for solar PV are embedded within functioning public-service infrastructure, rather than being unused water bodies.

The system's vulnerability is reflected in BP Batam's 2025–2029 Strategic Plan, which states that reservoir-based raw-water utilisation had reached maximum capacity by 2025, while some service areas still faced water stress due to distribution constraints. These pressures continued beyond the planning period. In March 2026, BP Batam was still addressing stressed service areas and planned to increase supply capacity by 850 litres per second, from 4,429 to 4,710 litres per second, to strengthen continuity of service. At the same time, BP Batam continued protecting catchment areas; in 2025, for example, it cooperated on forest rehabilitation around the Duriangkang catchment area to maintain raw-water quality. Taken together, these policies show that raw water is strategic infrastructure requiring active protection and is also a resource under pressure from both demand and quality risks.

These conditions are important for water management in Batam, which depends on stored rainfall as its source of raw water. BP Batam explicitly states that rainwater is captured in reservoirs before being treated as clean water and distributed to communities and industry. System resilience therefore depends not only on the volume of water available at a given time, but also on the ability of catchment areas to maintain the quality and continuity of inflows to the reservoirs. Such dependence means that changes in the use of a water body must be assessed in relation to the water-service system as a whole. From a planning perspective, the relevant question is not only whether sufficient surface area exists for solar PV coverage, but whether that change is compatible with the water-supply function under normal conditions and during drought, rising demand, or water-quality disturbances.

The legal framework for water resources provides a firmer basis for this assessment. Law No. 17 of 2019 gives the fulfilment of people's basic daily water needs the highest priority in the utilisation of water resources. Use of water resources for business purposes may proceed only after basic daily needs and smallholder agriculture have been met and sufficient water remains available, while taking account of social and environmental functions, the safety of state assets, and environmental sustainability. These provisions do not automatically mean that floating solar PV cannot be located on raw-water reservoirs. They do, however, establish that the water-supply function should form part of the initial assessment of whether a water body is suitable for such use, rather than merely one impact to be examined after the site has already been selected.

At this point, it is important to avoid assuming that floating solar PV is inherently incompatible with raw-water functions. The literature shows that floating photovoltaic technology can provide certain benefits to water bodies, including potential reductions in evaporation and higher generation efficiency due to the cooling effect of water (Garrod et al., 2024). These benefits do not remove the need to assess the specific characteristics of each water body. Scientific studies have also identified potential changes in light intensity, water-atmosphere exchange, hydrodynamics, biotic communities, and water chemistry resulting from panel coverage (Benjamins et al., 2024). Evidence-based reviews have identified changes in water chemistry, including potential nitrification and deoxygenation, as risks requiring attention, while the magnitude of impacts depends strongly on design, coverage area, and water-body characteristics (Exley et al., 2021).

The implications for Batam are fundamental. On a reservoir functioning only as a general water body, such uncertainties can be managed as part of project-level impact assessment. On a reservoir that is also a strategic raw-water source, a higher precautionary standard is warranted because changes in water quality or quantity may directly affect continuity of public service. In other words, the reservoir's environmental value lies not only in its aquatic ecosystem, but also in the water-supply service currently used by communities and economic sectors. Raw-water function should therefore be a screening criterion in site selection, not merely an impact parameter in the ANDAL.

Under this framework, protection of raw water requires at least four considerations during early planning: (1) the degree of dependence of the water system on the reservoir; (2) available supply capacity and continuity; (3) reservoir vulnerability to drought and changes in water quality; and (4) the ability of other sources to replace the reservoir's function in the event of disruption. These considerations are important because Batam's alternative water sources are not fully substitutable. BP Batam's current efforts to develop new sources such as SWRO and strengthen inter-reservoir connections demonstrate that diversification of water sources remains a system need.

6. Influence of the Green-Electricity Export Agenda

The green-electricity export agenda adds strategic value to the direction of solar PV development in Batam. Indonesia-Singapore energy cooperation has evolved from political commitments toward more concrete project development. In September 2023, Singapore's Energy Market Authority (EMA) granted Conditional Approvals to five projects for the import of a total of 2 GW of low-carbon electricity from Indonesia. These approvals followed several bilateral agreements on energy cooperation, renewable energy, and cross-border electricity interconnection. The projects were also designed to drive development of solar PV and battery energy storage systems (BESS) in Indonesia, with planned development of approximately 11 GWp of solar PV and 21 GWh of BESS.

These developments show that renewable electricity is no longer positioned solely as a means of meeting domestic demand, but also as part of a cross-border energy value chain. Batam's position is becoming increasingly strategic because of its geographic proximity to Singapore and because the Sumatra-Batam interconnection has been placed within the agenda for strengthening green transmission infrastructure. The 2025–2034 RUPTL includes the Sumatra-Batam-Bintan link among planned inter-island interconnections, while

PLN describes the Green Super Grid as infrastructure designed to connect renewable energy sources with centres of electricity demand.

Generation projects connected to an interconnection system and potentially supporting cross-border electricity trade have different implications from projects intended solely to meet growth in local demand. They involve certainty of generation capacity, grid readiness, investment, transmission infrastructure, bilateral commitments, and the importing country's decarbonisation targets. The export agenda can therefore increase the urgency and strategic value of a renewable energy project while expanding the number of actors with an interest in its successful and timely implementation.

This increased strategic value needs to be examined in relation to governance of decision-making under the green-electricity export programme. The relevant question is not whether green-electricity exports are good or bad policy, but whether the growing strategic importance of renewable energy projects changes the scope and sequencing of environmental decision-making at project level. When a project is embedded in a policy ecosystem involving bilateral commitments, capacity targets, investment, interconnection, and operating schedules, some decision parameters may become increasingly difficult to change once strategic commitments have formed.

This risk is particularly associated with temporal lock-in. Projects linked to the export agenda require alignment among generation construction, transmission readiness, storage systems, permitting, and interconnection schedules. The 2025–2034 RUPTL itself treats transmission development as a key prerequisite for evacuating renewable power and integrating it with demand centres. PLN also identifies the Sumatra-Batam interconnection within its transmission-development agenda for the period. Under such conditions, changing the generation site at a late stage could affect grid design, investment requirements, construction schedules, and commercial viability. These potential consequences do not prove that environmental decisions have been locked in, but they create institutional incentives to retain choices that have already gained policy and investment momentum.

This dimension becomes more important when considered alongside the characteristics of Batam's floating solar PV projects. If Duriangkang or Tembesi had entered the project configuration before in-depth environmental assessment, two processes need to be distinguished: formation of the energy project and environmental evaluation. The first may proceed on the basis of capacity targets, availability of land or water space, proximity to the grid, investment, and system needs. The second then evaluates impacts on water quality, hydrology, ecosystems, social conditions, and raw-water functions. A governance problem arises if the second process occurs after strategic decisions in the first have become difficult to change.

The export agenda must therefore be analysed together with the preceding indicators on the timing of environmental considerations, alternatives assessment, and protection of raw-water functions. The greater the economic and strategic consequences of changing a site after project commitments have formed, the more important it is to ensure that environmental issues are incorporated before site choices become difficult to reverse. This is especially significant in Batam because Duriangkang and Tembesi are not water bodies detached from public-service functions; they are parts of a raw-water system with strategic value for communities and economic activity.

At this stage, the RUPTL provides evidence of the export agenda and interconnection development, but not enough to establish a causal relationship between that agenda and the selection of Duriangkang or Tembesi. The available documents also do not support the conclusion that these sites were chosen because of electricity-export requirements for Singapore. This must be clearly distinguished from the fact that Batam lies within an area strategically linked to interconnection development and low-carbon electricity trade.

The analysis must also consider how the status of the export agenda has changed over time. In 2023, Singapore granted conditional approvals for imports of 2 GW of low-carbon electricity from Indonesia; in 2024, the five projects obtained Conditional Licences and Singapore added approvals for 1.4 GW of new projects. These developments indicate that the cross-border electricity-trading agenda has policy continuity and is not merely a short-term plan. In 2025, Indonesia-Singapore renewable energy cooperation was further reinforced through the renewable-energy interconnection agenda, with the Indonesian government emphasising that the cooperation must continue to safeguard national interests.

From an EIA-evaluation perspective, the principal implication is not that export-oriented projects should be treated more restrictively than domestic projects. Rather, projects with broader strategic significance require stronger transparency in decision-making. Where economic, diplomatic, investment, and decarbonisation interests are attached to a project, the environmental process must be able to demonstrate that those interests have not eliminated relevant alternatives or reduced the weight given to critical environmental functions. In Batam, raw-water function is one such critical interest.

The green-electricity export agenda should therefore be understood as a structural factor that can increase implementation pressure and reduce the reversibility of decisions, rather than as direct evidence that site decisions were determined by export interests. This distinction is methodologically important. Without evidence of a direct relationship between exports and site selection, the study cannot claim that the export agenda caused Duriangkang or Tembesi to be selected. However, the existence of the export agenda and interconnection development shows that decisions on solar PV capacity, location, and timing are being made within a policy environment carrying strategic interests across regions and national borders. This reinforces the need to test whether environmental considerations entered the process before project, investment, and grid commitments created lock-in around particular options.

7. Justice in the Energy Transition

The RUPTL places the principle that nobody is left behind within its just-energy-transition agenda. This includes community engagement, attention to Indigenous Peoples and vulnerable groups, gender equality, occupational health and safety, and protection of labour rights. At the policy level, this orientation shows that the energy transition is understood not merely as a change in generation technology, but as a process that must account for its social consequences. The 2025–2034 RUPTL also places accelerated renewable energy development within the transition toward Net Zero Emissions, with renewables accounting for a large share of planned additions to generation capacity.

These normative commitments, however, are not sufficient to determine whether an energy project satisfies principles of justice. From an energy-justice perspective, justice should be assessed through at least three interrelated dimensions: distributive justice, procedural justice, and recognition justice. Distributive justice asks how development benefits and burdens are shared; procedural justice considers who has opportunities to participate in and influence decisions; and recognition justice assesses whether affected groups, their needs, knowledge, and vulnerabilities are genuinely recognised in decision-making (Jenkins, 2016). Recent literature on solar PV projects likewise shows that all three dimensions matter because renewable energy development can generate broad benefits while concentrating particular burdens on communities near project sites.

This framework is relevant to Batam's floating solar PV projects because benefits and risks may be distributed across different geographic scales. Project benefits may occur at the system level through additional renewable-energy capacity, emissions reductions, improved system reliability, and support for the energy-transition agenda. Economically, the projects may generate investment, employment, construction activity, and opportunities for industrial development. If the generating plants form part of a green-electricity export configuration, their benefits may also connect to cross-regional and cross-border energy trade. Under the 2025–2034 RUPTL, renewable energy development is also projected to generate substantial economic and employment benefits, including potential green jobs.

By contrast, some risks and consequences of spatial use may be concentrated in a much smaller area. Communities around the reservoirs, water users, water-resource managers, people carrying out activities around the water bodies, and groups dependent on the quality and continuity of reservoir functions are more directly exposed to changes in water-space use. Duriangkang and Tembesi present a particular case because the water bodies used for energy infrastructure also serve as raw-water sources. Those receiving the additional benefits of electricity generation are therefore not necessarily the same people who are closest to potential environmental changes.

This spatial mismatch between beneficiaries and risk-bearers is a critical issue in assessing energy-transition justice in this case. A project may successfully accelerate the energy transition in aggregate terms yet still raise justice concerns if its principal benefits are enjoyed at the system or wider regional level while environmental and social risks are concentrated among communities and resource users around the project site. Literature on justice in solar-energy projects shows that a project's spatial configuration is an important part of its justice implications: broadly distributed benefits can coexist with much more concentrated local burdens.

Procedural justice is therefore especially important. Public consultation does not in itself establish procedural justice. Participation becomes substantive only when potentially affected parties receive adequate information, have opportunities to raise objections and propose alternatives, and have channels through which their views can influence decisions. Research on large-scale solar PV development shows that consultation may be formally inclusive while community influence remains limited when strategic decisions, information, or agendas have already been controlled by particular actors.

This has important implications for Duriangkang and Tembesi. If the sites had already narrowed before communities or water users had an opportunity to question the use of the water bodies, consultation during the EIA stage would have less scope to influence the outcome. Conversely, if affected groups are involved while site alternatives remain open, they can contribute not only to identifying impacts but also to determining whether a particular site is appropriate and whether lower-risk options exist. The difference between these two conditions determines whether participation functions as a mechanism for shaping decisions or merely as a mechanism for accepting them.

Recognition justice is also important because relevant parties are not necessarily limited to communities living immediately adjacent to the project boundary. Where a reservoir serves as a raw-water source, groups that depend on continuity of the water function may have significant interests even if they are not geographically close to the solar PV installation. Domestic water users, industry, SPAM operators, local government, and actors responsible for catchment sustainability have different relationships with the reservoir. Recognition of these groups determines whether the project's consequences are understood comprehensively or only from the perspective of communities nearest the site.

This dimension also broadens the meaning of "affected communities." Under an overly narrow approach, social impacts may be limited to people living near the project's physical site. An energy-justice approach should instead follow who depends on the resource whose function is being altered. This is especially relevant to Duriangkang because its raw-water function serves an area far beyond the reservoir's immediate surroundings. Project benefits and risks therefore cannot be mapped solely by geographic distance from the solar panels.

Justice also requires consideration of the relationship between energy-transition benefits and local benefits. Additional solar PV capacity provides low-carbon energy, but this does not automatically translate into direct economic benefits for communities around the reservoirs. Similarly, the creation of green jobs at the national level does not by itself demonstrate that local communities receive employment, income gains, or business opportunities from a particular project. Evaluation must therefore distinguish between aggregate energy-transition benefits and benefits actually received by communities at the project sites. The RUPTL describes macro-level benefits such as increased renewable energy and potential job creation, but these indicators do not explain how benefits are distributed at Duriangkang and Tembesi.

The same applies to risk. Risks to the reservoir environment cannot be assessed only in terms of aggregate impacts on the environmental system. They must also be linked to who loses what if reservoir functions decline. For communities dependent on continuity of water supply, even small changes in water quality or quantity may have very different consequences from those experienced by electricity consumers who benefit from additional solar PV capacity. The significance of an impact must therefore be considered together with the degree of dependence of the affected party.

In this context, protection of raw-water functions, discussed in the previous section, is directly linked to energy justice. If Duriangkang and Tembesi are important components of the raw-water system, decisions to use these water bodies for solar PV may distribute energy benefits and water-related risk burdens unevenly. Justice requires not only that communities have opportunities to express views on project impacts, but also that the value of the resource functions on which they depend is taken into account when deciding whether the project and its location are appropriate.

Based on the available documents, the RUPTL contains a general commitment to a just energy transition and expands attention to communities, vulnerable groups, workers, and social considerations. However, there is no specific information showing how benefits and risks are distributed at Duriangkang and Tembesi, which groups are most affected by changes in use of the water bodies, or the extent to which they can influence site selection. This gap indicates that the justice dimension cannot yet be verified at project level because benefit distribution, risk distribution, recognition of affected parties, and procedural influence are not adequately documented in the policy materials reviewed.



4.1.2. Synthesis of the Policy Framework Evaluation

Review of the seven indicators shows that sustainability has gained a reasonably strong position in energy-policy direction and power-sector planning, particularly through renewable-energy development targets, emissions reduction, environmental protection, water-resource management, and attention to social considerations. The 2025–2034 RUPTL provides several renewable-energy development options in the Riau Islands with a total allocation of 44.8 MW, including solar PV, solar PV plus BESS, and other renewable generation. At the system level, these options remain open, and site selection may consider system needs, reliability, and economic factors. The problem emerges when the policy framework is translated to the project level. The document review cannot clearly reconstruct every process linking sustainability objectives to the selection of Duriangkang and Tembesi as specific sites. There remains limited traceability regarding when the reservoirs' raw-water functions entered the analysis, how alternative sites were compared, and what weight water protection received in screening project options. This shows a gap between sustainability commitments at the policy level and the mechanisms that translate them into project-level decision criteria.

This gap is particularly important because Duriangkang and Tembesi perform strategic functions within Batam's raw-water supply system, while use of their water surfaces for solar PV has implications for aquatic space, reservoir operations, and water-quality management. The Duriangkang project documents include protection of spillway and intake functions and water-quality control as elements of environmental management. At Tembesi, the ANDAL also shows that solar PV use is taking place in a reservoir where more than one solar PV activity has been planned, with different intended uses of the electricity, including local demand and exports to Singapore. This shifts the issue from simple consistency with energy policy to the question of priorities among competing functions of space and resources. The green-electricity export agenda increases the strategic value of renewable energy development in Batam, but the available evidence is insufficient to conclude that it directly determined selection of the two reservoirs. Similarly, just-transition principles are present in energy-policy discourse, but they are not yet clearly evident as binding criteria when energy benefits, investment, raw-water functions, environmental risks, and local community interests are brought together.

Overall, the policy framework can be assessed as strong at the normative level, adequate at the system-planning level, but more limited in its influence over site and project-configuration decisions. The critical point is the timing of environmental considerations. As technology, location, capacity, and investment-scheme options become increasingly fixed, the space for environmental information to change the direction of decisions narrows. In this position, EIA remains important for assessing impacts, establishing management measures, and controlling risk, but its strategic influence depends heavily on whether preceding decisions can be revisited. The synthesis of the seven indicators is therefore better understood as a problem of connectivity between policy and decisions, rather than an absence of environmental concern. The key evaluative question for the next stage is whether the institutional framework and EIA process can close this gap, particularly where energy, investment, raw-water functions, and community interests converge within the same reservoir space.

Table 2. Policy Framework Evaluation Matrix for Batam Floating Solar PV Development

No	Key Findings from Policy Documents and Project Evidence	Critical Analysis	Level of Integration*	Gap
1	Integration of sustainability objectives			
	The 2025-2034 RUPTL places renewable energy, emissions reduction, system sustainability, environmental protection, and a just energy transition within the direction of electricity supply planning. The RUPTL was enacted through Minister of Energy and Mineral Resources Decree No. 188.K/TL.03/MEM.L/2025 as the guideline for power-system development for 2025-2034. (MEMR Legal Documentation and Information Network/JDIH ESDM)	Sustainability is strongly integrated at the level of objectives and system planning, but it has not yet been shown to function as a binding decision rule at the project level. In other words, the policy explains what is to be achieved, but does not sufficiently explain how those objectives are used to screen sites, capacity, reservoir-surface coverage, and floating solar PV design.	2 - Moderate	Field verification and a review of public documents found no sustainability-criteria matrix, siting criteria, or go/no-go criteria showing the weight assigned to environmental considerations in selecting Duriangkang-Tembesi. The RUPTL demonstrates a macro-level commitment, but does not demonstrate how that commitment was translated into site-selection decisions.
2	Timing of environmental considerations			
	The public chronology indicates that development of the Duriangkang-Tembesi floating solar PV projects had narrowed substantially by 2022: BP Batam stated that both reservoirs would be used, selected partners had been designated by December 2022, and 25-year cooperation agreements were subsequently signed. Initial-condition inspections of both dams were also conducted in 2022 before their use for floating solar PV. (BP Batam)	The project chronology can be partially reconstructed, but the substantive sequencing between site selection and environmental screening cannot yet be established. The baseline site visits show that dam safety and condition were considered, but do not demonstrate that raw-water functions and alternative sites informed the decision before the locations were selected.	1 - Low	The public-document review and field verification found no minutes of site-selection meetings, pre-siting studies, early environmental screening, site-selection matrix, or document recording when the raw-water function was first considered as a basis for decision-making. Available evidence shows when the project was formed, but does not sufficiently explain when environmental considerations shaped that formation.

3	Alternatives assessment at the policy level			
	The RUPTL provides system-level alternatives through the RE Base/ARED scenarios, solar PV, solar PV+BESS, BESS, other generation options, and interconnections. At the Batam level, BP Batam explicitly notes the existence of several reservoirs and stated in 2022 that floating solar PV development would focus on Duriangkang and Tembesi. Academic studies also identify several Batam reservoirs that could technically be considered for floating solar PV, although the studies subsequently focused their analysis on the two largest reservoirs. (BP Batam)	Potential alternatives exist, but they have not been demonstrated to have been genuine alternatives used in the decision-making process. The important distinction is between alternative availability and alternative assessment. Duriangkang and Tembesi may have been selected because of size, grid proximity, or technical-economic considerations, but the comparative basis for that selection has not been identified.	1 - Low	No comparative study was found in public documents or field evidence comparing Duriangkang and Tembesi with other reservoirs, land-based sites, multi-site configurations, or solar PV+BESS combinations against energy-water-environmental-social-economic criteria before site selection. The 2024 academic study is evidence that the feasibility of the two reservoirs was assessed, but not evidence that they emerged as the preferred options through an alternatives-assessment process.
4	Policy coherence			
	Floating solar PV development is aligned with the RUPTL and the renewable-energy agenda. At the same time, the reservoirs fall within BP Batam's institutional system for managing raw water, reservoirs, dams, and catchment areas. BP Batam regulations also explicitly govern the placement of solar cells on the surface of several reservoirs, including Duriangkang and Tembesi. (Batam JDIH)	Institutionally, there is scope for policy compatibility between renewable energy development and reservoir use. Regulatory compatibility, however, is not the same as substantive integration. It remains unclear how potential conflicts among electricity generation, water security, dam safety, water quality, spatial planning, and public-service interests were resolved in site selection and design.	1 - Low	No cross-sector document was found that explicitly demonstrates reconciliation or weighting of energy-water-spatial-planning-environmental interests before the site decision. What is available mainly consists of institutional mandates, reservoir-use rules, and each sector's policies. Policy coherence exists at the regulatory level; the mechanism for resolving project-level trade-offs has not been traced.

5	Protection of the raw-water function			
	The raw-water function has a strong institutional and operational position. BP Batam manages the reservoirs and raw water; Batam's clean-water system depends on reservoirs; and the 2025-2029 Strategic Plan states that services draw from eight reservoirs and that raw-water use reached maximum capacity in 2025. Duriangkang has a WTP capacity of 500 L/s and Tembesi 230 L/s. (Batam JDIH) BP Batam also describes Duriangkang as the backbone of Batam's clean-water supply and continues to protect its catchment area. (BP Batam)	The available evidence shows that the strategic value of raw water is well recognized by the managing institution. The issue is not the absence of recognition of the water function, but the lack of evidence that this function operated as a decision constraint in selecting the site and determining the scale/coverage of the floating solar PV project. The fact that solar-cell placement is permitted by regulation does not automatically mean that the site has passed water-security screening.	1 - Low	No reservoir carrying-capacity study specifically for floating solar PV, water-security screening, water-quality/quantity risk thresholds, analysis of panel-coverage effects on WTP operations, maximum coverage criteria based on water-supply needs, or document showing that lower-water-risk alternatives were compared was identified. The availability of reports on water capacity, water quality, and water use in BP Batam's public-information register indicates that these data exist institutionally, but their connection to the solar PV site-selection decision has not been identified. (BP Batam E-PPID)
6	Influence of the green-electricity export agenda			
	The export agenda has developed into concrete policy. Singapore issued Conditional Approvals in 2023 for imports of 2 GW of low-carbon electricity from Indonesia; in 2024, the five projects received Conditional Licences and a further 1.4 GW received Conditional Approvals. These projects are associated with solar PV and BESS development and cross-border interconnection. (Energy Market Authority) BP Batam has also promoted Duriangkang as a project planned to support electricity exports to Singapore. (BP Batam)	The export agenda increases the strategic value and urgency of renewable-energy development. However, public evidence is insufficient to conclude that exports caused Duriangkang to be selected. A more defensible finding is the potential for temporal lock-in: investment, grid, capacity, and trade commitments may make relocation increasingly costly once the project has taken shape.	1 - Low	No document was identified that explicitly links export targets to the decision to select Duriangkang/Tembesi, including a site-needs study, investment decision, power purchase arrangement, grid study, or minutes showing that exports influenced the project's location, capacity, or schedule. The relationship between the export agenda and site selection must therefore still be distinguished between strategic context and causal connection.

7	Justice in the energy transition			
	The RUPTL incorporates the principle that nobody is left behind, community engagement, vulnerable groups, labour, and social dimensions of the energy transition. At the project level, BP Batam states that the floating solar PV projects are intended to support green-energy needs and Batam's competitiveness. (BP Batam)	The justice commitment is present at the normative level, but justice at the site level must be assessed through the distribution of benefits, distribution of risks, recognition of affected parties, and procedural influence. The benefits of solar PV may be distributed at the system/investment scale, while the risks of reservoir use may be concentrated among water users, surrounding communities, reservoir managers, and ecosystems.	1 - Low	Field verification and public documents did not provide adequate evidence of benefit-risk distribution mapping, identification of reservoir-specific vulnerable groups, evidence that water users were treated as affected parties, or evidence that community views influenced alternatives/site/design choices. Consultation minutes, participant lists, the substance of objections, and a response matrix addressing community input remain key forms of evidence that were not available.

Table 3. Policy Framework Analysis Scoring Scale

Score	Level of Integration	Criteria
3	High	Integrated and demonstrably influences project decisions.
2	Moderate	Integrated at the planning level but not yet fully operational or site-specific.
1	Low	A general commitment or mechanism is available, but its influence on decisions has not been demonstrated.
0	Not traceable	No adequate evidence was found that the consideration has been integrated.

4.2. Institutional Framework Study

4.2.1. Institutional Framework for the Development of Batam Floating Solar PV Projects

The institutional framework for Batam's floating solar PV development is formed by several concurrent regimes of authority. These include authority over the power sector, management of the Batam area, water resources, environmental protection, investment, and cross-border energy cooperation. Each has a different legal basis and institutional interest. The issue is not simply the number of institutions involved, but whether relationships among them can produce consistent decisions when energy interests intersect with environmental protection and reservoir functions.

This question is relevant because Batam has an institutional configuration that differs from most regions. BP Batam is the agency responsible for managing, developing, and building the Batam Free Trade and Free Port Zone (KPBPB). Under Government Regulation No. 41 of 2021, the KPBPB institutional structure consists of the Area Council and the Concession Agency. BP Batam also has authority over licensing services within the zone.

At the same time, raw-water management sits within BP Batam's own institutional structure. The SPAM Business Entity manages water supply, while the Facilities and Environment unit carries out functions related to environmental management. BP Batam publicly records reports on raw-water utilisation capacity, reservoir water quality, raw-water use, and reservoir technical capacity as information managed by its SPAM, Facilities and Environment units. This creates an important institutional characteristic: the actor with an interest in accelerating investment in the Batam area is located within the same institution that bears responsibility for certain public-service and environmental functions.



1. Actors and Institutional Structure

Batam's floating solar PV development involves a cross-sector, multi-level institutional structure that is not fully hierarchical. The actors can be differentiated by the functions they bring to decision-making. At the policy and power-system levels are the Ministry of Energy and Mineral Resources (MEMR/ESDM) and PLN, with PLN Batam holding a Business Licence for Electricity Supply for the Public Interest (IUPTLU) and providing electricity in Batam, Rempang, Galang, and other licensed business areas. The 2025–2034 RUPTL provides the framework for national power-system planning, including renewable-energy expansion, transmission, and interconnection. On water resources and dam safety, the Ministry of Public Works (PUPR), through the Dam Safety Commission, performs a different function: ensuring that dam-safety requirements remain protected when a water body is used for an additional purpose. In September 2022, the Dam Safety Commission and BP Batam inspected Duriangkang and Tembesi to establish the initial condition of both dams before their use as floating solar PV sites. The inspection also involved BP Batam's upstream SPAM management, spatial-planning and building units, the Riau Islands Provincial BPKP, and the reservoir solar PV technical team. This structure shows that floating solar PV is not solely an energy issue, but also involves dam safety, spatial planning, water management, investment, and wider area-development interests.

BP Batam occupies a highly central position because it sits at the intersection of area management, reservoir and water-service management, and investment facilitation. In the floating solar PV projects, BP Batam not only provides or manages reservoir inundation areas, but also established a Technical Team for Cooperation on Reservoir Solar PV Development in the KPBPB and leads the project-development process. In September 2022, the head of BP Batam's technical team stated that development of solar PV at Duriangkang and Tembesi would be discussed intensively with ministries/agencies and all stakeholders. At the same time, the projects were already being directed toward large capacities—approximately 40 MW at Tembesi and 720 MW at Duriangkang—with local energy needs and export opportunities among the considerations. BP Batam's position is further reinforced because its relationship with developers did not begin only when EIA was discussed. In 2021, BP Batam signed an MoU with Sunseap Group for a Duriangkang floating solar PV project valued at approximately IDR 29 trillion, with permitting preparation and preliminary studies forming part of the follow-up. In the same year, BP Batam also developed cooperation on the Tembesi solar PV project with PT Toba Bara Energi, including data exchange, site visits, pre-feasibility studies covering legal, technical, business, and environmental aspects, and establishment of a cooperation committee. BP Batam therefore acts as a boundary actor connecting energy, investment, reservoir management, and public-service interests, rather than merely as a site administrator.

This structure was further reinforced as the investment process entered more formal cooperation stages. In December 2022, BP Batam stated that project development had entered discussions on cooperation agreements and that PT Batam Sarana Surya had been selected as the partner for use of the Duriangkang inundation area, while PT TBS Energi Utama Tbk had been selected as the partner for Tembesi. In 2023, BP Batam signed 25-year cooperation agreements for solar PV development at both reservoirs. These institutional relationships continued: in December 2024 an addendum was executed for provision of Duriangkang inundation infrastructure, and in February 2025 BP Batam further strengthened its cooperation agreement with PT Batam Sarana Surya through a Third Addendum.

This chronology matters because it shows that investment actors and the area manager had established institutional relationships well before the project reached the final stages of environmental decision-making. The concentration of roles in one entity raises a fundamental question: when a public body representing municipal government and managing public assets also acts as an investment driver and contractual partner of project developers, to what extent can community interests and environmental protection receive equal standing in decision-making? Institutional analysis therefore cannot stop at mapping who attends EIA consultations; it must also trace who already held authority, investment commitments, economic interests, and contractual relationships when project options began to take shape.

In addition to BP Batam and the developers, PLN and PLN Batam occupy distinct positions in the institutional structure. PLN brings national power-system planning and integration interests, while PLN Batam operates as the electricity supplier in the Batam area. Their connection to the solar PV projects is evident in requirements for integrating generation into the system, maintaining supply adequacy, planning the grid, and developing interconnection. In 2022, for example, BP Batam and the Ministry of Energy and Mineral Resources explicitly discussed electricity-supply adequacy, plans to add capacity, substation relocation, and prospects for the Sumatra-Batam interconnection. Under the 2025–2034 RUPTL, this agenda develops into a broader architecture of transmission and interconnection expansion, including the planned Sumatra-Batam-Bintan interconnection. PLN's role is therefore not merely that of a prospective power purchaser or user, but that of an actor determining how solar PV capacity is integrated into the system, how reliability is maintained, and how generation is positioned within the wider system configuration.

The Tembesi Floating Solar PV Plant is currently under construction and is intended to supply clean energy to the Batam area in 2025. The Tembesi Floating Solar PV Plant has a capacity of 35 MWac or 46 MWp and is located at Tembesi Reservoir, Sagulung District, Batam City, Riau Islands. The project is being developed in cooperation with PT TBS Energi Utama Tbk. (www.ptplnr.com).

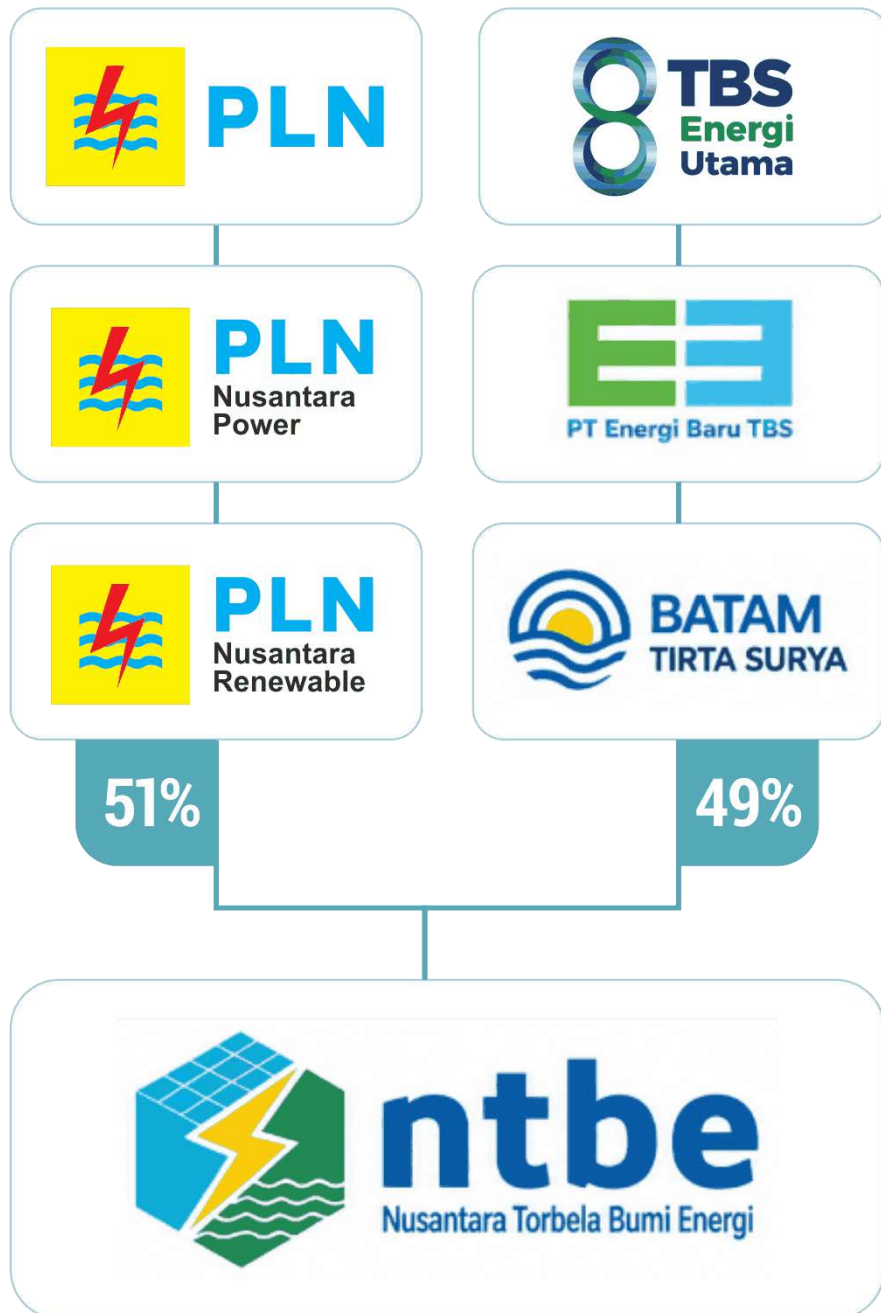


Figure 6. Actor Structure of the Tembesi Solar PV Project
(Source: www.ptplnnr.com).



Figure 7. Documentation of the Tembesi Solar PV Construction Process

Meanwhile, no floating solar PV construction activities have yet taken place at Duriangkang Reservoir, meaning that use of the reservoir water surface for power generation remains at the planning and development stage. This distinguishes Duriangkang from Tembesi Reservoir, where physical development has already begun, and leaves greater scope to assess environmental, technical, social, and governance considerations before the development decision is implemented.

Beyond government and corporate actors, there are groups with institutionally weaker positions that are nevertheless affected by project decisions, including water users, communities around the reservoirs, civil-society groups, academics, and other local stakeholders. Their position differs from BP Batam, PLN, ministries, and developers because they do not hold formal authority to determine sites or sign cooperation agreements. However, the reservoirs' role as raw-water sources makes water users' interests relevant to project evaluation. In field research, these groups should be understood not merely as participants in stakeholder consultation, but as holders of knowledge and interests capable of testing the consequences of decisions for water quality, continuity, and access.

Many institutions with different authorities and interests sit behind the development of Batam's floating solar PV projects. BP Batam plays a central role in area and reservoir management, while developers bring investment interests and concern for project continuity. PLN and PLN Batam seek to ensure that electricity can be reliably delivered, while the Ministry of Energy and Mineral Resources promotes achievement of energy-transition targets. The Ministry of Public Works, through the Dam Safety Commission, is responsible for dam safety. Each actor arrives with its own mandate and measure of success.

Environmental and raw-water interests, by contrast, are cross-sectoral and do not fall entirely under a single actor. This creates a risk of fragmentation and what may be described as a responsibility gap: each institution carries out its sectoral mandate, but no actor is explicitly responsible for ensuring that the full trade-off among energy, raw water, dam safety, investment, and community interests has been considered before the site decision becomes binding. When institutions focus only on their own mandates, responsibility for development impacts risks being passed from one to another. Reservoirs, however, do not recognise institutional boundaries. Water flowing to people's homes, environmental change, and development impacts do not stop simply because an issue moves from one bureaucratic desk to another. Every institution may feel it has fulfilled its duty, yet no one may be fully accountable for the consequences.

2. Cross-Sector Coordination

Normatively, the need for coordination has been clearly recognised. The National Water Resources Council (DSDAN) document explicitly identifies the need to integrate interests among parties and sectors in water-resource management. For floating solar PV, it identifies the involvement of PUPR for water bodies, ESDM and PLN for generation and the power system, Bappenas and local government for planning, and the industry and trade sectors for investment and utilisation of output.

The same document identifies a more specific problem: there is not yet a clear allocation of roles and responsibilities among agencies to support floating solar PV development, and there is a need to strengthen coordination and institutional mechanisms. This policy finding is important because it arises from evaluation of solar PV development on water bodies generally, rather than from criticism developed specifically for Batam. In other words, coordination is a structural governance issue already recognised in Indonesia's floating solar PV sector.

The need for coordination is also evident in the regulation of reservoir use. Minister of Public Works and Housing Regulation No. 7 of 2023 requires consideration of dam safety, reservoir functions, social, economic and cultural conditions, and the destructive force of water. Use of reservoir space is also linked to permits issued under the relevant authority and recommendations from water-resources technical implementation units. Decisions on floating solar PV therefore cannot be based solely on power-system needs. They require information on reservoir conditions and water functions held within different institutional domains. This is where coordination effectiveness must be tested empirically; the existence of coordination forums does not automatically mean that coordination is effective.

3. Clarity of Roles and Authority

The institutional issues in Batam's floating solar PV development cannot be understood solely through the distribution of authority among agencies. A more fundamental issue arises where government's authority to protect the public interest intersects with the authority of a concession agency mandated to attract investment. This intersection is particularly important in Batam because both functions are brought within a single leadership structure through the ex officio relationship between the Batam City Government and BP Batam.

Indonesia's legal framework allocates authority for area management. Government Regulation No. 41 of 2021 establishes BP Batam as the concession agency responsible for managing, developing, and building the Free Trade and Free Port Zone (KPBPB), with authority over licensing services in the area. Government Regulation No. 4 of 2025, meanwhile, provides that the Mayor of Batam serves *ex officio* as Head of BP Batam and the Deputy Mayor serves as Deputy Head. Under this arrangement, local-government office and leadership of the concession agency are brought under a single leadership structure, although they remain institutions with distinct legal mandates. The arrangement is intended to align regional development with investment-area development, facilitate coordination, accelerate decision-making, and reduce bureaucratic friction. From a governance perspective, however, it also creates a risk of concentrated power that can blur institutional roles and authority.

This is where the environmental-protection framework should serve as a counterbalance. Government Regulation No. 22 of 2021 regulates environmental-feasibility review through Environmental Feasibility Assessment Teams operating at central, provincial, and district/city levels. This allocation of authority is intended to ensure that environmental assessment is carried out in accordance with the characteristics of the activity and the relevant licensing authority. However, an administratively separate feasibility-review structure does not in itself guarantee that environmental considerations through EIA have equal influence in project decision-making.

The issue becomes more strategic when a project involves large investment values and activities such as cross-border electricity trade, bringing central-government interests into strategic project decision-making. Under such conditions, EIA confronts development choices that become increasingly difficult to change economically and institutionally. An electricity-export orientation, however, does not automatically mean that the entire environmental process must fall under central authority. Jurisdiction must still be determined by the location of the activity, the type of licence involved, and the applicable regulatory framework.

For governance in Batam City, this distribution of authority creates its own challenge. On the one hand, strategic project decisions may relate to central-government interests and regional economic development. On the other, environmental impacts and social consequences will be experienced directly in Batam. The higher the level at which decisions are taken, therefore, the more important it becomes to ensure that information, objections, and local community interests retain meaningful space to influence the outcome.

In Batam, functions are also divided between BP Batam and PLN Batam. BP Batam plays a major role in area and reservoir management, while PLN Batam is responsible for the electricity-supply system. Private developers bring investment interests, while the Ministry of Energy and Mineral Resources advances the national energy-transition agenda. These interests expand further where energy projects in Batam intersect with electricity-trading cooperation between Indonesia and Singapore. In June 2025, the two countries signed three memoranda of understanding covering clean-electricity trade, carbon capture and storage (CCS), and development of green industrial zones in the Riau Islands. Energy-development decisions in Batam therefore concern not only local needs, but also cross-border economic and energy interests.

The involvement of many institutions can be a strength if each party has space to oversee and correct the decisions of others. The opposite, however, is also possible. When each institution focuses only on ensuring that its own mandate is carried out, responsibility for development impacts can become something passed between them. Authority may be clearly written into regulation without it being equally clear who bears responsibility when a cross-sector problem occurs.

4. Fragmentation and Gaps in Authority

The institutional issue in Batam's floating solar PV projects is not limited to overlapping authority; it also includes potential gaps in authority. Regulation of solar PV on water bodies is one example. Minister of Public Works and Housing Regulation No. 7 of 2023 provides a legal basis for using reservoir space for floating solar PV and establishes technical limits and requirements. However, the DSDAN document identifies a continuing need for comprehensive regulation of solar PV on water bodies. It also notes the absence of an adequate basis or study for determining water-surface use and recommends further assessment.

Another issue is the absence of water-body zoning maps for floating solar PV development. The same document explicitly recommends a joint policy among ministries, particularly PUPR and ESDM, to establish zoning for water bodies strategic to investment. For Batam, this is particularly important because the reservoirs perform public-service functions. If the energy sector views a reservoir as a potential generation site while water managers view it as raw-water supply infrastructure, a mechanism is required to determine how those interests are reconciled. Thus, even if each institution exercises its authority correctly, the overall decision may remain unintegrated. An EIA perspective introduced at the planning stage can identify and help mitigate conflicts between two sectoral policies with different interests.

5. Decision Accountability

Accountability must be distinguished from authority. Authority answers who is permitted to make a decision; accountability answers who must explain the basis for that decision and bear responsibility for its consequences. In Batam's floating solar PV projects, this distinction matters because decisions are formed across several layers: energy development, technology selection, use of water bodies, investment cooperation, electricity supply, and Environmental Approval.

The EIA structure itself provides formal mechanisms for accountability in environmental assessment. Government Regulation No. 22 of 2021 provides for Environmental Feasibility Assessment Institutions and Environmental Feasibility Assessment Teams. These teams may operate at central, provincial, or district/city level depending on the nature of the activity and the relevant authority. EIA accountability requires testing feasibility and tracing the implications of the decision pathway: when environmental input is received, who decides how it will be followed up; when a risk is considered acceptable, who determines the threshold of acceptability; and when there are differences of opinion, where is the final decision recorded?

These questions are particularly relevant to the finding that the costs of conducting the EIA assessment are borne by the person or entity responsible for the business/activity. Legally, this funding mechanism does not mean that the assessment process loses its independence. From a governance perspective, however, the relationships among the project proponent, consultant, feasibility-assessment team, and decision-maker need to be traced in order to understand how independence and accountability are maintained in practice.

6. Process Transparency

In this study, transparency should not be understood merely as the availability of documents on government websites. A more substantive measure is whether parties outside the decision-making circle can understand how decisions were made, what information was used, who provided input, and what changed as a result of that input.

BP Batam has established a relatively formal information-disclosure structure. Its 2026 Public Information List records that the SPAM Business Entity and the Facilities and Environment unit hold important information, including reports on water-treatment-plant capacity, raw-water utilisation capacity, reservoir water quality, raw-water use, and reservoir technical capacity.

Institutionally, this is an important asset. The data needed to examine the impacts of solar PV on reservoir functions already exist within the government's information ecosystem. The problem is that access to information is not the same as traceability of decisions. The public may be able to obtain water-quality or reservoir-capacity data, but may still be unable to determine when those data were used in a solar PV siting decision, who requested them, or whether the findings changed the project design.

From an EIA-evaluation perspective, transparency must extend to the relationship between inputs and decisions. Studies of EIA effectiveness identify accountability and the ability of civil society to use the assessment process as important dimensions of environmental governance. SEA literature likewise emphasises that institutional context, transparency, participation, and capacity influence the ability of assessment to shape strategic decisions (Monteiro & Rosário, 2017).

7. Institutional Capacity

Institutional capacity cannot be measured solely by the existence of organisational structures. An institution may have a broad mandate but lack sufficient expertise, data, time, budget, or bargaining power to carry it out. The Batam case requires substantial capacity. Evaluating floating solar PV on reservoirs demands expertise in the power sector, hydrology, water quality, aquatic ecology, dam safety, spatial planning, economics, and social issues. Minister of Public Works and Housing Regulation No. 7 of 2023 itself links reservoir use for solar PV with dam safety, reservoir functions, social and cultural conditions, and the destructive force of water.

The DSDAN document also shows that each water body has different characteristics and requires different treatment and standard operating procedures. Institutional capacity therefore cannot rely on a uniform procedure for every reservoir. Batam has an important advantage in this respect: BP Batam already has dedicated structures dealing with raw water, environmental management, and reservoirs. BP Batam programme documents even include activities to supervise catchment areas, reservoirs, and dams.

The existence of internal technical capacity, however, does not establish whether that capacity is genuinely connected to the EIA process. The question is whether BP Batam's data and expertise feed into scoping, the KA-ANDAL, ANDAL, and RKL-RPL. SEA capacity is strongly influenced by institutional arrangements and the degree to which assessment is institutionalised within government systems (Monteiro et al., 2018). Research on Vietnam also finds that technical problems such as limited data and capacity often arise from deeper institutional issues, including incentives for information-sharing and public access.

4.2.2. Synthesis of the Institutional Framework Evaluation

The institutional framework for Batam's floating solar PV development includes a relatively complete set of sectoral actors and mandates, but this does not automatically produce integrated governance. BP Batam occupies the most central position because it sits at the intersection of area management, reservoir use, raw-water services, and investment facilitation. PLN and PLN Batam bring interests in reliability and power-system integration, ESDM operates in the energy-policy domain, while PUPR and the Dam Safety Commission hold mandates for dam safety and water-resource management. Environmental authorities perform environmental-feasibility assessment, while developers control the financial and technical resources needed to realise the projects. This structure creates multiple points of oversight, but also fragments authority when decisions involve more than one sectoral interest.

This condition can be seen in the project-development pathway, which formed institutional and investment relationships before environmental decisions reached their final stage. BP Batam established cooperation with development partners for Duriangkang and Tembesi from an early phase and later strengthened those relationships through development agreements and several addenda. At the same time, coordination with the Dam Safety Commission, SPAM operators, spatial-planning authorities, and technical actors had been taking place since project preparation in 2022. This sequence shows that project decisions evolved through an institutional network that was already active before the environmental process was complete. The key question is therefore not whether coordination occurred, but whether the outcomes of that coordination retained the capacity to change project decisions when environmental information revealed risks or conflicts of interest.

The relationship between sectoral authority and cross-sector responsibility is central to the institutional analysis. National Water Resources Council documents continue to identify the need to strengthen coordination, clarify roles, develop institutional mechanisms and standard operating procedures, and establish water-body zoning for floating solar PV development. This is particularly important in Batam because the reservoirs function simultaneously as raw-water service infrastructure and spaces for energy development. Each institution may perform its duties and exercise its authority without there being a mechanism explicitly responsible for testing the full trade-off among energy, water, dam safety, investment, and community interests. This creates an institutional gap in integrated decision-making. From an EIA-evaluation perspective, the gap matters because the environmental process may become one of the first arenas in which sectoral conflicts are brought together only after the project direction has already developed considerably.



Table 4. Institutional Framework Evaluation Matrix for Batam Floating Solar PV Development

No.	Key Findings from Documents and Fieldwork	Critical Analysis	Level of Integration*	Gap
1	Actors and institutional structure			
	Floating solar PV development involves BP Batam, PLN/PLN Batam, central-government institutions through the Ministry of Energy and Mineral Resources and the Ministry of Public Works, environmental authorities, local government, developers, and raw-water managers. BP Batam occupies a central position because it manages both the area and the reservoirs used as project sites. In 2022, BP Batam had established a technical team for cooperation on reservoir-based floating solar PV development and involved the Dam Safety Commission in inspections of Duriangkang and Tembesi.	The institutional structure is relatively complete, but the influence of the actors is not equal. BP Batam is strategically positioned at the intersection of area management, investment, reservoirs, and raw-water management. PLN/PLN Batam, meanwhile, has an interest in electricity demand and power-system integration, while developers have an interest in investment certainty and project feasibility. The structure shows that many relevant actors are already present, but integration of their interests still depends on inter-institutional relationships rather than on a single governance mechanism that explicitly integrates energy, water, and environmental considerations.	2 - Moderate	The formal structure of actors can be mapped relatively well from the documents and was confirmed through fieldwork. What still requires deeper examination is the actual hierarchy of influence: who sets the project direction, who can delay or alter a decision, and to what extent raw-water managers and community actors have a position in strategic decisions.
2	Cross-sector coordination			
	Cross-sector coordination has taken place since the early stages. The 2022 inspections of Duriangkang and Tembesi involved BP Batam and the Dam Safety Commission, with plans for intensive discussions with ministries/agencies and stakeholders. Project capacity was also planned with reference to dam-safety recommendations.	Field findings suggest that the central issue is how coordination translates into integrated decisions. If each institution provides input based on its sectoral mandate while the final decision remains driven by project interests that have already narrowed, such coordination is consultative rather than fully deliberative.	2 - Moderate	Field evidence already demonstrates interaction and coordination among institutions. The remaining gap concerns traceability of that coordination's influence: what decisions changed following coordination, whether technical recommendations were translated into design or capacity changes, and how differing views were resolved.

3	Clarity of roles and authority			
	Sectoral mandates are relatively clear. BP Batam acts as manager of the reservoirs and the area; PLN/PLN Batam is responsible for electricity demand and the power system; the Ministry of Public Works covers dam and water-resources aspects; environmental authorities oversee the environmental process; and private partners implement investment and construction. Long-term cooperation agreements for the Duriangkang and Tembesi floating solar PV projects have also been signed. (BP Batam)	Clear sectoral mandates do not automatically create clear cross-sector responsibility. The critical point arises when electricity-sector decisions have consequences for raw-water functions. No single institutional position is yet visible as explicitly responsible for the overall trade-off. Under such conditions, each institution may formally exercise its authority correctly while a responsibility gap persists at the level of strategic decision-making.	2 - Moderate	Fieldwork has helped identify the actors and division of functions. What still needs to be clarified is the decision owner at each critical point, particularly where electricity generation, dam safety, raw-water services, and environmental protection point toward different choices.
4	Overlap / gaps in authority			
	No issue was found that could simply be categorized as an inter-agency contest over authority. Rather, there is a need to bring together authority over energy, reservoirs, the environment, investment, and spatial planning within a single decision-making process. Developing floating solar PV on water bodies requires special arrangements because the same space performs an existing public-service function while acquiring a new economic function.	Gaps in mechanisms are more prominent than overlaps in authority. The underlying issue is the absence of a sufficiently strong mechanism for determining limits when energy use of the reservoir comes into tension with its raw-water function. Duriangkang is particularly significant because it is the backbone of Batam's clean-water supply; BP Batam itself has emphasized that floating solar PV development must preserve that function. (BP Batam)	1 - Low	Field findings have clarified the functions and main actors. The remaining gap is the mechanism for resolving competing interests: who has final decision-making authority when energy targets and reservoir-protection requirements point to different options.

5	Decision accountability			
	Project decisions have formed progressively through energy planning, partner selection, agreements on use of reservoir areas, technical studies, the environmental process, and construction preparations. For Duriangkang, cooperation with PT Batam Sarana Surya has been strengthened through several addenda, including the Third Addendum in February 2025.	Formal accountability exists at each stage, but the chain of reasoning behind decisions is not yet fully transparent. This is important because site and partnership decisions developed before the entire environmental process was completed. The evaluative question is whether environmental information can still alter decisions that already carry contractual and investment consequences, or whether it is used only to determine how the project can proceed with risks managed to an acceptable level.	1 - Low	Field surveys have provided information about the actors and decision-making process. What still needs deeper examination is the chronology of decisions and their causal relationships: whose decision determined the location, capacity, and design; what information formed the basis of those decisions; and whether any decision changed because of environmental considerations.
6	Process transparency			
	Information on floating solar PV development has been published by BP Batam, including partner selection, locations, cooperation arrangements, project progress, and technical visits. Tender documents for the use of the Duriangkang reservoir area were published as early as 2022.	Administrative transparency is relatively visible, but substantive transparency is not yet equally strong. The public can learn that the project is progressing and who the main actors are, but the more important question is whether the public can trace the reasons for site selection, comparison of alternatives, the basis for determining capacity, risks to raw water, and how community input was considered in decisions.	2 - Moderate	Fieldwork has provided information on actors' perceptions and experiences of the process. The remaining gap is connecting published information to the substance of decisions: what was disclosed to the public, when the information was provided, and whether key information was available before decisions became difficult to reverse.

7	Institutional capacity			
	Cross-sector technical capacity is evident through the involvement of reservoir managers, the Dam Safety Commission, PLN/PLN Batam, developers, and relevant agencies. BP Batam also has experience in reservoir operation and maintenance and raw-water management. An earlier ESG study of Duriangkang also recorded efforts to strengthen the capacity of dam-management personnel and monitoring of water quality, sedimentation, and existing environmental issues.	Institutional capacity is generally available, but the challenge lies in combining sectoral knowledge into an integrated risk assessment. Floating solar PV requires expertise in dam safety, hydrology, water quality, aquatic ecology, power systems, and social issues. Technical capacity dispersed across many institutions does not necessarily become collective capacity if data, methodologies, and study results are not effectively shared.	2 - Moderate	Field surveys have confirmed the presence of technical capacity and actors. What still needs deeper examination is evidence that this capacity was used in EIA decisions: how raw-water data, reservoir operations, water quality, dam safety, and local knowledge were translated into scoping, impact assessment, mitigation design, and project decisions.

Table 5. Institutional Framework Analysis Scoring Scale

Score	Level of Integration	Evaluation Criteria
3	High	Institutional structures, authority, coordination, accountability, transparency, and capacity function effectively and are demonstrably able to influence the integration of environmental considerations into decisions.
2	Moderate	Institutional mechanisms are available and functioning, but their influence on environmental decisions is not consistent or cannot yet be fully traced.
1	Low	Formal structures are available, but coordination, allocation of authority, accountability, or capacity are not yet sufficient to ensure environmental integration.
0	Very low / Not integrated	No adequate mechanism was found, or significant institutional gaps are present.

4.3. Procedural Framework Study

4.3.1. Procedural Framework for the Development of Batam Floating Solar PV Projects

The procedural framework for Batam's floating solar PV development encompasses a sequence linking project planning, determination of site and capacity, environmental studies, public consultation, preparation of EIA documents, and environmental decision-making. For Duriangkang and Tembesi, this sequence should be understood as a staged decision-making process, not merely as an administrative pathway for obtaining approval. EIA is important because this is the stage at which the project's consequences for reservoir functions, water quality, aquatic ecosystems, community activities, and other activities around the site begin to be translated into impact assessment and management plans. The different characteristics of the two reservoirs also require assessment that responds to site-specific conditions. At Duriangkang, for example, the sustainability of raw-water supply, reservoir drought, water quality, and community activities emerged as issues in the EIA process. Tembesi, meanwhile, must be understood in relation to other activities and plans for use of the reservoir area.

The principal procedural issue concerns the position of EIA in relation to strategic decisions already made. EIA has greater influence when environmental assessment takes place while there is still room to consider alternative locations, designs, capacities, technologies, or operating arrangements. Conversely, if the project direction, location, investment scale, and intended use of electricity have already been relatively fixed before environmental assessment takes place, EIA has less room to change the decision. Procedural quality must therefore be assessed through the relationship between the timing of EIA preparation, the depth of alternatives assessment, cumulative-impact assessment, the quality of public participation, and follow-up to the inputs received. Under this framework, procedural success is not measured simply by completion of EIA stages, but by the extent to which the process generates relevant environmental information with a real capacity to influence decisions on Batam's floating solar PV development.

1. Timing of EIA in Relation to Decisions

The first question is not whether EIA was completed before construction, but at what stage it entered the process relative to decisions on location, scale, and project form. International good practice places impact assessment as early as possible in decision-making, while there is still room to modify or even abandon a proposal (IAIA).

In the Batam solar PV case, the sequence shows that the development agenda had already acquired strategic status before the Tembesi project EIA process took place. Large-scale solar PV development in Batam had been positioned as a National Strategic Project, and since 2022 the local government and BP Batam had undertaken measures to accelerate investment, including discussions with the Ministry of Public Works and Housing on use of the Duriangkang and Tembesi Reservoirs. In December 2022, BP Batam also stated that project development had entered discussions on cooperation agreements following selection of partners for both reservoirs.

For Duriangkang, the ANDAL document shows that public engagement began on 1 August 2023 and continued on 26 March 2024. The first meeting, held at the Duriangkang Water Treatment Plant hall, was attended by 90 participants, while the second, in Sagulung District, was attended by 19 participants. EIA announcements were also published in print media in August 2023 and March 2024 (Duriangkang ANDAL, p. 4-1).

For Duriangkang, the ANDAL records registration in Amdalnet on 30 November 2023. At the same time, the project was positioned as part of the National Strategic Project portfolio through Coordinating Minister for Economic Affairs Regulation No. 6 of 2024 and a 2024 KPPIP letter (Duriangkang ANDAL, p. 1-1). This sequence matters. The project's strategic status developed while the EIA process was already underway, but the documents reviewed do not provide evidence that EIA findings were ever used to reconsider Duriangkang Reservoir as the principal site.

Tembesi follows a different pattern. PT BESS obtained its Approval of Conformity of Spatial Utilisation Activities (PKKPR) on 6 August 2024, while the EIA announcement was issued in September 2024 and public consultation took place on 12 September 2024. The KA form was then agreed on 27 February 2025 (Tembesi ANDAL, p. 221). Critically, this sequence indicates that some spatial decisions had already taken shape before EIA public consultation. The timeline is important because it shows that the decision to use the reservoir for solar PV had been developing for several years before the EIA reached agreement on the terms of reference.

The timing issue therefore concerns EIA's position in the chain of decisions. If site selection and the direction of reservoir use had already become relatively binding before the EIA process, EIA's influence shifts from determining whether and where the project should proceed toward determining how it should be implemented. EIA literature has long warned of this risk: alternatives analysis often loses influence when assessment begins after institutions or proponents have developed strong commitments to a particular proposal (Steinemann, 2001).

Assessment:



EIA timing can be considered reasonably effective in controlling design and impact management, but the available evidence does not show EIA occupying a sufficiently strong position to reopen strategic decisions on project location and development direction.

2. Evaluation of Site Alternatives

Alternatives assessment is one of the key distinctions between EIA functioning as a decision-making tool and EIA used primarily to control the impacts of a choice already made. [IAIA](#) treats examination of alternatives as a central part of EIA because alternatives can change a project's location, technology, scale, or method of implementation.

For Duriangkang, the KA and ANDAL consistently identify Duriangkang Reservoir as the solar PV site. The alternatives explicitly identified mainly concern points for local power delivery: the Panbil Industrial Estate, Muka Kuning Substation, and Batu Besar Substation. Each involves different land requirements and grid configurations (Duriangkang ANDAL, p. 1-1). Alternatives also exist for transmission technology. For Panbil, for example, the options include a 150 kV overhead transmission line (SUTT) or a 150 kV underground cable (SKTT). The document states that only one of the three local supply-point alternatives will be selected based on technical and feasibility studies (Duriangkang ANDAL, p. 2-3).

Tembesi presents a similar issue. The document establishes a single 210-hectare solar PV site, while the alternatives discussed concern mainly the grid and supporting facilities. There are in fact two planned solar PV projects within the reservoir, PT BESS and PT BTS. The projects have different intended uses for the electricity, but the document states that their locations do not overlap. This is important because the document itself identifies the surrounding environment as a complex area. The onshore site intersects with protected forest, water-resource areas, settlements, and other areas already serving social and ecological functions. It also records raw-water treatment facilities, protected forest, settlements, and agricultural land around the project (Tembesi KA-ANDAL, p. 27).

Under these conditions, the question of site alternatives becomes substantive. Was the reservoir option the alternative with the lowest environmental risk? Were land-based sites, other reservoirs, combinations of locations, or different project configurations ever compared using the same environmental and social criteria? The available documents do not provide an adequate answer. Alternatives appear primarily as optimisation of routes and technical components after the project location had already narrowed, rather than as a mechanism for retesting the site choice itself.

Assessment:



Alternatives assessment is present at the project-configuration level, particularly for transmission and supply points, but evidence of strategic site alternatives assessment remains limited. This is one of the clearest indications of the limitations of project-level EIA when strategic decisions have already narrowed.

3. Design and Scale Alternatives

Duriangkang provides more substantial material for evaluating design and scale. The KA form records a staged development plan. The initial phase was planned to cover approximately 34.3 hectares with around 61.58 MWp of capacity for local consumption in Batam. The final phase would cover approximately 720 hectares of reservoir surface with around 1,285.2 MWp directed toward export (Duriangkang ANDAL, p. 2). This change shows that scale is not a neutral technical parameter. Moving from an initial local-supply project to a 720-hectare development with an export orientation changes the amount of space used, transmission infrastructure, pressures on the water body, and the distribution of project benefits.

A later version of the Duriangkang ANDAL describes use of 720 hectares, around 20–30% of the inundated area, with capacity of up to approximately 2,000 MWp DC (Duriangkang ANDAL, p. 1-1). The document also contains several alternative transmission configurations. The issue, however, is not whether technical choices exist—they do—but whether scale alternatives were tested against their ecological and social consequences or mainly against technical feasibility and system requirements.

Tembesi is simpler. The assessed plan has a capacity of 257.9 MWp and uses approximately 210 hectares of reservoir surface. The main document does not show an openly compared range of scale scenarios. Yet Tembesi is highly relevant to cumulative analysis because another solar PV project is planned on the same reservoir (Tembesi KA-ANDAL, p. 184).

There is an important difference between analysing the impacts of a selected design and comparing several designs before a design is selected. The available evidence is stronger for the first category. The EIA explains what will happen if the selected design is implemented, but does not show a systematic comparison, for example, among different surface-coverage levels or different capacity scenarios.

Water-related concerns are precisely why project scale needs to be tested. Community concerns explicitly include declines in reservoir water quantity and quality. In Sungai Beduk, 27% of concerns related to water quantity and 18% to water quality; in Tembesi, 23% related to reservoir water pollution (Tembesi ANDAL, p. 225). The existence of water-impact analysis is therefore not enough to demonstrate that project capacity and design were selected on the basis of environmental evaluation. This is exactly where EIA's function as a decision-making tool must be tested.

Assessment:



Alternatives are reasonably evident in technical configurations, but scale alternatives as an environmental choice have not received comparable weight. At Duriangkang, the shift from a local-scale project toward an export-oriented scale makes it especially important to ask whether the increase in scale was matched by greater depth in environmental assessment.

4. Cumulative Impacts

Cumulative impacts are among the most important indicators for assessing the quality of EIA for Batam's floating solar PV projects. In international practice, cumulative effects include environmental change from a project combined with other past, present, and reasonably foreseeable future human activities (IAIA). The Duriangkang documents do use cumulative character as a criterion in impact assessment. Several impacts are considered cumulative, including disturbance to flora and fauna and traffic impacts from transmission activities. For water quality, the approach is more specific to the project's contribution. For panel installation, the document calculates the difference in total suspended solids (TSS) between without-project and with-project conditions. In one analysis, TSS is projected to increase to 34–36.9 mg/L and remain below the 50 mg/L standard (Duriangkang ANDAL, p. 6-97). This approach, however, is not equivalent to a cumulative effects assessment at the area or system level. Such analysis would examine how the solar PV contribution interacts with hydrological change, industrial activities, traffic, transmission development, reservoir use, land-cover change, and other energy projects.

The Tembesi document also models water quality and projects dissolved oxygen (DO) conditions after panel installation. However, the cumulative nature of water-quality impacts is still classified as non-cumulative. The KA document uses the cumulative nature of an impact as one criterion for determining impact significance, and this criterion reappears in the Significant Hypothetical Impact (DPH) evaluation matrix (Tembesi KA-ANDAL, p. 202). Normatively, this is important because Government Regulation No. 22 of 2021 requires impact evaluation to consider relationships among impacts and with other activities.

The question is whether using “cumulative” as a screening criterion is equivalent to conducting a cumulative effects assessment. Ideally, cumulative assessment examines a project's contribution to environmental change together with past activities, ongoing activities, and reasonably foreseeable future activities. The analytical gap is therefore that a model of water-quality change caused by one project does not automatically constitute cumulative-impact analysis. Cumulative assessment requires asking how the project contributes to the condition of an ecosystem already under pressure from other activities. IAIA treats identification of past, present, and reasonably foreseeable future actions as a core element of cumulative effects assessment.

The Tembesi documents in fact contain a basis for this broader reading. The study area is located around raw-water treatment facilities, settlements, agriculture, plantations, protected forest, an airport, industrial areas, and commercial activities. The document explicitly records these activities as part of the without-project condition (Tembesi KA-ANDAL, p. 197). There is, however, a notable inconsistency. In one section, the document states that there are no other activities in Tembesi Reservoir apart from raw-water treatment, while the surrounding terrestrial area consists of the reservoir buffer zone and protected forest. This statement may be correct in the narrow sense that there is no other project physically within the reservoir body, but it is insufficient for understanding cumulative pressures on the wider ecological and social system. In other words, the document recognises other activities, but this does not necessarily mean that interactions among their cumulative pressures have been analysed in depth.

**Assessment:**

Cumulative impacts appear as a formal category in the EIA, and several impacts are assessed cumulatively. However, the analysis is stronger for the accumulation of specific impacts with nearby activities than for cumulative assessment at the reservoir-ecosystem and Batam energy-area level.

5. Interaction with Other Activities/Projects

The Duriangkang documents incorporate existing activities into several analyses. The clearest example concerns construction of the underground transmission cable (SKTT). Air-quality and noise impacts are categorised as cumulative with existing traffic conditions (Duriangkang ANDAL, p. 6-109). This approach is relevant for local impacts. However, there is a difference between recognising the presence of other activities and integrating them into project decision-making.

Tembesi presents a more complex issue. Two solar PV projects are located on the same reservoir, although their physical locations are stated not to overlap. One project is oriented toward local supply and the other toward industrial areas and exports. The absence of spatial overlap does not automatically mean an absence of ecological interaction. Both projects share the same water-body context. At reservoir-system scale, questions of ecological capacity, water quality, water-level fluctuations, sedimentation, use of water space, access, and public-service functions are more appropriately examined as system-level issues. The documents also show that water-related concerns entered public participation. In Tembesi's public consultation, communities asked for the electricity and water needs of surrounding residents to be prioritised.

During scoping, the document uses the influence of an activity on other activities as one criterion for evaluating potential impacts (Tembesi KA-ANDAL, p. 95). This is appropriate because project impacts do not occur in an empty space. The document also maps activities around the project, including the Tembesi Reservoir raw-water treatment facility, protected forest, settlements, agriculture, and infrastructure networks. For several impacts related to water quality and reservoir biota, the ecological boundary is expanded to encompass the entire Tembesi Reservoir inundation area of approximately 842 hectares (Tembesi KA-ANDAL, p. 190).

The document does not limit the environment to the solar-panel footprint. For water quality and reservoir biota, the study area covers a much wider water body than the physical panel area. However, mapping activities is not automatically the same as analysing their interaction. A distinction must be made between "Project A is near Activity B" and "Project A changes the risks already created by Activity B." This distinction is particularly important for raw-water functions. Water-treatment facilities, land-use change, runoff, sedimentation, settlement activities, and solar PV can interact through the same hydrological system.

Assessment:

Interactions with surrounding activities have been considered for several impacts, particularly traffic and construction. However, interactions among solar PV developments within the reservoir system have not yet been treated as a single ecological issue requiring comprehensive analysis.

6. Appropriateness of Assessment Methods

Methodologically, the documents have a relatively complete structure. Study methods include data collection and analysis, impact prediction, and holistic evaluation. Primary data are obtained through observation, sampling, laboratory analysis, and interviews; secondary data come from agencies, research, universities, and local government. The documents also combine formal and informal methods. Impact prediction may use formulas, quality standards, analogies, professional judgement, and literature. For social assessment, for example, community perceptions are measured through questionnaires and analysed descriptively.

Tembesi uses primary data, social surveys, interaction matrices, flow diagrams, and water-quality modelling. For water quality, a quantitative approach compares without-project and with-project conditions. At Duriangkang, reservoir water quality is monitored at 11 points to support impact evaluation. These strengths should be recognised, but methodology must be assessed against the nature of the issues presented by the project. Floating solar PV on a raw-water reservoir involves dynamic and cross-component issues. Risks to water quality, sedimentation, biota, hydrology, water use, and pressures from surrounding activities may change over the life of the project.

In the available documents, adaptive approaches are more visible in monitoring and management than in decision design. The documents refer to data collection for short-term correction and long-term monitoring (Tembesi KA-ANDAL, p. 200). However, there is no explicit mechanism linking monitoring results to possible changes in capacity, layout, operations, or even partial suspension of activities. Adaptive management requires a clear relationship among uncertainty, monitoring, evaluation, and changes in action. Monitoring should therefore be more than a reporting obligation.

Assessment:

The assessment methods are reasonably diverse and in several areas use quantitative approaches. The principal challenges concern the adequacy of the analytical scale, consistency of the data baseline, and the methods' ability to address long-term and cumulative risks, rather than simply whether scientific methods are present.

7. Public Representation

Formally, public participation has taken place. Announcements were made through print media and at district and subdistrict offices. At Duriangkang, two public consultations were held with 90 and 19 participants. Participants included community members and relevant agencies. Following the consultations, six people from Tanjung Piayu, Muka Kuning, Mangsang, Duriangkang, Kabil, and Tembesi were appointed as community representatives in the EIA process.

Tembesi also held public consultations in Sungai Beduk and Tembesi Subdistrict. Two consultations were held on 12 September 2024 (Tembesi KA-ANDAL, pp. 29–30). Participants included government, affected communities, environmental observers, the project proponent, and consultants. The Sungai Beduk consultation was attended by 59 people and the Tembesi consultation by 31. Four people were subsequently selected as community representatives in the EIA process (Tembesi ANDAL, p. 221).

Procedurally, this coverage shows an effort to involve communities around the project area. Representation, however, cannot be judged solely by participant numbers. The more important question is who attended and who did not. Groups with interests in the reservoir's raw-water function, farmers affected by transmission routes, users of reservoir space, groups economically dependent on local resources, and civil-society organisations have different interests. The Tembesi documents themselves record community concerns about agricultural land, settlements, water quality, flora and fauna, and access to electricity and water. Communities sought certainty over land ownership, priority for local labour, avoidance of settlements in transmission-route selection, information on construction schedules, and attention to local electricity and water needs. These concerns are not trivial. In Tembesi, 32% related to land compensation, 26% to electric and magnetic fields, 23% to reservoir water pollution, and 19% to dust and noise (Tembesi KA-ANDAL, p. 227).

From a procedural-justice perspective, participant lists are insufficient to establish that different interests have equal weight. Meaningful participation requires space for the public to influence issues, alternatives, and decisions, not merely to attend meetings. International EIA principles likewise treat involvement of affected communities and the interested public as a core part of the process. In the Tembesi case, four people were subsequently appointed as community representatives in the EIA process (Tembesi ANDAL, p. 222). Representation may be practically justified, but it does not automatically capture the diversity of interests across the entire study area.

Assessment:



Administrative arrangements for public representation have been established, but the available evidence is stronger in demonstrating attendance and the recording of views than in demonstrating an equal capacity for communities to influence project choices.

8. Access to Information and Quality of Participation

There is a difference between access to attend consultations and access to information that allows communities to make meaningful assessments. IAIA identifies early engagement, openness, inclusiveness, and accessibility as important principles of public participation. Formal access to information was provided. At Duriangkang, announcements were published in print media and posted at district offices and the Environmental Agency. Tembesi used print media and posted announcements at district offices and at the Duriangkang, Mangsang, and Tembesi subdistrict offices.

The issue is that access to information is not the same as the ability to understand it. Technical solar PV documents contain highly complex information on capacity, panel configuration, transmission, water modelling, and ecological risk. The documents do not provide sufficient evidence to confirm that all of this information was translated into materials readily understandable to communities before consultation. Notably, participants in the Duriangkang consultation asked for outreach before construction and for the raw-water supply function to be maintained. They also raised concerns about reservoir drought and environmental impacts (Duriangkang ANDAL, p. 4-3).

At Tembesi, communities requested information on construction timing and communication with communities during construction and operation. Participation appears stronger where community inputs were translated into EIA issues. Concerns about reservoir water quality, for example, were recorded as environmental issues; concerns over land and transmission were incorporated into the Significant Hypothetical Impact (DPH) evaluation; and demands for local employment were translated into management commitments (Tembesi ANDAL, p. 232). A more fundamental issue, however, remains unresolved. Communities were given information about the project being assessed, but there is no evidence that they received equivalent information about the options available before the project had narrowed. If communities are only asked to respond to a location, design, and scale that have already been determined, their scope for participation is different from a situation in which they can compare several alternatives. This matters because participation quality is not determined by the number of meetings, but by the extent to which information and deliberative space allow communities to influence the substance of decisions.

Assessment:



Information channels are available, but the quality of participation is easier to demonstrate at the level of dissemination and consultation than at the level of informed deliberation that enables communities to examine alternatives and risks on an equal footing.

9 . Follow-Up to Public Input

This indicator provides reasonably strong evidence of a relationship between public input and project management. The ANDAL documents include tables matching community inputs with responses from the project proponent. In Duriangkang, communities asked for priority to be given to local workers, attention to reservoir drought, coordination among parties, outreach before construction, protection of raw-water supply, and attention to land used for transmission-tower sites (Duriangkang ANDAL, p. 4-3). The document then records the proponent's commitment to prioritise local labour and manage and monitor environmental and social impacts.

Tembesi provides more explicit evidence. Input on transmission locations was met with a commitment to consider settlements when determining points and routes. Requests for communication during construction were met with plans for coordination and joint evaluation with government and communities. Community electricity and water needs were also recorded for follow-up. Requests to verify land ownership were answered with commitments to conduct inventories; demands for local labour were met with commitments to prioritise local workers; and concerns about transmission locations were answered by considering settlements in route selection (Tembesi ANDAL, p. 223).

Inputs concerning electricity and water needs were also recorded and stated to be subject to follow-up. This shows that public consultation did not end with a list of complaints. However, being "responded to" is not the same as "influencing the decision." Three levels need to be distinguished:

- a. Input is recorded;
- b. Input is answered;
- c. Input causes a substantive change to the project.

The documents provide strong evidence at the first and second levels. Evidence at the third level is much more limited. For example, communities requested involvement in determining transmission points, but the available documents are insufficient to establish that route changes occurred as a direct result of this input. Caution is therefore needed before concluding that public participation was meaningful. Administrative responses to input are an important indicator, but the capacity of that input to change decisions is a stronger one.

Assessment:



public input has a reasonably clear pathway into impact management, but evidence of its influence on strategic decisions remains weak. Participation appears more effective in changing mitigation and management measures than in changing project choices.

10. Influence of EIA on Decisions

The final indicator brings the entire analysis together, because the preceding nine indicators ultimately inform the question: what decisions were actually produced on the basis of EIA analysis? Formally, EIA plays an important role in determining significant impacts, preparing the RKL-RPL, evaluating technical alternatives, and providing a basis for environmental-feasibility considerations. At Duriangkang, the ANDAL explicitly states that impact evaluation includes review of significant impacts, selection of the best alternative, management and monitoring directions, and an environmental-feasibility statement (Duriangkang ANDAL, p. 2-3).

Tembesi uses a similar approach in its holistic evaluation. Scoping produced 57 potential impacts and 43 Significant Hypothetical Impacts (DPH). Surface-water issues, reservoir biota, disruption to clean-water use, health, community concern, land, and socio-economic conditions were included in the study framework (Tembesi KA-ANDAL, pp. 184–185). EIA also established spatial and temporal study boundaries. For water-quality and biota impacts, for example, the ecological study area was expanded to include the approximately 842-hectare inundation area of Tembesi Reservoir (Tembesi KA-ANDAL, p. 190). This shows that EIA has a real influence on how the project is managed and monitored.

When this indicator is extended to strategic decisions, however, the limits of EIA's influence become visible. At Duriangkang, the reservoir had already become the basis of the project, while the alternatives explicitly available mainly concerned transmission networks and supply points. At Tembesi, the 210-hectare location had become the basis of the assessment and PKKPR had already been obtained before public consultation in September 2024. The available evidence is therefore much weaker in showing that EIA affected strategic decisions about the project itself. There is insufficient evidence that EIA findings caused:

- a. the solar PV site to change;
- b. project capacity to be reduced or increased;
- c. panel coverage on the reservoir to be significantly changed;
- d. an alternative site to be selected;
- e. the principal project design to be changed;
- f. the project to be postponed because of environmental risk;
- g. or the no-project option to be seriously considered..

EIA analysis produces considerations on how the project should be built and controlled. Examples include selection of transmission routes to avoid settlements, management of water quality, control of construction impacts, priority for local labour, and social management. At Duriangkang, changes in technical parameters and several alternative transmission configurations were also analysed. However, there is still little strong evidence that EIA has an equivalent capacity to answer the more fundamental questions: is this location the environmentally preferable option; is the selected scale the most acceptable in light of the reservoir's carrying capacity; and are local benefits commensurate with the risks borne by communities and ecosystems?

This gap matters because good EIA should leave room to modify a proposal when new environmental information emerges. IAIA explicitly positions EIA as a process for understanding the consequences of an action while there is still an opportunity to modify or abandon the proposal (IAIA). In the Tembesi case, the available evidence more strongly shows EIA functioning as an instrument for refining and controlling an already narrowed project than as an instrument for determining whether the project, its site, or its scale is the best option.

Assessment:



EIA influence over strategic decisions is low because the project location, reservoir-use arrangements, partnerships, and capacity had already narrowed before the EIA process was completed. EIA influence is more visible in technical requirements, risk management, and impact control during construction and operation, although evidence of project-design changes directly resulting from EIA findings remains limited.

4.3.2. Synthesis of the Procedural Framework Evaluation

One pattern is reasonably consistent across both sites. EIA works most effectively when the question is: "How should this project be implemented so that its impacts can be controlled?" Its influence becomes more limited when the question changes to: "Were this location, scale, orientation, and development configuration the most appropriate choices from the outset?"

This distinction is important for understanding Batam's floating solar PV projects as strategic energy-transition projects. At Duriangkang, the shift from an initial phase of around 34.3 hectares for local consumption toward a 720-hectare plan with an export orientation shows that decisions on project scale and function have consequences far beyond the technical question of electricity generation. At Tembesi, the presence of two solar PV projects with different intended benefits within a single reservoir system demonstrates the need to consider impacts at area and system scale, rather than treating each project in isolation.

From an environmental-governance perspective, the principal issue is not the absence of EIA. EIA is present; it uses field data, involves communities, conducts modelling, identifies impacts, and produces management plans. The issue is EIA's position within the decision architecture. When site choices, investment directions, export requirements, or project scale have already acquired policy legitimacy before the full environmental consequences are strategically examined, EIA risks functioning primarily as a mechanism for controlling the impacts of decisions that have already taken shape.

This is where the SEA approach becomes relevant. IAIA positions SEA as an instrument operating earlier at the policy, plan, and programme levels, with particular attention to alternatives, cumulative impacts, participation, and long-term consequences. In Batam, this need is especially visible in the choice of water bodies, the scale of reservoir use, the relationship between local demand and export, and the accumulation of multiple energy projects within a single ecological system.

Table 6. Procedural Framework Findings and Assessment Matrix

No.	Indicator	Duriangkang Findings	Tembesi Findings	Assessment
1	EIA timing	The participation process had been underway since 2023; the project subsequently obtained National Strategic Project (PSN) status in 2024.	The Conformity of Spatial Utilization Activities (PKKPR) was obtained in August 2024, followed by public consultation in September 2024.	The scope for influencing early-stage decisions was not strong.
2	Site alternatives	No comparison of alternative reservoirs was identified; alternatives focused mainly on transmission/offtaker arrangements.	One solar PV site; alternatives were focused more on supporting configurations.	Weak at the strategic level.
3	Design/scale alternatives	Phased development and several transmission configurations were considered.	The range of scale alternatives was not strongly evident.	Moderate; stronger on technical aspects.
4	Cumulative impacts	Several impacts were assessed cumulatively with surrounding activities.	Two planned floating solar PV projects are located within the same reservoir, but the systemic analysis remains limited.	Moderate to weak at the area-wide level.
5	Interaction with other projects	Traffic and surrounding activities were included in several analyses.	PT BESS and PT BTS are located within the same reservoir system.	Not yet fully assessed as an integrated system.
6	Assessment methods	Surveys, sampling, water modelling, and ecological analysis.	Dissolved oxygen (DO) modelling, water sampling, and social surveys.	Technically fairly strong, but greater consistency in the data baseline is needed.
7	Public representation	Two consultations, with 90 and 19 participants; six representatives.	Two main forums, with 59 and 31 participants; four representatives.	Formally adequate, but the quality of representation needs to be assessed.
8	Access to information	Mass media, government offices, and consultations.	Mass media, subdistrict/village offices, and consultations.	Formal access is available.
9	Follow-up	Input was incorporated into environmental-management commitments.	Several inputs received specific responses.	Stronger in mitigation than in changing decisions.
10	EIA influence on decisions	Influenced environmental management and certain project configurations.	Influenced mitigation and environmental management.	Limited ability to change strategic choices.

4.4. Effectiveness of the Policy, Institutional, and Procedural Frameworks in Practice

4.4.1. Alignment between Policy Claims and Practice

Indonesia's energy-policy framework has positioned renewable energy as part of the energy transition, emissions reduction, and low-carbon economic development. This direction has been strengthened in the latest power-sector policy. The 2025–2034 RUPTL targets 69.5 GW of additional generation capacity, 76% of which is to come from renewable energy and energy-storage systems. The government also positions the RUPTL as an important instrument for increasing the use of clean energy while meeting national electricity demand. At the regional level, this orientation intersects with the agenda to develop Batam as an industrial and investment centre. BP Batam's 2025–2029 Strategic Plan explicitly includes development of the Duriangkang Reservoir floating solar PV project as a development agenda. Normatively, there is therefore reasonably clear alignment among national policy direction, the regional-development agenda, and the emergence of floating solar PV projects in Batam.

This alignment is also visible in the relationship between Batam's clean-energy development and Indonesia-Singapore cooperation. In June 2025, the two countries signed three MoUs covering cross-border electricity trade, renewable and low-carbon energy technologies, and development of a Sustainable Industrial Zone in Batam, Bintan, and Karimun. The Indonesian government explicitly linked this cooperation to green-energy development and sustainable industrial areas. At the implementation level, the Duriangkang solar PV project has taken concrete institutional form through cooperation between BP Batam and PT Batam Sarana Surya. That agreement was reinforced through a Third Addendum in February 2025. BP Batam has publicly linked the project to renewable-energy needs supporting the sustainability of Batam's industry. A similar pattern is visible at Tembesi, which entered a solar PV development cooperation scheme with BP Batam in 2022. From the perspective of energy-policy implementation, these developments show that claims of accelerating renewable energy and green investment have been translated into concrete projects, investment partnerships, and regional-development agendas.

Field findings, however, need to be assessed at a different analytical level. Alignment between policy claims and practice is relatively strong for the energy and investment agendas, but not yet equally strong for ecological sustainability. In practice, project success is easier to trace through generation-capacity indicators, investment partnerships, institutional support, and integration with industrial needs. By contrast, the relationship between sustainability claims and protection of reservoir functions as raw-water sources still requires stronger evidence at the project-decision level. This is important because Duriangkang performs a highly strategic raw-water service function; in 2025 BP Batam was still carrying out forest rehabilitation around the Duriangkang Catchment Area to protect raw-water quality. Within the same geographic space, therefore, two development agendas are treated as strategic: increasing renewable-energy capacity and maintaining the reliability of raw-water sources.

Evaluating policy claims against practice therefore produces a finding of partial rather than full alignment. Energy-transition policy has clearly been translated into solar PV development. Claims of green investment have also taken form through cooperation among government, business entities, and the Indonesia-Singapore regional agenda. However, the meaning of sustainability becomes more problematic when applied to water bodies that already perform public-service functions. The issue is not the presence of solar PV on a reservoir in itself, but whether protection of raw-water functions receives equal weight when decisions are made on solar PV location, scale, design, and operation. This is where the gap between policy claims and practice must be read more critically: the energy-transition agenda has successfully moved from policy to project, while mechanisms ensuring that ecological and water-service functions operate as substantive limits on the project are not visible with equal strength.

The assessment for this indicator should therefore be framed as “high integration for the energy and investment agendas, but moderate integration of cross-sector sustainability.” Field findings do not support the conclusion that energy policy ignores the environment. Rather, the problem lies in an imbalance in the degree to which different policy components are realised. Renewable-energy targets, green investment, and area development have clear implementation pathways, while links between those targets and protection of raw-water functions, distribution of environmental risk, and the ability of environmental considerations to change project choices are more difficult to trace. In other words, policy has succeeded in making the energy transition a development decision, but it has not yet been fully demonstrated that sustainability principles operate as an equally strong constraint on how that decision is implemented.

Assessment:

Alignment between policy claims and practice = Moderate-High.



Strong alignment is evident in translating renewable-energy targets, green investment, and area development into concrete solar PV projects. The rating remains Moderate-High because integration of ecological considerations, particularly protection of the raw-water function and the influence of environmental considerations on project decisions, does not yet have empirical traceability comparable to the energy and investment dimensions.

4.4.2. Alignment between Institutional Design and Practice

Formally, the institutional design for Batam's floating solar PV development has established a relatively clear division of functions. BP Batam occupies an important position because it controls area management and reservoir use, while business entities act as project-development partners. In December 2022, BP Batam selected PT Batam Sarana Surya as partner for Duriangkang Reservoir and PT TBS Energi Utama Tbk for Tembesi Reservoir. The cooperation was structured for a 25-year period. At Duriangkang, the institutional relationship was later reinforced through a Second Addendum in December 2024 and a Third Addendum in February 2025. BP Batam publicly positions this cooperation as support for renewable-energy development and for increasing Batam's industrial competitiveness. This structure shows that solar PV development is not treated as a stand-alone energy project. It is embedded within the asset- and area-management system under BP Batam's authority and translated into contractual relationships with business entities.

Field findings show that this division of functions operates within an institutional structure that already includes reservoir and raw-water management. This matters because BP Batam does more than provide space for solar PV development. Its SPAM, Facilities, and Environment units also handle water services and environmental management. The organisational structure of BP Batam's Integrated One-Stop Service Centre (PTSP) demonstrates continuity in these functions; officials currently responsible for integrated services previously had direct experience in reservoir, raw-water, and SPAM management. Institutionally, this provides a reasonably strong basis for coordination because energy and water interests exist within the same organisational environment. Institutional proximity, however, does not automatically resolve conflicts of interest. Precisely because one institution holds interests in area development, asset utilisation, water services, and investment facilitation, it is necessary to assess whether each function receives equal weight when decisions are made about use of reservoir surfaces.

This issue is particularly important at Duriangkang and Tembesi because the reservoirs performed public-service functions before the solar PV projects were planned. BP Batam identifies Duriangkang as one of Batam's principal clean-water sources, while Tembesi Reservoir also supports clean-water production. In 2025, BP Batam was still rehabilitating forest around the Duriangkang Catchment Area to protect raw-water quality and clearing structures from the Tembesi Catchment Area on the grounds of protecting raw-water-source quality. In early 2026, BP Batam again made raw-water security a priority and instructed SPAM operators to strengthen monitoring of supply quality, quantity, and continuity. These facts show that protection of water functions is not merely a normative mandate; it is an active service function under management and subject to its own pressures. In this context, using reservoir surfaces for solar PV creates a more complex institutional relationship than a simple relationship between an asset owner and an investor.

From an independent perspective, an important issue in this study is which actor has the authority to set limits when solar PV development interests conflict with the need to protect reservoir functions. Public documents show that BP Batam consistently supports both agendas. On the one hand, it promotes use of reservoirs as part of green-energy development. On the other, the same institution carries out catchment-area protection, forest rehabilitation, expansion of water-treatment capacity, and oversight of raw-water security. This cannot automatically be categorised as an institutional conflict. It does, however, create a potential conflict of functions that should be addressed through a clear decision-making mechanism. If the raw-water function represents a safety and public-service constraint, it should be clear how that constraint is translated into conditions for reservoir use, solar PV design, the area that may be covered, and the circumstances under which solar PV operations may be limited.

Project development also shows that institutional relationships were formed relatively early. By 2022, BP Batam had completed partner selection for both reservoirs and entered discussions on cooperation agreements. At Duriangkang, that relationship continued to be reinforced through addenda until 2025. This sequence is important for evaluating EIA effectiveness. When an asset-owner/partner relationship has been established before the environmental process produces substantive decisions, EIA has less room to change the institutional direction of the project. EIA can still impose conditions and influence implementation, but the authority to determine the direction of asset use has already been operating through a separate institutional pathway.

Tembesi provides a clearer illustration of this issue. Since 2022, BP Batam had selected a partner to use the Tembesi Reservoir inundation area for solar PV development. At the same time, reservoir management continued as part of Batam's raw-water system. In 2025, BP Batam was still enforcing controls in the Tembesi catchment area to protect raw-water quality. These two processes proceeded in parallel. The institutional structure was therefore able to accommodate two interests within the same area, but the available evidence is stronger in demonstrating coexistence of functions than in demonstrating a mechanism that explicitly determines priority when those interests conflict.

These findings require the assessment of institutional design to be distinguished from the assessment of institutional effectiveness. The institutional design can be considered reasonably strong in its allocation of actors and establishment of working relationships, but the effectiveness of cross-functional coordination cannot be rated highly merely because formal structures exist. For a project using a water body for both energy and public-service functions, institutional effectiveness should be visible in the structure's ability to produce traceable decisions: who sets limits on reservoir use, who assesses consequences for raw-water supply, who has authority to reject or modify the project design, and who is responsible when trade-offs arise between electricity generation and water security?

The triangulation of documents, project developments, and field findings is therefore best interpreted as partial alignment between institutional design and practice. The formal structure has functioned to connect the reservoir owner/manager with business entities and enable projects to move from policy agenda to concrete development. However, a checks-and-balances mechanism explicitly separating investment-development interests from raw-water protection functions is not visible with the same level of traceability. This is highly relevant to EIA effectiveness: if conflicts among institutional functions have already been resolved or channelled through contractual relationships before EIA reaches its substantive stage, EIA will have less room to influence strategic decisions.

Assessment:

Alignment between institutional design and practice = Moderate.



The actor structure and institutional relationships have functioned in practice in the development of Duriangkang and Tembesi. The limitation lies in the lack of strong public evidence on mechanisms for determining priorities and accountability when energy, investment, raw-water services, and environmental protection point toward different choices. This is one of the most important issues in assessing whether EIA functions as a decision-making instrument or operates mainly within institutional decisions that have already been formed.

4.4.3. Alignment between the EIA Process and Stakeholder Experience

The EIA process for Batam's floating solar PV projects incorporates social information through surveys, interviews, and public consultations at both sites. However, findings from Duriangkang and Tembesi show that community experiences of the projects are not identical. At Duriangkang, concerns are more strongly related to continuity of the reservoir's raw-water function, loss of assets or cultivated land, participation in development, and safety risks. At Tembesi, concerns relate more to water quality, temperature, radiation, lightning, safety, participation in development, and disruption to economic activities. These differences matter because they show that public participation generated location-specific information rather than simply expressions of support or opposition.

At Duriangkang, the ANDAL records that 77% of respondents were aware of the planned solar PV project while 23% were not. The largest source of information was the subdistrict government at 55%, followed by neighbours at 22% and district government at 18%. Seventy-eight per cent of respondents agreed with the project and 5% strongly agreed, primarily because of expectations of employment opportunities. At the same time, 6% gave no response, 8% somewhat disagreed, and 2% disagreed. The document links some negative attitudes to limited information about the project. These figures require careful interpretation. High levels of support do not in themselves mean that communities understand all project consequences. The presence of groups that had not received information and respondents who did not express a view demonstrates that participation quality should be assessed through the depth of information received, not simply by the proportion expressing support.

Concerns raised at Duriangkang also show a direct relationship between community interests and the reservoir's ecological function. Among 96 respondents, the largest concerns related to lightning and radiation hazards at 22%, loss of assets or livelihoods at 19%, and exclusion of residents from development at 16%. Concerns about disruption to reservoir water sources accounted for 3%, reservoir water pollution 2%, disruption to community clean-water sources 1%, and disruption to socio-economic activity 6%. These percentages should not be read as indicating low concern about water. In the more specific public consultation, the reservoir's principal function emerged as the issue receiving the greatest weight. The matrix of consultation concerns records changes in reservoir water quality and quantity, given its raw-water function, as the highest concern at 27%. Concern about residents not being involved in development reached 23%, while disruption to socio-economic activities accounted for 11%.

These findings have important implications for evaluating EIA quality. Concern about raw water did not remain merely a social perception. In the Duriangkang environmental documents, installation of panels over approximately 720 hectares is linked to potential increases in total suspended solids (TSS) during construction. Because reservoir water is used as raw water, this impact is treated as a Significant Hypothetical Impact. There is therefore a relatively clear relationship between community concerns and the environmental issue subsequently incorporated into technical analysis. At this stage, the EIA process shows reasonably good alignment with stakeholder experience.

Tembesi shows a different pattern. The ANDAL records 100 respondents in the 2025 primary survey. Seventy-five per cent agreed and 5% strongly agreed with the development plan, with the main reason for support being expectations of employment opportunities for surrounding communities. However, 10% gave no response because of limited knowledge about the project. At the same time, 91% of respondents reported concerns about the planned activity. These related mainly to increased temperature (47%), radiation (24%), lightning hazards (14%), disruption to economic activity (6%), and reservoir water pollution and exclusion of communities from development (11%). Concerns were also raised regarding disruption to clean-water sources and land-compensation values.

Tembesi illustrates an important point for evaluating the EIA process: support for a project and concern about its impacts can exist simultaneously. Communities may accept a project because they expect jobs and economic benefits while at the same time remaining concerned about environmental quality and safety. These positions should not be treated as contradictory. For communities around the reservoir, economic benefits and environmental risks are two consequences of the same project. Support for development therefore cannot be used as the sole indicator that participation has produced strong social acceptance.

The Tembesi documents also provide a more detailed picture of communities' relationship with reservoir resources. Activities around the area include cultivating land and using the water body. Some residents use Tembesi Reservoir for fishing and cast-net fishing as supplementary sources of livelihood, even though the area is formally designated for raw-water functions and has been subject to enforcement action by BP Batam. This makes the definition of affected communities more complex. Impacts do not always take the form of land loss or relocation. Restrictions on access to resources that have long been used informally can also constitute socio-economic change that needs to be considered in the environmental process.

In terms of spatial coverage, both EIAs attempt to include communities around the projects. The Duriangkang document covers six subdistricts in the study area, while the Tembesi document uses communities around the reservoir and the transmission corridor as the basis of its social assessment. This geographic coverage is relatively broad. However, a wide survey area does not automatically ensure substantive representation of all interested groups. Groups expecting employment benefits, people cultivating land, communities dependent on water functions, and parties concerned with reservoir quality have different positions and levels of dependence. Representation quality is therefore better assessed by the diversity of interests incorporated into the analysis than by the number of subdistricts or respondents alone.

Differences between Duriangkang and Tembesi are also visible in how community concerns are translated into impact assessment. At Duriangkang, concern about disruption to reservoir water is recorded in the operational impact assessment. The document then classifies it as a Managed and Monitored Non-Significant Impact (DTPH) on the grounds that operation and maintenance do not use large quantities of chemicals. At Tembesi, community concern arising from operational activities is also quantified. The document records 54 respondents concerned about operational activities compared with 80 respondents holding positive perceptions, and calculates the level of concern at 67.5%. These approaches show that neither EIA simply ignores community perceptions; both incorporate them into the assessment method. The evaluative question then becomes whether measuring those perceptions is strong enough to change project design and management.

This is where an important limitation in the EIA process appears. Quantifying concern can show the proportion of communities that are worried, but the number does not automatically explain the substantive significance of a concern. The fact that 11% of Tembesi respondents are concerned about water pollution does not mean the issue is less important than a concern with a higher percentage. For a reservoir functioning as a raw-water source, the significance of an issue also depends on its potential ecological and public-service consequences. Similarly, at Duriangkang, the proportion of respondents concerned about reservoir water should be considered together with the reservoir's strategic function and the findings of water-quality, hydrological, and construction-risk analysis.

Comparison of the two sites must also take account of project scale. At Duriangkang, the planned solar PV development extends to around 720 hectares and the EIA identifies approximately 1.8 million panels. At Tembesi, the plan in the available ANDAL is much smaller, at around 210 hectares. This difference matters because the form and intensity of community concerns cannot be compared directly using respondent percentages alone. Duriangkang raises issues across a much larger spatial scale and occupies a highly important position in Batam's raw-water system. Tembesi has a smaller project scale, but surrounding communities have forms of land and water use that need to be taken into account. The two sites therefore require different socio-ecological readings within the same procedural framework.

Developments in Batam's water system in 2026 further reinforce the importance of this context. BP Batam continued to identify Duriangkang and Tembesi as reservoirs requiring attention to maintain raw-water security. BP Batam even prepared weather-modification operations when declining reservoir levels became a concern during the dry season. These facts provide new context for community concerns recorded in the EIA process. Concerns about water quantity and continuity cannot be treated as perceptions alone because water security is in fact an operational issue still being managed by the reservoir authority.

From an independent perspective, alignment between the EIA process and stakeholder experience is moderate, with different characteristics at Duriangkang and Tembesi. At both sites there is evidence that communities were involved and that their concerns entered the environmental documents. Duriangkang shows a stronger link between community input on raw-water functions and identification of water-quality impacts in the ANDAL. Tembesi presents a broader spectrum of social concerns, ranging from water quality, temperature, radiation, lightning, and employment to economic access to the reservoir. However, this involvement cannot yet be fully interpreted as influence over decisions. The available evidence is stronger in showing that EIA captures and classifies community experience than in demonstrating that those experiences changed site selection, scale, design, or strategic project decisions.

These findings also clarify the position of EIA within overall project governance. In September 2022, BP Batam and the Ministry of Public Works' Dam Safety Commission visited Duriangkang and Tembesi to assess the initial condition of the two reservoirs before their use for solar PV. At that time, BP Batam had already identified initial targets of approximately 40 MW at Tembesi and 720 MW at Duriangkang. By December 2022, partner selection for both reservoirs had also been completed. This means that consultation and environmental assessment took place in the context of projects whose basic direction had already been formed. Participation retained scope to influence risk management and project implementation, but had less room to change the underlying decision to use the two reservoirs as solar PV sites.

Assessment:**Alignment between the EIA process and stakeholder experience = Moderate.**

Both Duriangkang and Tembesi show efforts to capture community experience through surveys and consultation. At Duriangkang, the raw-water function emerged as an important issue directly linked to analysis of water-quality impacts. At Tembesi, the EIA process captured a wider range of concerns regarding environmental quality, safety, employment, and access to resources. The main limitation is the lack of strong evidence that such input had the power to alter strategic project decisions. EIA has provided a channel for community voices to enter the assessment process; the remaining question is how far those voices can move from consultation into binding decisions.

4.4.4. Current Socio-Ecological Conditions

Duriangkang and Tembesi cannot be treated as empty spaces waiting to be filled by energy infrastructure. Both are parts of Batam's raw-water supply system, with social and ecological functions that existed before the solar PV plans emerged. BP Batam planning documents position reservoirs as principal raw-water sources, while water-treatment capacity from Duriangkang and Tembesi already forms part of the city's water-service system. In 2025, BP Batam recorded that use of reservoir raw water had reached maximum capacity and that stressed service areas remained in the network. This provides important context for environmental assessment: additional activities on the water bodies must be assessed against existing service functions, not only against their physical condition at the time of sampling.

At Duriangkang, the ecological baseline in the ANDAL shows that water quality was not uniform across all parameters. Measurements at several points show TSS below the applicable quality standard, but other parameters such as BOD and certain nutrients vary across sampling points. The available ANDAL records TSS at six points ranging from 13.6 to 18.2 mg/L against a standard of 50 mg/L. These data matter because "meeting the standard" is not equivalent to an absence of ecological pressure. The baseline should be understood in terms of spatial variation, parameters already under pressure, and the reservoir's function as a raw-water source.

This becomes more important when the baseline is compared with the characteristics of the planned project. Solar panels at Duriangkang are planned over approximately 720 hectares with more than 1.8 million panel units. Construction activities, including installation of supporting facilities and a launching platform, are expected to increase TSS and affect water quality. The EIA explicitly links this risk to Duriangkang's raw-water function and classifies it as a Significant Hypothetical Impact. Community concern about declining water quality due to construction was also recorded during scoping. There is thus a clear link among the reservoir's ecological function, social concerns, and the issue incorporated into EIA analysis.

Field surveys in early September 2026 produced findings different in character from the planning documents. Construction of the Duriangkang solar PV project had not begun, and the reservoir was still functioning as a raw-water source at the time of the visit. Interviews with communities around Tanjung Piayu also showed that the reservoir was understood first in relation to water needs rather than as a space for energy development. This is important for interpreting the position of EIA. Risks recorded in the documents remain forecasts, while communities on the ground experience the water function as an actual and everyday reality.



Figure 8. Documentation of Interviews with Residents of RT 3, Tanjung Piayu, Sei Beduk, Duriangkang

The difference between baseline conditions that still comply with quality standards and potential changes caused by the project deserves attention. Baseline compliance does not in itself answer whether project-induced ecological change is acceptable. For a reservoir functioning as a raw-water source, small changes in quality, quantity, temperature, sedimentation, or water-circulation patterns can have different significance than they would in a water body without a public-service function.



Figure 9. Documentation of Construction Progress at the Tembesi Reservoir Solar PV Project

At the time of the field survey in early September 2026, construction of the Duriangkang solar PV project had not begun. The reservoir was still used solely for raw-water supply through the SPAM system. Reservoir managers and surrounding communities had not yet received detailed information on the planned development of solar PV at Duriangkang Reservoir.



Figure 10. Documentation of Duriangkang Reservoir

Tembesi presents a different configuration. The reservoir also serves as a raw-water source and is connected to Batam's water-supply system. The ANDAL records water-quality sampling at eight points covering the upstream area, the vicinity of the planned BESS/power plant, the centre of the solar PV site, the downstream area, and the dam body. Under baseline conditions, several parameters already showed water-quality concerns. BOD exceeded the standard at sampling point AP-5, while total phosphate exceeded the standard at AP-1 and AP-2. The document links these conditions to organic compounds that may affect the aquatic ecosystem. This means Tembesi has an ecological baseline that needs to be understood in more nuanced terms than simply stating that the reservoir "meets quality standards."

These findings are even more relevant because the Tembesi solar PV plan covers around 210 hectares of reservoir surface and approximately 387,872 panels. The ANDAL estimates that land preparation for onshore facilities could generate around 2.56 tonnes of suspended material per day that could enter the water body. At one point near the BESS, TSS was recorded at 26 mg/L against a quality standard of 25 mg/L. Thus, Tembesi's baseline already includes parameters at or above reference values before all project activities take place. In this context, post-project monitoring should not simply compare results with quality standards; it should examine change from the baseline, the location and timing of that change, and the project's contribution to existing pressures.

Tembesi's social dimension also differs from Duriangkang. Formally, the reservoir is designated as a raw-water source and communities are not permitted to use it for fishing activities. In practice, the ANDAL still identifies residents who catch fish using cast nets or fish from the reservoir edge. Communities also cultivate land around the reservoir. BP Batam has gradually undertaken enforcement against such activities. This reveals a difference between the reservoir's official function and the socio-economic functions taking place in practice.



Figure 11. Documentation of Interviews with Tembesi Community Leaders
(a. Head of RT 1 Tembesi; b. Head of RT 3 Tembesi)

This distinction matters for environmental assessment because changes in spatial use caused by the solar PV project are not taking place in an area wholly unused by communities. On the one hand, community access to the reservoir had already been restricted before the solar PV project. On the other, some residents still use the area for economic activities. Solar PV may therefore add to restrictions on access already subject to enforcement. These effects should not all be categorised as entirely new project impacts, but neither should actual patterns of use be ignored simply because they do not conform to the reservoir's formal function.

Current conditions at Tembesi also show that raw water is not merely a hypothetical issue. The ANDAL records that before the project, Tembesi functioned as one of Batam's main raw-water sources and no disturbance to water quality or quantity directly affecting community use of clean water had been identified. On that basis, the impact of interference with clean-water use during solar PV operation was assessed as non-significant and non-cumulative. At the same time, the community survey records that 11% of respondents were concerned about reservoir water pollution and 1% about disruption to clean-water supply. This difference indicates a distinction between the absence of actual disturbance at baseline and concern about possible changes after project operation. The two findings are not contradictory.

These findings raise an important methodological issue. Where an impact is assessed as non-significant because no actual disturbance exists at baseline, that assessment may accurately describe the starting condition. However, for a project placing hundreds of thousands or millions of panels on a raw-water reservoir, a good baseline is also a reason to strengthen the ability to detect change. The Tembesi EIA plans monitoring of water quality and quantity before and during operation in response to community concerns. In other words, the absence of baseline impacts does not guarantee that water functions will remain unaffected after the project begins operating.

The hydrological context in 2026 reinforces this argument. In May 2026, BP Batam stated that declining water levels at Duriangkang and Tembesi were a concern and prepared Weather Modification Technology operations to maintain reservoir volumes. In August 2026, BP Batam again stated that reservoirs are the principal source of raw water and that water security faced pressure from the dry season and El Niño. This information is highly relevant to current socio-ecological conditions because field surveys were conducted in early September 2026, precisely when water security was a concern for reservoir managers. These hydrological conditions provide context not fully reflected in earlier EIA baselines.

Several arguments emerge from assessing the two sites symmetrically. Duriangkang is more sensitive in terms of its water-service function and the scale of the planned solar PV project, while Tembesi shows more visible water-quality pressures and social-use dynamics in the EIA documents. This does not mean that one site is necessarily riskier overall; their risks arise through different mechanisms. At Duriangkang, the central issue is how a very large project can be located on the reservoir that forms the backbone of Batam's water system. At Tembesi, the issue concerns interactions among the project, a water-quality baseline already showing problematic parameters, and changing community access to a space that has been used on a limited basis.

This comparison shows that current socio-ecological conditions cannot be reduced to compliance with quality standards. Standards provide normative thresholds for environmental quality, but do not describe the full sensitivity of a water body to change. At Duriangkang, water quality below standards must be considered together with the reservoir's strategic function and project scale. At Tembesi, parameters already exceeding or approaching standards must be clearly distinguished as baseline conditions from any project contribution. This approach better differentiates existing pressures, pressures potentially added by solar PV, and changes arising from the interaction of the two.

Field findings also show the importance of separating pre-project conditions from perceptions of project risk. At Duriangkang, the absence of construction means there is no empirical evidence of solar-PV-induced changes in water quality. At Tembesi, the same applies to operational impacts on raw-water functions. Community concerns therefore cannot be treated as evidence that impacts have already occurred, but neither should they be dismissed simply because impacts have not yet happened. Within EIA, such concerns function as signals of environmental components considered important by communities and requiring monitoring.

From an independent perspective, socio-ecological conditions at both reservoirs show that EIA has recognised a number of relevant risks, but the strength of environmental protection depends heavily on maintaining the baseline, monitoring change, and linking monitoring results to operational decisions. Duriangkang does not yet provide field evidence of actual solar PV impacts because construction has not begun. Tembesi likewise does not yet provide a basis for concluding that solar PV operations have caused declining water quality or disruption to raw-water functions. The documents provide ecological baselines, pre-existing social conditions, community concerns, and impact forecasts. Conclusions about environmental-protection effectiveness therefore cannot yet be based on the presence or absence of post-project pollution, but rather on how strong the system is in detecting and responding to change once projects enter construction and operation.

Assessment:

Current socio-ecological conditions = Moderate.



Both EIAs provide sufficient baseline information to identify reservoir functions, water quality, social conditions, and potential project-related changes. However, current conditions show that both reservoirs were already experiencing pressures and socio-ecological dynamics before solar PV operations began. Duriangkang is highly strategic for Batam's water security, while Tembesi faces certain water-quality issues and community uses of reservoir space. EIA effectiveness therefore cannot be measured only by compliance with quality standards. A more decisive measure is its ability to distinguish baseline conditions, existing pressures, project contributions, and cumulative changes affecting the raw-water function.

4.4.5. Distribution of Benefits and Risks

Batam's floating solar PV development generates benefits at several levels. At the system level, the projects support additional renewable-energy capacity and reduce dependence on fossil-fuel-based generation. At the area level, they are linked to green investment, stronger energy infrastructure, and Batam's industrial development. At the local level, the most visible benefits in the EIA documents are employment and business opportunities during construction and operation. At Tembesi, for example, construction is expected to involve approximately 943 workers, around 900 of whom would be unskilled workers expected to come from local communities. Business opportunities for food stalls and other local economic activities are also identified as potential benefits.

Large investments and macro-level benefits, however, do not automatically mean that benefits are proportionately distributed to communities around the reservoirs. During Tembesi's operational phase, the workforce is estimated at only around 36 people, with priority given to qualified local residents. At the end of the lease period, the documents also anticipate termination of those 36 workers when the assets are transferred to BP Batam. Employment benefits are therefore limited in number and dependent on project operational needs. They do not automatically become long-term benefits for all communities around the reservoir.

A similar pattern appears at Duriangkang. The EIA identifies local employment as a project benefit and provides for monitoring the number of local workers recruited. The monitoring area includes Duriangkang, Mangsang, Tanjung Piayu, Muka Kuning, Kabil, and Tembesi. The planning documents also state that after the 25-year lease period ends, an operational evaluation will take place before the assets are transferred to BP Batam, with the consequence of employment termination for 31 operational workers. Under this structure, local economic benefits need to be differentiated among benefits during construction, benefits during operation, and benefits after asset transfer to BP Batam.

The larger economic benefits occur at the investment and energy-system levels. BP Batam and PT Batam Sarana Surya entered into a 25-year cooperation agreement for Duriangkang solar PV development, while BP Batam also describes solar PV development at Duriangkang and Tembesi as part of Batam's green-energy development. For Duriangkang, the partner-selection process set a rental value for use of the inundation area at IDR 57,500 per square metre per 25 years, together with a 0.30% revenue-sharing scheme based on electricity throughput once the plant generates power sold commercially. This structure demonstrates that economic value is created through use of reservoir space. The justice question therefore extends beyond whether the project generates benefits to who receives the largest share of the value created and in what form those benefits return to the area providing the ecological space.

This issue is further complicated because electricity generated from Indonesia's renewable energy projects sits within a regional electricity-trading ecosystem. Singapore increased its ambition for low-carbon electricity imports from 4 GW to around 6 GW by 2035. In September 2024, five Indonesian projects had obtained Conditional Licences totalling 2 GW, while two additional Indonesian projects received Conditional Approvals for 1.4 GW. EMA subsequently explained that low-carbon electricity imports are positioned both as a strategy for Singapore's decarbonisation and as a means of strengthening regional electricity grids.

This broader context should be treated carefully in analysing Batam's solar PV projects. Singapore's 6 GW import target cannot automatically be counted as a benefit arising from Duriangkang or Tembesi. There is insufficient basis to equate the entire Indonesia-Singapore electricity-trading agenda with the output of these two projects. The developments do, however, show a wider market and policy context in which low-carbon electricity from Indonesia has strategic value beyond Batam's local needs. Economic and geopolitical value may therefore accrue at the regional level while some ecological and social risks remain concentrated at production sites.

This is where risk distribution becomes more visible. Environmental risks are attached to particular water bodies and borne by the ecosystems and communities around them. Duriangkang is an important raw-water source for Batam and is planned to accommodate solar PV on a very large scale. At that scale, relevant risks extend beyond construction-related water quality and include use of reservoir surface space, changes in the water body's physical conditions, infrastructure safety, sedimentation, and possible disruption of water-service functions. Tembesi is smaller, but its EIA records water-quality parameters already at or above standards and communities still using reservoir space for certain activities. The risk profiles of the two sites are therefore not identical.

Field findings reinforce the need to distinguish beneficiaries from risk-bearers. Around Duriangkang, communities understand the reservoir primarily through its raw-water supply function. When fieldwork was conducted in early September 2026, Duriangkang solar PV had not entered construction. Local communities therefore had no directly observable economic project benefits, while the raw-water function was already part of daily life. This differs from benefits projected normatively through the project, such as investment and employment. The gap between projected benefits and benefits actually received is an important aspect of distributive justice.

Tembesi provides a somewhat different picture. The EIA identifies economic benefits from workforce recruitment and local business activity. At the same time, it records residents still using the area around the reservoir for fishing, cast-net fishing, and cultivation, even though these uses do not fully conform to the reservoir's official function. When reservoir-surface space is allocated to solar PV, changes in access to these resources can become a distributional issue. The impact is not always a directly quantifiable loss of income. Restricting access to spaces that have been used informally also changes livelihood options available to communities.

Another issue is who bears risk if projected economic benefits do not materialise. EIA documents use projections of employment, business opportunities, and income as a basis for identifying project benefits. However, many of these benefits depend on the construction phase and labour demand. Once operation begins, workforce numbers decline substantially. At the end of the lease, jobs may be lost as assets are transferred to BP Batam. Local economic benefits therefore operate on a different time scale from investment and energy benefits. Communities may receive relatively significant benefits during construction, while environmental risks and changes in spatial use persist over a much longer operational period.

This matters from a just-transition perspective. Energy transition often derives legitimacy from the global benefit of emissions reduction. That legitimacy does not eliminate the obligation to examine who provides the space and resources, and who experiences environmental change, in order for the transition to occur. In Batam, energy production is located on reservoirs that also perform public-service functions. The value of electricity can flow into a wider economic system while ecological consequences remain around Duriangkang and Tembesi.

Comparison of the two reservoirs shows different distributional patterns. Duriangkang has the potential for very large economic and energy benefits because of project scale, but also carries more sensitive implications for raw-water functions. Tembesi has a smaller project scale and more limited local employment benefits, while community use of reservoir space must also be considered. Justice therefore cannot be measured using the same indicator for both sites. At Duriangkang, the central concern is proportionality between the project's economic value and protection of the raw-water function. At Tembesi, greater attention is also required to changes in access to resources and distribution of local economic benefits.

From an EIA perspective, some distributional issues have entered the assessment. Local employment is monitored, business opportunities are identified, and the consequences of job loss after asset transfer are recorded. However, this approach remains stronger in calculating project socio-economic impacts than in assessing how benefits and risks are distributed among actors. EIA can explain how many workers are employed or how many people experience changes in income, but questions about the share of economic value returning to surrounding communities, the economic value of reservoir space accruing to the manager, and who bears risk if water functions are disrupted do not receive equivalent weight.

On this basis, distribution of benefits and risks in Batam's floating solar PV development can be assessed as moderate. Project benefits are relatively clear at the levels of investment, energy, employment, and the regional decarbonisation agenda. Evidence of equitable benefit distribution at the local level, however, remains limited. Environmental and social risks are geographically concentrated among communities and ecosystems around the two reservoirs. This imbalance does not mean that the projects have empirically produced injustice: Duriangkang has not entered construction and actual benefits cannot yet be fully observed. A more accurate finding is that the project structure shows potential inequality between benefits operating at the regional scale and risks concentrated locally, while mechanisms to ensure fair distribution of benefits are not yet as visible or robust as mechanisms for controlling environmental impacts.

From this position, the justice question in Batam cannot be resolved merely by stating that the projects produce clean energy and jobs. The more fundamental question is whether communities living alongside the reservoirs receive benefits commensurate with the changes in space and risks they face, and whether protection of raw water is treated as a non-negotiable constraint rather than compromised in pursuit of energy and investment value. Just transition brings together the effectiveness of the policy, institutional, and procedural frameworks; the success of the energy transition should therefore be measured not only by the low-carbon electricity produced, but also by how value, benefits, risks, and responsibilities are distributed across the project chain.

Assessment:**Distribution of benefits and risks = Moderate.**

The benefits of floating solar PV are evident in additional renewable energy, investment, and employment opportunities, but most benefits extend beyond the local level. Environmental and social risks, by contrast, are concentrated mainly around Duriangkang and Tembesi. EIA has identified these benefits and risks, but has not yet demonstrated a strong capacity to ensure that benefits are shared in proportion to the risks borne by communities and the reservoir environment.

4.4.6. EIA's Capacity to Influence Decisions

An EIA may be administratively complete, contain technical studies and public consultation, and include the RKL-RPL. Yet completeness alone does not prove that EIA genuinely influences project decisions. The more important measure is whether environmental-study findings and community input can change site choices, design, scale, construction methods, reservoir management, or even whether a plan proceeds at all. Under Indonesia's environmental regulatory framework, EIA forms part of the Environmental Approval process; it is not merely an accompanying document produced after project decisions have been completed.

At Duriangkang, the EIA documents record several specific community concerns, including reservoir drought risk, continuity of raw-water supply, the need for outreach before construction, and issues concerning transmission-tower sites. The inclusion of these issues shows that community engagement was not wholly a formality. Recording an issue, however, is not the same as influencing a decision.

Fieldwork in early September 2026 found that construction of the Duriangkang solar PV project had not begun and surrounding communities still understood the reservoir primarily as a raw-water source. As a result, there is not yet direct community experience of solar PV construction impacts that could be used to assess the effectiveness of the RKL-RPL in practice. Instead, this condition reinforces the importance of asking whether information about the raw-water function has carried weight in decisions before construction begins. EIA has stronger influence when such information is used to prevent or change risky decisions, not only to establish mitigation measures after development decisions have been made.

Field findings at Tembesi provide a point of comparison because project implementation is more concrete. Construction activities make it possible to examine more directly the relationship between environmental-document commitments and field practice. Changes in reservoir-space use, management of community activities, water-quality management, and monitoring implementation are important points for assessing whether environmental requirements genuinely operate as project constraints. Under the applicable framework, Environmental Approval also does not end when a document is issued; compliance with environmental standards and operational obligations remains subject to oversight after approval.

Institutionally, Batam's environmental governance has also undergone an important development. Since 2026, BP Batam has stated that it strengthened the Environmental Approval mechanism through an Environmental Feasibility Assessment Team involving BP Batam, the Batam City Environmental Agency (DLH), and academic experts. The mechanism is designed to verify environmental documents technically, transparently, and accountably. This strengthens the formal position of EIA in decision-making, but does not yet prove that substantive assessment findings can change strategic project choices. EIA effectiveness still depends on the extent to which environmental-assessment results provide a basis to approve, reject, limit, or modify a proposed activity.

EIA capacity in the Batam floating solar PV case must therefore be distinguished between influence over technical-operational decisions and influence over strategic decisions. The available evidence is stronger in showing influence on impact management and mitigation. Evidence that EIA can change decisions on location, scale, project configuration, or choices over reservoir use is more limited. This distinction matters because those strategic decisions fundamentally determine the magnitude of pressures that must later be managed through the RKL-RPL.

Assessment:

EIA capacity to influence decisions = Moderate.



EIA has a formal position and can bring environmental issues and community input into project approval and management processes. Its influence is more visible in determining mitigation measures and operational controls. However, evidence that EIA can change strategic decisions on the location, scale, or configuration of solar PV projects remains limited.





CHAPTER V. CONCLUSIONS AND POLICY RECOMMENDATIONS

5.1. Conclusions

The policy framework for Batam's floating solar PV development has integrated principles of renewable energy, emissions reduction, environmental protection, water-resource management, and social justice, and has recognised the raw-water and dam-safety functions of Duriangkang and Tembesi from an early stage. However, since development locations began to narrow in 2022 and were reinforced through development cooperation and investment, there has been insufficient evidence of systematic comparison of alternative locations, scales, and configurations using water security as a primary criterion before decisions became binding. This shows that environmental integration remains stronger at the normative and planning levels than as a mechanism that materially shapes project choices, particularly in the context of the expanding Indonesia-Singapore energy-transition and low-carbon electricity-trading agenda.

The institutional framework for Batam's floating solar PV development involves a relatively complete set of actors and mandates, including BP Batam, PLN, the Ministries of Energy and Mineral Resources and Public Works, local government, environmental authorities, developers, SPAM operators, and communities around the reservoirs. The principal weakness is the limited strength of mechanisms integrating energy, raw-water, environmental, and investment interests within a single chain of decisions with clear accountability. Fieldwork also shows a difference in position between communities that depend on reservoir functions and actors holding formal authority over the projects. The institutional structure is therefore present, but cross-sector coordination and allocation of responsibility do not yet fully bridge interests that may come into conflict.

The EIA process for Batam's floating solar PV projects has performed its formal functions through scoping, impact studies, public consultation, preparation of the ANDAL, and the RKL-RPL, including consideration of raw water, reservoir drought, cumulative impacts, and community input at Duriangkang and Tembesi. EIA has functioned to identify risks and formulate environmental management and monitoring measures, but its influence over strategic decisions remains limited. The available evidence more strongly demonstrates influence on technical-operational aspects and impact mitigation, while changes to location, scale, configuration, or reservoir-use choices are less evident. Differences in project stage reinforce this finding: Tembesi had reached a more concrete stage of development, whereas Duriangkang had not entered construction when fieldwork was conducted in September 2026.

When the three frameworks are read together, the principal issue in Batam's floating solar PV development is not the absence of policy, institutions, or EIA procedures, but the way these three connect in decision-making. Policy provides the direction of the energy transition, institutions allocate mandates among actors, and EIA provides mechanisms for impact assessment and management. Yet empirical findings from Duriangkang and Tembesi show a continuing gap between the existence of these instruments and their influence over strategic decisions, particularly site selection, design, water security, cross-sector coordination, and responses to community input. EIA has functioned in controlling impacts, but its influence over strategic decisions remains limited. Strengthening environmental governance therefore requires environmental considerations to enter earlier and to have real consequences for development choices.

5.2. Policy Recommendations

1. Treat Water Security as a Decision Constraint for Solar PV Development on Reservoirs

Where a reservoir functions as a raw-water source, its water function should be treated as a decision constraint rather than merely one impact parameter. Every floating solar PV proposal should first demonstrate the state of water security, reserve capacity, reservoir functions, drought risk, and the consequences of disruption to water quality or quantity. This approach is consistent with Minister of Public Works and Housing Regulation No. 7 of 2023, which requires assessment of the effects of floating solar PV on continuity of reservoir functions, dam safety, water quality, environmental carrying capacity, and social, economic, and cultural conditions.

2. Ensure that Environmental Considerations Enter Before Strategic Project Decisions Are Made

BP Batam, together with the relevant authorities, should ensure that environmental considerations form part of the process for determining project location, capacity, design, and patterns of reservoir use from the earliest stage of project development. Environmental assessment should not be given meaningful space only after investment decisions and site choices have narrowed. Development of the Duriangkang and Tembesi floating solar PV projects should therefore include a trace of the decision-making chronology to establish the extent to which environmental studies influenced development choices. Decisions that have already obtained investment support must remain open to review and modification if environmental risks are identified that were not adequately considered.

3. Conduct an Independent Alternatives Assessment of Project Location, Capacity, and Configuration

BP Batam, together with developers and relevant agencies, should conduct a more open and measurable evaluation of alternatives for floating solar PV development. The assessment should do more than demonstrate that Duriangkang and Tembesi are technically capable of accommodating power generation. It should compare them with other locations, alternative capacities, different levels of solar-panel coverage, and phased-development options. Water security, dam safety, environmental carrying capacity, and community interests should be primary criteria. A site that can technically be developed is not necessarily the most appropriate site to select. The results should provide a basis for retaining, modifying, or reconsidering project-development plans.

4. Strengthen Cross-Institution Coordination and Clarify Accountability for Development Decisions

BP Batam should promote stronger coordination among developers, PLN Batam, the Ministry of Energy and Mineral Resources, the Ministry of Public Works, environmental authorities, SPAM operators, and local government. Coordination should not be directed only at accelerating permitting and project implementation, but must ensure that each interest has room to influence decisions. Clear responsibility should be established, particularly for cross-sector risk management, resolution of differences in technical assessment, and follow-up to environmental recommendations. When problems arise, responsibility should not be passed between institutions. Every decision should have a clearly identified accountable actor, including where the decision creates environmental or community impacts.

5. Strengthen EIA Independence and Prevent Conflicts of Interest in Decision-Making

BP Batam's position as area and reservoir manager and investment facilitator requires stronger oversight and conflict-of-interest controls. BP Batam should ensure a clear separation of functions among those promoting investment, those managing public assets, and those providing technical assessments of area use. At the same time, the EIA process must remain under the supervision of the competent environmental authority and must not be influenced by investment commitments formed in advance. This is important to reduce vulnerability to regulatory capture, in which environmental oversight instruments risk being used primarily to accommodate investment decisions rather than independently test them.

6. Establish a Decision Trace between EIA and Project Decisions: Make EIA a Genuine Basis for Future Development Decisions

Drawing on the findings from Batam's floating solar PV development, BP Batam and environmental authorities should ensure that, for future development projects, every issue identified through the EIA process does not end as a note in a document. Every environmental finding, study result, and community objection should have a clear follow-up pathway showing how the issue was assessed, what decision was taken, and who is responsible for implementing it.

Going forward, EIA should no longer be viewed simply as a document that must be completed for a project to proceed. It must have the power to correct development decisions, even where those decisions have already received investment sup.



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