# Regulatory Governance of Small Hydropower in Malaysia and China: A Comparative Study

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## ABSTRACT

This study examines the regulatory governance of small hydropower (SHP) as a renewable energy source in Malaysia and China through a comparative doctrinal and regulatory document analysis. While SHP is often presented as a lower-impact alternative to large hydropower, its sustainability depends on governance arrangements that ensure institutional coordination, adequate implementation capacity, financing support and environmental compliance mechanisms. The study analyses the legal and policy frameworks governing SHP development in Malaysia and China, with particular attention to incentive structures, administrative coherence and emerging sustainability standards. The findings suggest that Malaysia's SHP development remains largely incentive-driven under the Feed-in Tariff system but is affected by fragmented governance and limited SHP specific regulatory safeguards. By contrast, China demonstrates stronger integration between legislation, fiscal instruments and provincial implementation, including evolving "Green Small Hydropower" governance initiatives. The study proposes staged regulatory governance reforms for Malaysia aimed at strengthening SHP sustainability, institutional accountability and long-term legitimacy.

**Keywords:** Regulatory governance; Compliance; Energy regulation; Institutional coordination; Small Hydropower Policy

## INTRODUCTION

Hydropower remains one of the most established renewable energy sources globally because it provides electricity through the conversion of kinetic and potential energy from flowing water into mechanical rotation via turbines, which is subsequently converted into electrical output through generators. Unlike fossil fuels, hydropower is generally categorised as a renewable resource because it relies on the water cycle, which is continuously replenished through rainfall, river discharge and catchment processes. In modern electricity systems, hydropower plays a crucial balancing function because it can be dispatched rapidly to meet demand peaks and provide reserve capacity during grid disruptions. These system-level advantages are well recognised, particularly in electricity markets where intermittent renewable sources such as solar and wind are expanding, because hydropower contributes to grid stability, inertia and flexibility services (International Energy Agency [IEA], 2023; International Hydropower Association [IHA], 2024).

Nevertheless, the contemporary policy and legal debate has shifted from hydropower's technical efficiency to its broader governance impacts. Hydropower projects are no longer assessed only by energy output and economic returns, but also by the social and environmental burdens imposed across affected communities. This is especially significant because hydropower infrastructure often requires land use conversion, modified river ecology, altered sediment flows and risk exposure related to flooding or operational failure. While hydropower can support flood regulation and water supply management, these benefits often coexist with localised ecological and social harms, which can generate long-term contestation, including resettlement disputes and livelihood disruption (Zarfl et al., 2015; Moran et al., 2018). This reality means that hydropower governance is fundamentally a question of regulation and justice, not merely an engineering challenge.

In Malaysia, small hydropower (SHP) is typically associated with run-of-river developments. It is legally integrated into the renewable energy ecosystem through mechanisms such as the Feed-in Tariff (FiT) framework under the Renewable Energy Act 2011 and administered through institutions such as the Sustainable Energy Development Authority (SEDA) (Sustainable Energy Development Authority Malaysia [SEDA], 2024; Wong, 2015). While the technical classification varies across jurisdictions, SHP is commonly defined internationally as hydropower below 10 MW. However, some states adopt thresholds as high as 30 MW or 50 MW, depending on national circumstances and river systems (United Nations Industrial Development Organization [UNIDO], 2024).

This definitional variability has real regulatory implications because the size threshold determines whether projects qualify for simplified licensing, incentive eligibility and environmental compliance tiers. In other words, the legal definition of SHP is not purely descriptive: it affects regulatory burdens, market access and investor risk.

The governance relevance of SHP is increasingly acknowledged because SHP projects are often presented as a less destructive alternative to large hydropower dams. SHP generally involves smaller physical footprints, reduced reservoir requirements and potentially lower displacement outcomes in run-of-river configurations. However, it is not accurate to assume SHP automatically avoids sustainability and safety risks. Scientific and governance literature increasingly notes that cumulative effects may occur where multiple SHP facilities are deployed across connected river basins, resulting in ecological fragmentation and biodiversity impacts that resemble considerable hydropower pressures when aggregated. Therefore, the legal and policy challenge is not merely to promote SHP but to ensure it is deployed under governance conditions that prevent cumulative harm and enforce accountability (Liu et al., 2019; IHA, 2024).

Regulatory governance of small hydropower may be analysed using policy implementation theory, which explains why regulatory frameworks that appear coherent at the design stage frequently produce uneven outcomes when translated into practice. Pressman and Wildavsky (1973) argue that implementation failure often occurs because policy objectives are disrupted by fragmented administrative authority, inadequate institutional capacity, weak monitoring systems and inconsistent enforcement across implementing units. This concern is reflected in contemporary regulatory scholarship, which highlights an enduring policy implementation gap between formal rules and actual compliance, particularly in complex sectors such as environmental and energy regulation (Hill & Hupe, 2014). Complementing this perspective, Ayres and Braithwaite's (1992) theory of responsive regulation contends that effective governance depends on structured compliance mechanisms that combine persuasion with escalating enforcement strategies and credible sanctions when non-compliance persists. Applied to small hydropower, these theories suggest that sustainable outcomes depend not merely on the existence of statutes or incentive instruments, but on the practical strength of enforcement capacity, inter agency coordination, transparent compliance monitoring and institutional accountability mechanisms that ensure sustainability safeguards are operationalised rather than remaining aspirational (Baldwin, Cave, & Lodge, 2012).

The problem in Malaysia is not that SHP lacks potential, but instead that SHP governance remains institutionally fragmented and normatively under-specified. At present, SHP development is primarily shaped by incentive mechanisms such as FiT. At the same time, more profound regulatory questions remain insufficiently addressed, including technical compliance standards, flood-level planning, long-term operational auditing and the governance capacity to regulate siting decisions.

This raises a doctrinal and policy gap: a pricing incentive may encourage investment, but it does not itself establish complete legal governance. Consequently, Malaysia faces a structural challenge in ensuring that SHP implementation is not only financially viable but also sustainable, safe and socially legitimate.

This gap becomes more visible when compared with China. China has adopted a broader renewable energy governance architecture through the Renewable Energy Law of the People's Republic of China, complemented by fiscal incentives, special funds, preferential loans provincial regulatory instruments (Renewable Energy Law of the People's Republic of China, 2009; World Bank, 2021). In addition, China has increasingly developed "Green Small Hydropower" policy directions aimed at improving environmental standards and the legitimacy of SHP operations (Liu et al., 2019; Shiji, 2021). While China's SHP governance also faces criticism in terms of ecological impacts and regulatory enforcement consistency, its legislative-institutional

model provides a stronger illustration of how financial incentives can be integrated into an overall governance framework rather than functioning as isolated tools (World Bank, 2021; Shiji, 2021).

## LITERATURE REVIEW

SHP has long been discussed in renewable energy literature as a technically mature and decentralised energy option capable of supporting rural electrification and enhancing energy diversification, particularly in developing contexts. SHP is commonly associated with generation capacities below 10 MW in international policy and technical assessments, although definitional thresholds differ across jurisdictions depending on institutional and hydrological conditions. This definitional variability is not merely descriptive; it has governance significance because it influences licensing thresholds, eligibility for tariff incentives, environmental compliance intensity and the classification of projects for investment purposes. In this respect, the literature highlights that SHP governance should be evaluated not only in terms of energy output but also in relation to regulatory design and administrative categorisation, which shape the risk profile of SHP development (UNIDO & ICSHP, 2019; Wong, 2015).

The literature generally recognises that SHP is often promoted as a lower-impact alternative to large hydropower projects. In particular, run-of-river SHP systems are frequently described as involving smaller physical footprints, reduced impoundment requirements and fewer resettlement consequences compared with reservoir based large dams. However, contemporary research increasingly questions the assumption that SHP is inherently sustainable, emphasising that cumulative ecological effects may emerge where multiple SHP plants are deployed across connected river systems. Such cumulative effects may include habitat fragmentation, disruption of sediment transport, altered flow regimes and biodiversity impacts, thereby requiring more sophisticated environmental governance tools rather than reliance on simplified “low-impact” narratives. As a result, the scholarly direction has shifted towards examining SHP as a governance challenge requiring regulatory safeguards, environmental accountability and transparent decision-making frameworks (IHA, 2024; UNIDO & ICSHP, 2019).

From a policy and governance standpoint, SHP also occupies an important position in energy transition debates because it can provide dispatchable and stabilising electricity services in systems increasingly dependent on intermittent sources such as wind and solar. Hydropower’s capacity to respond quickly to demand peaks, support grid resilience and contribute to balancing services has been widely documented in global energy policy literature. Nevertheless, the same literature stresses that hydropower governance is contested because benefits are typically dispersed at the national or grid level. In contrast, burdens may be concentrated locally through ecological disruption and livelihood impacts. This mismatch has increasingly encouraged scholars to evaluate hydropower development through justice-oriented frameworks rather than purely technical or economic frameworks (IEA, 2023; Sovacool et al., 2020).

Within this governance turn, the energy justice framework has become a prominent analytical lens for assessing renewable energy systems, including hydropower. Energy justice is commonly structured through distributional justice, procedural justice and recognition justice. Distributional justice concerns whether the benefits of renewable energy deployment, such as electricity access, income opportunities and development gains, are allocated fairly, particularly for rural and marginalised regions. Procedural justice addresses the transparency of project approval processes, public participation, access to information and grievance mechanisms, which are especially relevant for river-based infrastructure. Recognition justice further concerns whether affected stakeholders, including rural landholders and indigenous communities, are treated as legitimate decision-making participants whose interests are meaningfully considered. This framework is increasingly regarded as helpful in assessing SHP governance because SHP development typically intersects with water governance, land use, environmental regulation and local community rights (Jenkins et al., 2021; Sovacool et al., 2020).

The Malaysian renewable energy literature illustrates that renewable energy expansion has been shaped substantially through market-based and incentive-driven policy tools. In particular, Malaysia’s Feed-in Tariff under the Renewable Energy Act 2011 is frequently identified as a critical driver enabling renewable electricity participation and investment certainty. However, scholars have also documented that incentive mechanisms alone may not produce complete governance outcomes where regulatory frameworks remain fragmented or

insufficiently detailed, particularly for infrastructure projects requiring river-based siting decisions and long term operational oversight. This is relevant because, while SHP is integrated into Malaysia's renewable energy portfolio, SHP governance involves regulatory responsibilities extending beyond tariff pricing, including technical compliance standards, hydrological risk assessment, flood-level planning and environmental monitoring. The literature, therefore, suggests that Malaysia's renewable energy policy success should be evaluated not merely through deployment indicators but through governance maturity, institutional coordination and enforcement capacity (Wong, 2015; Wan Abdullah et al., 2019).

China's literature, by contrast, demonstrates a more institutionally embedded governance architecture for renewable energy development. Scholars have described China's Renewable Energy Law as a key legal foundation that integrates renewable energy prioritisation with fiscal and financial enabling instruments, including development funds, preferential loans and tax incentives. This legal framework is complemented by provincial policy instruments that translate national renewable energy goals into localised implementation, including decentralised participation models and targeted funding mobilisation. In relation to SHP specifically, the literature has increasingly highlighted China's move towards "Green Small Hydropower" governance standards, reflecting a shift towards improved sustainability compliance mechanisms rather than treating SHP as automatically low-impact. While China continues to face challenges related to enforcement consistency and ecological impacts, the literature nonetheless demonstrates that China's SHP framework offers valuable comparative governance insights for states like Malaysia, where incentive-based arrangements exist but SHP specific governance remains underdeveloped (World Bank, 2021; UNIDO & ICSHP, 2019).

Despite growing scholarly interest in SHP as a renewable energy pathway, comparative regulatory governance analysis between Malaysia and China remains limited, particularly in relation to how SHP governance design affects justice outcomes and institutional effectiveness. Existing studies tend to focus either on technical feasibility and energy potential or on policy performance in isolation. There remains a doctrinal gap in understanding how Malaysia's renewable energy framework regulates SHP governance in practice and which elements from China's legislative and provincial governance architecture may be adapted to strengthen SHP regulation in Malaysia. This study addresses this gap by adopting a comparative doctrinal approach, guided by the energy justice framework, to evaluate SHP governance structures and propose staged reforms that align SHP development with sustainability, institutional accountability and justice-based governance.

## RESEARCH METHODOLOGY

Accordingly, this research adopts a doctrinal and regulatory document analysis to examine whether Malaysia's current legal architecture sufficiently regulates SHP management and what regulatory governance reforms can be proposed by drawing lessons from China's governance model. The comparative inquiry is not intended to transplant Chinese policy directly, but rather to identify transferable governance components, including clearer SHP-specific standards, integrated institutional coordination, improved financing risk tools and sustainability safeguards. In this way, the paper aims to contribute not only to renewable energy discourse but also to the development of regulatory solutions that reconcile SHP growth with justice, sustainability and good governance.

## FINDINGS

### Definitional and classification uncertainty shape the regulatory treatment of SHP.

The study finds that the legal and policy governance of SHP is influenced by definitional thresholds, which vary considerably between jurisdictions and directly affect eligibility for regulatory simplification, incentives and environmental compliance requirements. In Malaysia, SHP is operationally managed within renewable energy governance primarily through the FiT mechanism administered by the Sustainable Energy Development Authority (SEDA), where hydropower capacity is categorised for tariff determination across defined generation bands. By contrast, China commonly treats SHP as hydropower installations below 50 MW, reflecting a more expansive threshold that aligns with rural electrification and local development priorities. The definitional divergence is not merely technical; it has regulatory consequences because it determines whether SHP is governed through simplified licensing and incentive eligibility, or whether it is treated under broader hydropower regulatory and environmental frameworks.

**Malaysia's SHP governance model is incentive-driven but institutionally fragmented.**

The findings confirm that Malaysia's SHP development has primarily been shaped through incentive-based mechanisms rather than a dedicated governance framework. Malaysia's renewable energy transition initiatives, beginning with the National Energy Policy 1979, followed by the National Green Technology Policy 2009 and the National Renewable Energy Policy and Action Plan 2009, culminated in the formalisation of the FiT through the Renewable Energy Act 2011. Under this arrangement, SHP is permitted to participate in the renewable electricity market through Renewable Energy Power Purchase Agreements, enabling the sale of generated electricity to Tenaga Nasional Berhad at FiT rates determined by capacity tiers. While this framework creates market confidence and promotes SHP uptake, it does not constitute a complete governance architecture for SHP management. The study identifies a structural gap in Malaysia: SHP governance is not supported by an SHP-specific regulatory regime addressing siting standards, hydrological risk planning, safety compliance and long-term operational audit requirements. As a result, SHP is effectively treated as a component within renewable market policy rather than as a regulated river-based infrastructure sector with environmental and safety implications.

**Implementation constraints in Malaysia include technical capacity limitations and financing risk gaps.**

The study finds that the most significant barriers to effective SHP management in Malaysia are not legal permissibility but implementation capacity. The document analysis highlights two significant constraints: first, a shortage of hydropower-specific technical expertise, particularly in project design consultation and risk assessment; second, the limited ability of financial institutions to assess SHP project risks with confidence. These constraints weaken the effectiveness of Malaysia's incentive-driven model because they increase project uncertainty, delay investment cycles and may affect compliance quality during development and operation. Furthermore, the findings indicate that SHP governance information and data remain dispersed across institutions, limiting public transparency and weakening coordinated planning. In a governance context where procedural legitimacy matters, the absence of well-integrated communication and disclosure undermines confidence in SHP planning. It may reduce meaningful stakeholder participation in project-related decision making.

**China's SHP governance demonstrates stronger integration between legislation, fiscal support and provincial implementation.**

In contrast to Malaysia's incentive-centred model, China's SHP governance is supported by a broader legislative and institutional architecture. Renewable energy development in China, including SHP, which is governed under the Renewable Energy Law of the People's Republic of China (2005, amended 2009), which establishes renewable energy prioritisation as a state policy objective and provides a clear legal basis for developing market and non-market instruments. The most significant comparative finding is China's integrated financing architecture, particularly through explicit legal recognition of fiscal incentives. Chapter VI of the Renewable Energy Law provides for a renewable energy development fund, preferential loan mechanisms with financial discounting and tax-based preferential policies intended to accelerate renewable energy deployment.

While Malaysia's FiT provides revenue certainty, China's approach extends beyond tariff design by legally embedding multiple financial levers, including fiscal funds and credit facilitation, capable of reducing risk exposure across a broader range of SHP investors.

**Provincial policy instruments in China institutionalise SHP investment models and decentralised participation.**

The study further finds that China's SHP governance is reinforced through provincial policy instruments that translate national priorities into local implementation mechanisms. Provincial measures such as Yunnan's SHP development decisions, Guizhou's transfer rules on hydropower development rights and Zhejiang's hydropower management policies demonstrate an approach that integrates taxation incentives, investment participation models and ownership structures. In particular, the "who invests, who owns, who benefits" policy reflects a decentralised investment governance model, enabling both individual farmers and corporate actors to participate through joint-stock and cooperative arrangements. This is complemented by financing mobilisation through multi-level government allocation and targeted bank loan structures. The combined effect is a regulatory ecosystem that treats SHP as both an energy infrastructure system and a rural

development tool, thereby widening the investor base and increasing the probability of implementation success.

**China's "Green Small Hydropower" framework reflects emerging environmental governance maturity.**

Finally, the study finds that China has increasingly acknowledged the environmental consequences of SHP by formalising policy direction towards "Green Small Hydropower". This includes government-led development of certification standards, institutional guidance documents and implementation targets intended to improve environmental performance and social legitimacy. The introduction of green SHP standards reflects governance evolution by embedding environmental safeguards into SHP policy rather than treating SHP as automatically low-impact. Malaysia has not yet developed a comparable SHP-specific environmental governance initiative, which strengthens the inference that Malaysia's SHP policy remains primarily investment-oriented. At the same time, China's model increasingly incorporates sustainability compliance as an explicit governance objective.

The Green Small Hydropower certification framework in China also has quantifiable business standards such as the ecological flow preservation standards, fish passage standards, river connectivity standards and the mandatory reconstruction of the affected riverbanks. Periodic environmental performance auditing and reporting to provincial authorities is also part of certification. These standards go beyond incentive-based regulation by entrenching standards of operational sustainability into the license of SHP and its renewal.

## RECOMMENDATIONS

Building upon the foregoing comparative findings, this study proposes time-phased regulatory and policy recommendations aimed at strengthening the governance of SHP in Malaysia. The findings show that Malaysia's SHP development has primarily been shaped by incentive-based arrangements under the renewable energy ecosystem, particularly through the Feed-in Tariff framework, but remains affected by institutional fragmentation, insufficient SHP-specific governance guidance, limited technical capacity and financing constraints. These shortcomings are not merely operational challenges; they represent a structural governance gap whereby investment incentives exist without corresponding maturity in regulatory oversight mechanisms, risk governance frameworks and sustainability safeguards.

These staged reforms respond directly to the policy implementation gap identified in regulatory governance theory, ensuring that enforceable compliance mechanisms and institutional accountability support incentives.

By comparison, China's approach demonstrates a stronger integration between legislation, financing instruments and provincial-level implementation, supported by explicit fiscal mechanisms and sustainability driven initiatives such as the emerging "Green Small Hydropower" policy direction. While the Malaysian context differs in its political economy and institutional structure, the comparative analysis indicates that several governance components from China may be functionally adapted rather than transplanted wholesale, particularly in relation to integrated financing support, more precise institutional coordination and sustainability-oriented compliance standards.

Accordingly, the recommendations are organised into three time horizons: immediate (present to two years), medium-term (two to five years) and long-term (five to fifteen years). This approach reflects the practical reality that regulatory governance reforms in renewable energy require staged implementation: specific interventions may be introduced through administrative guidelines and coordination measures in the short term, whereas more complex reforms, such as financing architecture, decentralised investment participation models and green certification standards, require longer institutional maturity and legal-policy harmonisation. The framework also ensures that Malaysia's SHP governance reforms remain coherent, progressive and aligned with sustainability and energy justice objectives.

**Institutional Perspectives from Malaysian Regulators**

Published policy documents and operations resources of the Sustainable Energy Development Authority (SEDA) and the Energy Commission suggest that the renewable energy policy in Malaysia is now inclined to provide incentives and grid access rather than to provide SHP-specific environmental or hydrological management. The FiT documentation of SEDA highlights the quota, tariff eligibility and power purchase, and the technical location of the river, flood prevention and cumulative impact assessment are distributed among

several agencies. This institutional division supports the implementation gap that is observed in this research, in which there are institutional rules of renewable energy implementation. However, the application of SHP is still disjointed.

**Immediate Recommendations (Present to 2 years)**

Malaysia should first strengthen the governance of SHP by developing a dedicated SHP regulatory guideline or subsidiary governance instrument, rather than relying mainly on incentive schemes. While SHP currently falls under renewable energy arrangements through the Renewable Energy Act 2011 and the FiT mechanism, the present structure does not sufficiently regulate SHP-specific risks such as river safety, flood exposure, siting requirements, cumulative environmental impacts and operational compliance. A short-term recommendation is therefore for Malaysia to produce a national SHP governance guideline coordinated through relevant agencies, including SEDA, the Energy Commission, the Department of Irrigation and Drainage and state authorities, to ensure institutional clarity and reduce fragmented decision-making. This would address the governance insufficiencies highlighted in the findings, particularly the lack of SHP-specific management and dispersed institutional responsibility.

These guidelines should also strengthen institutional accountability by clarifying regulatory responsibilities and embedding compliance mechanisms such as monitoring requirements, reporting obligations and enforceable sustainability standards for SHP operators.

In addition, Malaysia should improve its capacity-building ecosystem by establishing a hydropower technical advisory pool, involving qualified hydropower engineers and risk consultants. This directly targets the implementation challenge identified in the findings regarding limited technical expertise and weak risk assessment capability by financial institutions. In the short term, the government can introduce structured technical collaboration with universities and technical agencies to improve hydropower planning, engineering validation and siting decisions.

Malaysia should also strengthen transparency and procedural legitimacy by consolidating SHP data reporting into a publicly accessible system. The findings show that data collection is dispersed among agencies and poorly coordinated. A single official SHP reporting platform would improve accountability, planning efficiency and public understanding, supporting procedural justice principles.

**Medium-Term Recommendations (2–5 years)**

Comparative analysis conducted at the preliminary stage indicates that the FiT model in Malaysia does not mitigate the initial cash risk on the developers of SHPs but offers certainty in revenue. In comparison, the preferential loan facilities are used in China to reduce start-up financing expenses by providing subsidised interest and credit facilitation by the government, which increases project bankability in the initial stages of their development. A slight decrease in the interest rates can considerably enhance SHP's internal rate of return with a normal operating life span of 15-20 years. An exclusive Malaysian SHP financing facility, which would involve FiT revenue certainty with concessional green loans or partial credit guarantees, would be more effective at enhancing project viability than tariff incentives.

Thus, in the medium term, Malaysia should adopt a more integrated financing model for SHP development. While FiT supports revenue certainty, it does not fully address financing barriers where banks lack experience in evaluating SHP risks. Malaysia may draw lessons from China’s model, where renewable energy development is supported not only through prioritisation policy but also through explicit fiscal incentives, development funds and preferential loan mechanisms. Malaysia should therefore establish a targeted SHP financing support programme, potentially including low-interest green loans, risk-sharing mechanisms and government-backed credit facilitation, similar in functional purpose to the fiscal support architecture described in China’s Renewable Energy Law.

Malaysia should also develop a structured model for decentralised participation in SHP investment. China’s experience demonstrates that SHP expansion can be strengthened through investor diversity, such as local farmers, cooperatives, joint-stock structures and private enterprise participation. Malaysia may adapt this by introducing community-based SHP models or cooperative project structures under apparent regulatory

oversight, particularly for rural electrification and local development objectives. This also strengthens distributional justice as rural communities can share both economic and energy benefits.

A further reform should focus on institutional strengthening and coordination. Malaysia's SHP governance should shift from fragmented agency roles towards a single coordination framework, possibly under a national SHP governance taskforce or a specialised unit. Such coordination would reduce regulatory uncertainty and strengthen implementation capacity through unified siting standards and compliance planning.

**Long-Term and Future Directions (5–15 years)**

Climate variability brings in growing hydrologic uncertainty, which directly impacts the SHP generation in terms of reliability and eventually predictability of revenue in the FiT itself. Long dry seasons will have the tendency to lower the yield, whereas heavy rainfall increases operational risk and maintenance. The lack of adjusting mechanisms to climate will cause the FiT-based income models to be increasingly mismatched to reality. Climate-adjusted generation modelling, adaptable tariff calibration and periodic hydrological reevaluation must therefore be put in place in responsive SHP governance with the view of sustaining investor confidence and system reliability.

Although these adaptation strategies are the response to the operational risk due to climatic factors, technical and tariff changes cannot be the sole solutions related to long-term SHP resilience, but there should be a wider transition in governance towards sustainability integration and institutional responsibility.

In the long-term sustainability, Malaysia should move beyond incentive-led SHP development by developing an SHP governance model that integrates environmental protection and social legitimacy safeguards. China's direction towards "Green Small Hydropower" reflects governance maturity because it recognises that SHP is not automatically low-impact and may generate cumulative ecological effects. Malaysia should therefore develop a future SHP governance framework that institutionalises sustainability safeguards through certification standards, cumulative impact planning, biodiversity protection criteria and compliance auditing, similar in structural direction to China's green SHP standard evolution.

This requires stronger institutional accountability supported by compliance mechanisms, including certification standards, periodic audits and transparent performance reporting.

Malaysia should also introduce long-term planning measures that align SHP deployment with national climate commitments and energy transition goals. Because hydropower currently contributes a meaningful share to electricity supply, SHP development must be framed as part of long-term renewable energy system balancing and resilience building. Future SHP policies should therefore be integrated into national energy transition planning through more precise targets and grid planning coordination.

Finally, Malaysia should modernise hydropower regulation in a forward-looking manner by establishing periodic legal review cycles. China's model illustrates the governance value of keeping renewable energy regulatory mechanisms updated through evolving policy instruments and implementation guidance. Malaysia should formalise periodic review of SHP governance standards, allowing regulatory updating in response to climate variability, hydrological risk, flood exposure and technological improvements. This would ensure that SHP governance remains responsive rather than static. The above discussion can be summarised as per Table 1 below.

**Table 1. Policy Roadmap Recommendations for Malaysia**

| Timeframe | Goal | Key Recommendation |
|---|---|---|
| 0–2 years | Fix governance gaps | SHP guideline, data consolidation, technical advisory pool |
| 2–5 years | Improve implementation success | SHP financing support, investor diversification and inter-agency coordination |
| 5–15 years | Make SHP sustainable & legitimate | Green SHP standards, cumulative impact safeguards, periodic legal updates |

# CONCLUSION

This study has examined the governance of SHP through a comparative doctrinal analysis of Malaysia and China, focusing on the extent to which legal and policy frameworks support SHP deployment in a manner that is institutionally coordinated, financially feasible and environmentally sustainable. The findings indicate that Malaysia's SHP sector has developed primarily within an incentive-oriented renewable energy ecosystem, where SHP is operationalised through mechanisms such as the Feed-in Tariff and related power purchase arrangements. While these instruments have played a valuable role in increasing renewable electricity participation, the study demonstrates that Malaysia's SHP governance remains structurally incomplete in several respects. Specifically, the Malaysian framework does not yet demonstrate the features of a mature SHP regulatory regime, including coherent institutional coordination, systematic technical capacity support, consolidated data governance and sustainability-focused compliance tools necessary for long-term legitimacy and risk management.

By contrast, China's governance model reflects a broader institutionalisation of renewable energy development through legislative clarity, fiscal and credit facilitation and decentralised provincial implementation. The study highlights that China's Renewable Energy Law and supporting instruments extend beyond tariff incentives by embedding renewable energy development into a broader system of fiscal funds, preferential loan arrangements and structural policy support, thereby reducing investment risk and strengthening implementation certainty. In addition, China's provincial policy mechanisms illustrate how SHP governance can be integrated into local development planning through diversified participation models. Notably, China's shift towards "Green Small Hydropower" signals an evolving governance maturity that recognises the cumulative ecological implications of SHP and the need for sustainability-driven safeguards rather than treating SHP as automatically low-impact.

The comparative analysis yields two central implications for Malaysia. First, there is a pressing need to move from an incentive-centred governance approach towards a more integrated SHP framework that improves institutional alignment and strengthens implementation capability. Second, Malaysia's long-term SHP strategy should incorporate sustainability and legitimacy safeguards as core policy objectives, ensuring that SHP expansion does not undermine environmental protection duties or stakeholder confidence. In this respect, China's integrated financing architecture, provincial governance instruments and green SHP policy direction offer practical insights that may be adapted to Malaysia's institutional setting without requiring wholesale legal transplantation.

In contribution, this study advances the scholarly understanding of SHP governance by demonstrating that SHP regulatory effectiveness is determined not only by the existence of market incentives but also by the degree of institutional coordination, financial facilitation and sustainability-oriented compliance embedded within the regulatory system. The proposed staged recommendations provide a pragmatic roadmap for Malaysia to strengthen SHP governance progressively, aligning SHP development with broader renewable energy transition objectives while maintaining environmental integrity, governance legitimacy and long-term implementation feasibility.

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This manuscript was prepared with the support of artificial intelligence tools, which were used solely to assist with drafting, editing and language refinement. All intellectual content, scholarly analysis, interpretation and

conclusions presented in this work are the original work of the authors. The use of AI tools was transparent, supervised and did not contribute to the generation of original research data or substantive intellectual content.

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