

# Assessing Environmental Governance and Renewable Energy Performance in Developing Countries Comparative Analysis of China and Vietnam

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**Abstract.** There are 193 sovereign countries in the world, and they are classified, according to The World Economic Situation and Prospectus (WESP) into one of three broad categories: developed economies, transition economies and developing economies. Developing economies' sustainable development needs sustainable energy. In this article, we will analyze the situations in China and Vietnam regarding environmental governance and renewable energy. For the last four decades, China and Vietnam have experienced rapid industrial growth while grappling with severe ecological challenges. China has advanced toward an "ecological civilization," while Vietnam continues to reform its environmental legislation to align with global standards. This comparative study evaluates environmental governance and renewable energy performance in both countries through policy review, empirical data, and case studies. The analysis explores institutional evolution, environmental impact assessment (EIA) effectiveness, and renewable-energy governance frameworks. The study identifies similarities in policy ambition and contrasts in implementation: both nations strengthen legal frameworks and monitoring systems but still face coordination challenges, weak public participation, and uneven enforcement. Through the comparative analysis of China and Vietnam, this article assesses environmental governance and renewable-energy performance to identify three interrelated solutions: technology transfer, financial support, and strong environmental governance for overcoming the sustainable-development dilemmas of developing economies. This study proposes interrelated solutions like strong environmental governance, technology transfer as pathways to strengthen sustainable development in developing economies.

## 1 Introduction

Environmental governance can be said to be all the processes used by the society to regulate its interaction with the natural environment by use of laws, institutions and participation processes. It is important in the developing countries in balancing the environment and industrial development. Both China and Vietnam are socialist oriented economies. They have registered robust industrial development and grave environmental

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problems. They share ideological and developmental origins, yet their directions of governance and environmental performance are extremely opposite.

This study seeks to evaluate the impact of institutional evolution, renewable energy performance and governance capacity on environmental outcomes in both countries. The study aims to achieve three goals. First, to analyze the technology transfer contribution to renewable-energy uptake and pollution reduction. Second, to analyze how financial support mechanisms can enhance governance and policy implementation. Third, to evaluate the contribution of strong environmental governance anchored on institutional enforcement, transparency and public participation to strengthen sustainable development. The paper uses comparative literature, World Bank, OECD, and UNDP data to argue that these three approaches, which stem from different literatures, can solve sustainable- development dilemmas for emerging countries like Vietnam and China as they are interlinked. Using a comparative analysis approach based on published data, this paper investigates technology transfer for renewable energy and environmental governance. The study concludes with a critical assessment of the performance of China and Vietnam within the context of developing nations.

## **2 Theoretical Foundations of Environmental Governance and Performance Assessment**

The ways in which we people govern the environment and all human interactions with the environment formal and informal institutions, legal systems, policies, decision-making procedures are called environmental governance [1] The purpose of this framework is to set the standards for the country that need to be adhered to at all times. Performance assessment refers to an assessment tool that can be applied to evaluate the effectiveness of public policy evaluation. It is based on quantitative and qualitative indicators. For instance, air-quality indices, emissions levels, public satisfaction.

In developing regions, centralized planning, weak institutional capacity, and resource poverty shape governance of the environment. China's system of governance evolved from strict top- down control to a hybrid model that combines market rewards with civil society. The socialist- oriented market economy of Vietnam enhanced environmental management of Vietnam under the guidance of external donors such as the World Bank and the Asian Development Bank. The Environmental Performance Index (EPI), the Sustainable Development Goals (SDGs), and environmental statistics by country support comparatives. These theoretical dimensions— capacity, coherence, and participation— correspond directly to this study's three proposals on technology transfer, financial support, and governance strength, which jointly determine environmental outcomes

Governance theory focuses on three factors that determine environmental performance: appropriate public involvement; public participation; and institutional capacity [2]. There are three ingredients required to ensure effectiveness of NAMA. Firstly, institutional capacity refers to coordination of administration and access to resources. Secondly, policy coherence deals with coordination of environment, industrial and energy sector. Thirdly, public participation refers to social legitimacy and enforcement responsibility. China and Vietnam are state-led, although societal participation is more and more recognized for effective governance.

## **3 Evolution of Environmental Governance in China and Vietnam**

The evolution of environmental governance in developing nations is rarely linear, often reflecting a nation's shifting priorities and developmental stage. In China and Vietnam, this transformation has been particularly dramatic, moving from rudimentary pollution control to more holistic and ambitious paradigms. This transition marks a fundamental

rethinking of the relationship between the state, the economy, and the environment. To illustrate this profound shift, we first turn to China, whose journey encapsulates a move from a reactive, end-of-pipe approach to the proactive, guiding philosophy of Ecological Civilization.

### **3.1 China: From Pollution Control to Ecological Civilization**

First enacted in 1979, the Environmental Protection Law (EPL) failed to enforce pollution control things. In 2003, the Environmental Impact Assessment (EIA) Law established prevention evaluation procedures, with an emphasis on the principle of polluting prevention before building.

In 2014, the reformed EPL incorporated more responsibility, increased penalties, and enabled non-governmental organizations (NGOs) to initiate environmental litigation. Environmental targets were incorporated into the Five-Year Plans, particularly the 13th (2016-2020) and 14th (2021-2025), which tied ecological performance to the measures of government evaluation, enhancing vertical accountability at bureaucratic tiers [4]. This policy shift marked the consolidation of China's "Ecological Civilization" framework, which aims to integrate sustainability into all sectors of governance.

### **3.2 Vietnam: Institutional Reform and Decentralization**

The way of environmental governance in Vietnam is representative of the overall post Doi Moi reforms. The first Law on Environmental Protection (LEP) was introduced in 1993 with a concept of environmental management under state leadership. In 2005 and 2014 changes were made to EIA, pollution control and community. According to Gibson, Strategic Environmental Assessment (SEA), provincial compliance and alignment with the Paris Climate accord (2020) were the major reforms of the LEP 2020 [1].

In Vietnam, the management of the environment is under the control of the Ministry of Natural Resources and Environment (MONRE). However, the decentralization process they initiated produced disparities, which have affected the enforcement of environmental rules and regulations in the different provinces. Local authorities often prioritize economic growth over environmental compliance, especially in regions heavily reliant on foreign direct investment (FDI). Nevertheless, the increased involvement of Vietnam in ASEAN environmental arrangements and collaboration with the World Bank, the ADB, and the UNDP have contributed to better regulatory modernization [5].

### **3.3. Comparative Institutional Development**

Both countries have a history of moving from fragmented institutional frameworks to integrated environmental governance systems Vietnam's decentralized political structure compares to China's highly centralized one, and this has resulted in differing outcomes in implementation. As shown in Table 1 below, both countries have been modernized in a parallel manner since 2000 but show backward governance in administration.

Both nations have transitioned from fragmented regulations to integrated governance. China's 2025 ESG taxonomy institutionalizes environmental disclosure, whereas Vietnam's 2025 Decree 12 decentralizes monitoring. This divergence exemplifies how strong governance capacity—the third proposal—enables China to achieve cohesive enforcement despite complex industrial structures. The contrasting timelines highlight China's pursuit of policy uniformity through centralized control, against Vietnam's emphasis on local adaptability via decentralization, presenting two distinct models for environmental governance in developing contexts.

**Table 1.** Key Environmental Governance Reform Milestones (2000–2025)

Year	China – Key Reform	Vietnam – Key Reform	EU – Key Reform	Japan – Key Reform
2003	EIA Law enacted; public consultation introduced	MONRE established	Directive 2003/35/EC on public participation	Basic Environment Plan revised
2014	Revised EPL; citizen litigation enabled	LEP 2014; SEA integrated	EU 2030 Climate & Energy Framework	Feed-in Tariff Act strengthened
2017	Carbon-trading pilots (7 provinces)	National Strategy on Climate Change (2017)	EU ETS Phase III	5th Strategic Energy Plan
2020	14th FYP links GDP to ecological metrics	LEP 2020; provincial EIA reform	EU Green Deal adopted	Carbon-neutral goal 2050
2023	National ETS expansion (4 Gt CO <sub>2</sub> )	Renewable-Energy Law pilot phase	“Fit for 55” package	Hydrogen Strategy
2025	Green Finance Guidelines	Environmental Governance Decree (Decree 12/2025/NĐ-CP)	EU Net-Zero Industry Act	Circular Economy Act enforced

Source: [1], [3], [4], [9], [13].

## 4 Comparative Environmental Performance

Performance evaluation includes objective measurement of air quality, emission intensity, and compliance rates. China decreased the average annual PM<sub>2.5</sub> concentration levels in the air by approximately 34% between 2013 and 2019 when adjusted by meteorological factors [5]. This decrease came after the adoption of the Air Pollution Prevention and Control Action Plan (2013) and the so-called Blue Sky initiatives aimed at major urban clusters.

In comparison, Vietnam still shares relatively high levels of PM<sub>2.5</sub>. Most provincial averages were 9–41 µg/m<sup>3</sup> in 2019 and dropped slightly to 8–36 µg/m<sup>3</sup> in 2020, which is higher than the WHO threshold of 5 µg/m<sup>3</sup> [6]. Although the national policies of Vietnam recognize air quality as a health concern, the implementation is localized, and real-time monitoring systems are currently available in large cities like Hanoi and Ho Chi Minh City only.

China’s cumulative 39 % decline since 2013 outpaces Vietnam’s 39 → 23 µg/m<sup>3</sup> (–39 %) but from a lower baseline. The stricter “Blue Sky Plan II (2023–2025)” coupled with nationwide ETS expansion accounts for rapid improvement. Vietnam’s decline, though moderate, reflects localized clean-energy transition and donor-funded monitoring. The data shows both countries achieved similar percentage reductions in PM<sub>2.5</sub>, but China started from a much higher baseline and implemented more aggressive, centralized policies, resulting in a larger absolute improvement in air quality.

**Table 2.** Average PM<sub>2.5</sub> Concentration (µg/m<sup>3</sup>), 2013–2024

Year	China (national avg)	Vietnam (provincial avg)
2013	72	38
2015	60	35
2017	50	30

2019	47	28
2020	44	26
2022	43	24
2024	41	23

Source: [5], [6], [14].

#### 4.1 Governance Indicators and Institutional Capacity

In addition to air quality, governance effectiveness can also be measured by law strength indicators, coordination, citizen involvement, and enforcement levels. Table 3 offers a comparative overview, considering the synthesized evaluations of scholarly and institutional sources. This multi-indicator approach is also consistent with recent work on developing a provincial environmental performance index for Vietnam, which highlights the importance of combining environmental-health and governance indicators [12].

**Table 3.** Comparative Environmental Governance Indicators (2024)

Indicator	China	Vietnam
Legal framework strength	9.2	7.6
Institutional coordination	8.4	7.1
Public participation	6.6	5.4
Transparency & data disclosure	7.8	6.0
Enforcement capacity	8.9	6.5
Composite governance index	8.2	6.5

Source: [3], [4], [5], [14].

Enforcement and coordination of china is more centralized and because of the centralized accountability; Vietnam gains its insider incremental transparency through ASEAN peer review mechanisms. Increased scores on the governance index confirm the fact that environmental performance is directly determined by governance strength a validation of Proposal [3].

Higher implementation and coordination scores in China are explained by both the centralized administrative framework and performance-based accountability of the local authorities in Vietnam. The decentralized structure is also flexible in the governance of the country, but lacks standardization of implementation and technological capabilities to conduct surveys. These signs suggest that institutional coordination and enforcement of the main aspects of good environmental governance have a direct effect on the renewable-energy performance.

The differences between political institutions are also shown in involvement. China is improving the way citizens have an impact on counting pollution issues, but Vietnam is lagging behind. Both countries are experiencing a steady increase in transparency everywhere it is needed.

Legal reforms are unlikely to change the way countries are governed unless there is also a way to enforce them effectively. China's example shows that adding environmental measurement to political performance standards raises the government's

overall responsibility for damage to the environment. The layout in Vietnam shows us how having printed reports can really benefit us on. Than what we do know we can than find out more of cross border concerns than not knowing more of cross border concerns. The governance scores clearly reveal China's top-down model excels in legal frameworks and enforcement, while Vietnam's decentralized approach shows relative weaknesses in coordination and implementation capacity, directly impacting its environmental outcomes.

## **5 Environmental Impact Assessment Frameworks and Case Studies**

Environmental Impact Assessment (EIA) serves as a cornerstone of modern environmental governance, designed to predict and mitigate the adverse effects of development projects. The effectiveness of an EIA system, however, is ultimately tested by its real-world application and outcomes. It is through the lens of specific case studies that the strengths and weaknesses of a nation's framework become most apparent. To explore this dynamic, this section first examines China's EIA system, using the highly contentious Xiamen PX (paraxylene) project as a pivotal case to illustrate the complex interplay between policy, public participation, and enforcement.

### **5.1 China's EIA Framework and the Xiamen PX Project**

The Environmental Impact Evidence EIA system in China has existed since 2003. The Environmental Impact Assessment Law 2003 mandates all major projects submitted by developers in China to include reports concerning their probable environmental impact. The Ministry of Ecology and Environment (MEE) performs a three-tier evaluation process: screening, scoping, and approval. As time went on, endeavours to boost government participation were undertaken, particularly in the wake of certain controversies [2].

Using blogs, microblogs, text messages and so on, they created a force of civil resistance which resulted in mass protests causing the local government to suspend, and eventually relocate the project. This case can show, through the application of digital media, the animating of citizen responsibility, in an authoritarian context, as a case of democratic environmentalization in China [7].

There were significant shifts in institutions after the Xiamen protests. The MEE has also introduced new requirements mandating that EIA reports be made accessible online and undergo a public consultation lasting a minimum of ten days. In later years, enforcing payoffs benefited consultants who made reports look more plausible in EIA documentation. The case of Xiamen shows that adaptive learning can happen in a hard state where state responsiveness to social mobilization strengthens the legitimacy of institutions without undermining the authority of the centre. This case underscores how strong environmental governance, specifically through institutional adaptability and public accountability, translates citizen participation into legitimate regulatory reform, embodying the third proposal of this study.

### **5.2 Vietnam's EIA Framework and the Formosa Ha Tinh Steel Incident**

The Vietnam legal and institutional framework of EIA that is based on the 1993 LEP and updated in 2005, 2014 and 2020 contains some international best practices, which are hindered by institutional flaws. LEP 2020 also stipulates that project developers are expected to carry out EIA before they can be given permission to construct. In addition, the results are expected to be released in compliance with MONRE authority. However, there are far more allowances in approvals at provincial level, and this introduces uncertainty in standards [1].

The case of 2016 Formosa Ha Tinh steel revealed weaknesses. A leakage of cyanide effluent and phenol on the central coast of Vietnam has killed a tremendous amount of

marine life in a 200-kilometre stretch, affecting the local fisheries and the local tourism. Nationwide outrage. It was found out that the local authorities had ratified project EIA without proper risk assessment. The government responded by fining Formosa 500 million US dollars and creating an emergency reform, NEIRP (1).

The Formosa crisis displayed two significant weaknesses: technical skill problem on provincial level and transparency mechanisms. It however accelerated the incorporation of environmental protection as part of political legitimacy into the political discourse of Vietnam. Later collaborations with Japan and the World Bank in a bid to improve quality assurance of EIA, environmental monitoring and legal compensation to victims of pollution. Formosa case reveals that environmental justice is compromised when there are no good governance mechanisms in place. This puts emphasis on the importance of good and clear governance towards sustainable development.

### **5.3 Comparative Insights from the Two Cases**

The Xiamen and Formosa cases have studied may give us an idea of some of the various capabilities that the systems have. The capacity of the Chinese institutions to absorb the activism of grassroots and facilitate regulatory adjustment is the strength of China. The advantage of Vietnam is that it gave way to civil-society activism within reforming but pluralism. In both cases, transparency and accountability are the most effective factors of EIA.

The national policy is quickly spreading especially because China is a centralized country. It can be seen through the lessons of Xiamen policies that resulted in changes in national regulations on EIA in 2008 and 2015. The Vietnamese system is decentralized, which allows situation-specific solutions. Yet it has the tendency of undermining enforcement. This contrast

can be said to teach us that the environmental governance in developing nations must be seen to carry the implication of trade-off of both flexibility and power and the citizen participation empowers the regulators more than it disempowers them [10]. The two EIA experiences emphasize that transparency and participation by the people are still central. The Xiamen and Formosa cases demonstrate how the adaptability of governance and agency of the citizens transform reactive policy into learning institutions, which supports the Proposal 3 strong governance to legitimate sustainability.

## **6 Renewable-Energy Governance and the Dilemma of Developing Countries**

The pursuit of renewable energy presents a profound dilemma for developing nations: balancing urgent economic growth with long-term environmental sustainability. This transition is not merely a technological shift but a complex governance challenge, fraught with institutional, financial, and political obstacles. How these countries navigate this path offers critical insights into the broader discourse on sustainable development. To illustrate these dynamics, this section first examines the case of China, a paradigm of rapid industrialization now pioneering an ambitious state-led energy transformation.

### **6.1 China's Renewable-Energy Transition**

China leads the world in investing in renewable-energy, with a one-third of the capacity additions in the world. Its system of governance is a convergence of environmental objectives and industrial policy. In the 2005 Renewable Energy Law, along with the later Five-Year Plans, feed-in tariffs (FITs), renewable portfolio standards and green certificates were also introduced [9].

As of 2023, the installed renewable generation rate in China was 1,300 GW, or approximately 48 percent of the total power generation rate. Hydropower, solar and wind dominate the energy mix. A comparative overview of the performance of the renewable-energy in China and Vietnam is shown in table 4.

**Table 4.** Comparative Renewable-Energy and Carbon-Intensity Indicators (2025)

Indicator	China	Vietnam
Share of renewables in electricity (%)	48	36
CO <sub>2</sub> emissions per GDP (kg CO <sub>2</sub> 2015)	0.40	0.50
Installed solar capacity (GW)	520 → 560	20 → 24
Installed wind capacity (GW)	420 → 450	13 → 16
Carbon pricing/trading mechanism	National ETS (4 Gt)	Pilot markets (3 regions)
Energy-efficiency improvement 2015–2025 (%)	19	13

Source: [8], [9], [13].

The data demonstrates China's superior performance in renewable energy adoption, with significantly higher capacity and growth rates, driven by its national carbon pricing mechanism. Vietnam's progress is more modest, constrained by policy instability and grid limitations, highlighting the critical role of consistent infrastructure and policy support in technology transfer. The consistency of the Chinese policy and the presence of state-owned enterprises to finance the scaling process allow China to achieve the goal quickly; the fluctuation of feed-in-tariffs in Vietnam (2019-2022) and grid capacity constraint hamper adoption. Therefore, a combination of technology transfer and financial support Proposals 1 and 2 can become the determinant of transition success.

The Chinese system of carbon trade is the largest in the world, which involves over 4 billion tons of emissions of carbon dioxide per year. Provincial emission-intensity caps have triggered technological modernization in steel, cement and energy industries. However, coal also continues to play an important role in China, at about 55% of its total energy consumption, and is, as such, a symptom of the lock-in effect of fossil infrastructure.

Technological innovation has facilitated the shift to green finance and government ownership businesses. But local governments, due to their need to provide employment, and due to their need to receive revenue, do not all the time turn away new coal enterprises which are one of the most anti-decarbonization national goals. The two poles denote the conflict between the central governance policies and the economic pressures in the local level [7].

## 6.2 Vietnam's Renewable-Energy Development

Vietnam is a rapidly developing renewable-energy platform in Southeast Asia, where solar expansion and foreign investment have become key drivers of the transition. Recent analysis of Vietnam's low-carbon development pathway similarly emphasizes the centrality of solar and wind deployment, policy continuity, and grid integration challenges in the country's energy transition [11]. Solar capacity grew by 18 GW between 2019 and 2024 with the support of liberalized feed-in tariffs and bilateral assistance of the World Bank, Asian Development Bank, and Japanese International Cooperation Agency (JICA). Power Development Plan VIII (PDP8) aims to achieve 47 percent renewables by 2030, but infrastructural limitations and grid instability remain a hindrance to integration.

Financial assistance and foreign aid have a central role to play. The Vietnam Renewable Energy Acceleration Program (2023) by the World Bank, which provides \$500 million to finance grid reinforcement and energy-storage studies, and Japan's Green Transformation Facility, which offers low interest loans to individual solar

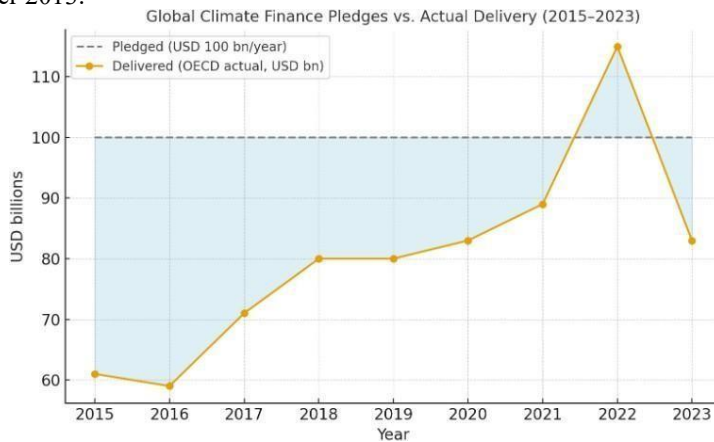
participants, both finance the programs. However, external dependence on funds increases the vulnerability of Vietnam to policy instability especially in cases where donor interests change. By 2024, 2.8 percent of GDP is filled by renewable investments, increasing by 1.1 percent since 2020 but the inability to disburse efficiently due to delays in implementation.

To achieve sustainable financing, Vietnam must transition from aid-dependence to diversified green finance instruments. Establishing a domestic green bond market, expanding blended-finance models, and incentivizing private-public partnerships could stabilize renewable investment flows. The success of China’s carbon-market revenue reinvestment strategy (2023) provides a replicable template for Vietnam to align economic aid with governance reform.

### 6.3 Shared Dilemmas of Developing Economies

Prasidya et al. [8] highlight a core dilemma faced by both countries: the short-term economic advantages of fossil fuels versus the long-term benefits of renewables. Transitioning energy systems requires significant time and investment. While the necessary technologies largely exist, their implementation and mastery take time. Consequently, populations facing poverty often prioritize affordable energy over environmental protection.

As shown in Fig. 1, both China and Vietnam experienced an overall decline in annual PM2.5 concentrations during the study period, although China’s reduction was steeper after 2013.



**Fig. 1.** Annual PM2.5 Concentration ( $\mu\text{g}/\text{m}^3$ ), 2013–2020

Source:[5,6.]

The table highlights a fundamental divergence in future strategies: China plans to leverage domestic policy and financial innovation to address its climate finance gap, while Vietnam relies more heavily on international cooperation and external funding. This contrast underscores China’s self-reliant approach versus Vietnam’s collaborative model for overcoming implementation challenges.

China has solved this inconsistency due to the harmony between state-directed investment and industrial policy, while Vietnam relies on foreign coalitions and donor aid. Sustainable energy transitions can happen when environmental governance frameworks are made to include financial innovation, transparency, and policy stability [8]. No matter what the scale of some governance experiences, this is what those experiences seem to suggest.

There is a remarkable growth in regional cooperation on renewable energy courses between the two nations. Vietnam is working with the Asean power grid and China’s

BRI green projects. This case contributes to synergies in infrastructure for clean energy in the Global South and carbon intensity.

## **7 Policy Learning and Implications for the Global South**

The experiences of China and Vietnam offer a rich repository of lessons for other nations in the Global South navigating similar development trajectories. A critical dimension of this policy learning revolves around a central, often contentious, dilemma: how to pursue rapid economic growth without compromising long-term environmental sustainability. This challenge is not merely technical but deeply embedded in national priorities and governance structures. Therefore, this section will explore the complex strategies and trade-offs involved in trying to balance these two seemingly essential goals.

### **7.1 Balancing Growth and Sustainability**

It can be seen from the case studies of both China and Vietnam, that economic growth need not compete with environmental protection. Both countries have started including environmental accounting in economic planning. The Green GDP by the Chinese and the Vietnamese National Strategy on Green Growth 2021-2030 institutionalize the inclusion of environmental indicators in development indicators [3,6].

Still, fossil-fuel subsidies, uncoordinated policy frameworks and uneven enforcement continue to pose challenges. The developing countries, therefore, should implement multi-level governance strategies which incorporate fiscal reform, public-private partnership, and open monitoring framework. Considering these aspects, carbon-market construction in China and participation reforms in Vietnam illustrate a joint response to adaptation issues. The experiences of China and Vietnam demonstrate that multi-level governance reinforced by financial and technological cooperation aligns with the study's proposed solutions

### **7.2 Regional and South–South Cooperation**

The three proposals technology transfer, financial support, and governance reform are not isolated mechanisms but interdependent strategies essential for the Global South. According to both countries' examples, long-term political will, responsive legal reforms, and investment in environmental institutions lead to success.

Knowledge, technology, and capacity-building measures through South-South collaboration can accelerate development. China has previously experimented with the renewable-energy technology, pollution control, and carbon-market design that could be useful for its peers including Indonesia, Kenya or Brazil. Smaller economies can learn from how Vietnam works with donors and manages community-based resource use.

Devoting the lessons to the Sustainable Development Goals (SDGs), specifically SDG 7 (Affordable and Clean Energy) and SDG 13 (Climate Action) of the UN, developing countries can formulate governance frameworks that have local legitimacy but global relevance. As of 2025, China's South–South Climate Cooperation Fund (USD 3 billion) and Vietnam's ASEAN Power Grid partnership demonstrate how technology and finance are becoming regional public goods, amplifying collective resilience through shared governance networks.

## **8 Synthesis of Key Findings**

Findings indicate that environmental outcomes improve when technology transfer accelerates renewable innovation, when financial support ensures sustained investment, and when strong governance enforces accountability. Even though the Vietnamese system is new, they have been learning about institutions through various means and developing their civic consciousness [9].

The Chinese legal system, in comparison with the Vietnam one, is designed to safeguard the environment and offer more developed renewable-energy power. Vietnam is said to be progressing in the area of experimentation of open and participatory governance. These two cases demonstrate that to ensure sustainable environmental performance, a self-supportive combination of law, enforcement, participation and innovation is needed at four fronts.

The issue of renewable-energy governance should not be a concern in such case as compared to environmental policy. The environmental governance of the developing nations is experiencing a fresh evolution with reactive management of the natural resources to a responsive and hosting transformation. According to our research, centralization and decentralization cannot be good. What counts is the harmony of consistency in the design and development priorities in governance.

## 9 Conclusion

This comparative study between China and Vietnam shows that a large amount of progress has been made on the areas of environmental regulation and changes in renewable energies. Nevertheless, prolonged imbalances in enforcement, financial autonomy and voter participation limit complete transformation. The new 20242025 data show that the two nations are on similar paths of sustainable-development realization, albeit by differentiated strategies China by relying on centralized responsibility and Vietnam by promoting pluralistic engagement.

Transfer of technology, financing and governance reform should be a triadic unit. The international cooperation, transparent organizations, and stable funding are the keys to low- carbon innovation. During the COP30 Summit in Belém, Brazil (2025), there were discussions about how to unify regional undertakings on climate finance and South-South cooperation, presenting a chance for China and Vietnam to move towards this direction. Finally, sustainable development will be based on the capacity of developing nations to balance the growth of the economy with the conservation of the environment using inclusive, adaptive, and accountable governance systems. In this paper, we analyze viable technology transfer for renewable energy and environmental governance, using the experiences of China and Vietnam as case studies. We hope this analysis can benefit other developing countries in strengthening their own environmental governance.

## References

1. N.K. Bui, A. Kopytova, E3S Web Conf. **164**, 11005 (2020).
2. B.D. Clarke, C.C. Vu, Heliyon **7**, e06139 (2021).
3. J. Wu, M. Xu, P. Zhang, J. Clean. Prod. **184**, 227–238 (2018).
4. Q. Ye, S. Dai, G. Zeng, Chin. J. Popul. Resour. Environ. **16**, 1–11 (2018).
5. Q. Zhong, S. Tao, J. Ma, J. Liu, H. Shen, G. Shen, J. Hu, One Earth **4**, 448–458 (2021).
6. N.T.T. Nhung, V.T. Duc, V.D. Ngoc, T.M. Dien, L.T. Hoang, T.T.T. Ha, G. Morgan, Front. Public Health **10**, 1056370 (2022).
7. W. Jin, H.Q. Zhang, S.S. Liu, H.B. Zhang, J. Clean. Prod. **211**, 61–69 (2019).
8. T. Prasidya, W. Suhaedi, M.A. Fikri, I. Rakhmawati, J. Ilm. Tata Sejuta STIA Mataram **11**, 38–58 (2025).
9. Y. Li, Y. Chiu, T.Y. Lin, S.M. Wang, T.H. Chang, Int. J. Environ. Sci. Technol. **21**, 5955–5970 (2024).
10. S. Zheng, M.E. Kahn, W.C. Liao, SSRN Working Paper 5563644 (2025).

11. J. Hansen Eeg, A Study of Vietnam's Energy Transition Pathway to Low-Carbon Development, Master's Thesis, NTNU (2023).
12. T.T. Nguyen, C.T. Tran, T.B. Ly, T.T. Nguyen, *Environ. Dev. Sustain.* **25**, 622–647 (2023).
13. International Energy Agency (IEA). *World Energy Outlook 2025: Renewables and Energy Transition Data Set*. Paris: IEA, (2025).
14. World Bank. *Global Air Quality Database 2025 (Version 3.0)*. Washington DC: World Bank Group, (2025)