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Review Article

Energy Transition and Governance: A Systematic Literature Review

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Abstract

The global shift toward a low-carbon economy has intensified scholarly and political attention on the governance of energy transition, which is critical for ensuring equitable, efficient, and sustainable outcomes. Despite the rapid expansion of research in this field, existing studies remain fragmented, with varying emphases on financial, policy, and technological dimensions, limiting the ability to form integrated governance frameworks. This systematic literature review addresses this gap by synthesizing current knowledge on "Energy Transition and Governance" through a rigorous search and selection process. Advanced database searches were conducted in Scopus and Web of Science, applying predefined inclusion and exclusion criteria to ensure relevance, quality, and novelty. From an initial pool of studies, 25 primary articles were identified for in-depth analysis. The findings were thematically organized into three core domains: (1) Financing, Economic Drivers, and Market Risks in Energy Transition, which explores investment flows, risk mitigation strategies, and the role of economic incentives; (2) Governance, Policy, and Justice in Energy Transition, which examines institutional frameworks, regulatory effectiveness, and equity considerations; and (3) Technological Innovation, ESG, and Data-Driven Solutions, which highlights the integration of emerging technologies, environmental, social, and governance (ESG) practices, and data analytics in accelerating transition goals. The review reveals that while financing mechanisms and technological advances are well-documented, policy coherence, cross-sectoral governance, and equitable justice frameworks remain underdeveloped. This underscores the need for future research to adopt interdisciplinary approaches, bridge policy–technology gaps and enhance governance models that align financial incentives with social equity and environmental integrity. By consolidating evidence across diverse perspectives, this study provides a comprehensive foundation for policymakers, industry leaders, and researchers seeking to design effective governance systems for a just and sustainable energy transition.

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1. Introduction

The "energy transition" is the process of switching from conventional energy sources to renewable and sustainable ones, with governance playing a pivotal role in shaping and implementing this transformation. It encompasses a multitude of local initiatives and public policies embedded within a multi-level governance system, requiring the coordination of different actors and knowledge within a territory [1]. Beyond being a normative and target-driven process, climate neutrality, sustainability, economic efficiency, and energy security are examples of systemic aspects of the energy transition [2]. The pace and nature of this transition vary globally due to differences in governance models, institutional structures, and the organization of economic actors in the energy sector [3]. To provide a structured overview of the governance dimension, Figure 1 presents a concept map outlining the core governance components in energy transition, organized into four interconnected domains, comparative governance, local governance, energy democracy, and decarbonization strategies, each containing thematic subtopics that shape transition outcomes.

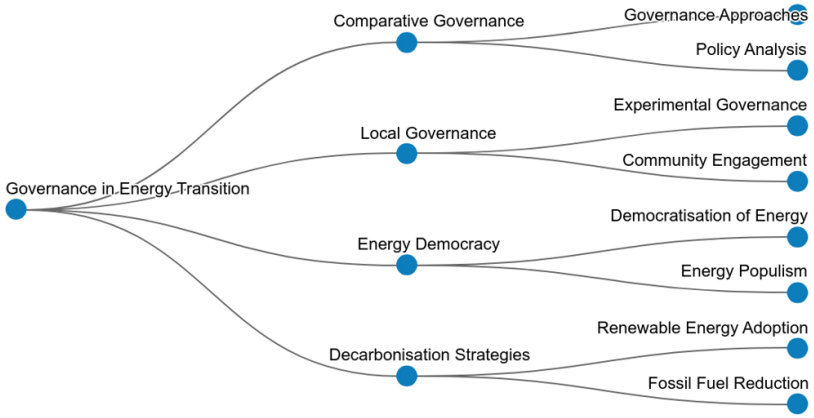

Figure 1. Governance dimensions and thematic pathways in energy transition.

The concept map places Governance in Energy Transition at the centre, emphasizing governance as the central mechanism for enabling, directing, and sustaining energy transformation. The first branch, Comparative Governance, includes *Governance Approaches* and *Policy Analysis*, highlighting the need to assess and adapt different governance models to fit specific political, economic, and institutional contexts. This reflects the importance of identifying best practices and policy frameworks that can accelerate transition efforts. The second branch, Local Governance, encompasses *Experimental Governance* and *Community Engagement*. These subthemes highlight the importance of place-based innovation and participatory methods, where local authorities and communities collaborate to design, test, and implement solutions tailored to regional energy needs. The third branch, Energy Democracy, contains *Democratisation of Energy* and *Energy Populism*, which address equity, fairness, and public influence over energy decision-making. These aspects concentrate on empowering citizens, decentralizing control, and making sure that the advantages of the energy transition are distributed fairly, while also acknowledging the political narratives that can shape public perception and policy directions. The fourth branch, Decarbonisation Strategies, includes *Renewable Energy Adoption* and *Fossil Fuel Reduction*. This represents the technical and policy-driven pathways to achieve low-carbon goals, combining investment in renewable infrastructure with systematic reduction of fossil fuel dependency. By mapping these governance elements, the figure provides a structured lens through which to

understand how various governance levels and approaches interact to influence the success and equity of the energy transition process.

Building on the earlier discussion and the relationships illustrated in the concept map, it becomes clear that governance operates as a pivotal lever in shaping the trajectory of the energy transition process. This connection between the structural, technological, and socio-political elements outlined previously sets the stage for a deeper examination of the governance-related challenges and opportunities in driving sustainable change. The process faces several challenges, including the dominance of centralized energy-grid systems, coordination problems, and difficulties in scaling up renewable technologies [4]. Success is not solely dependent on collaborative governance structures but also on the role of power dynamics and key individuals who influence governance outcomes [5]. Additionally, converting abandoned fossil fuel-powered buildings into renewable energy facilities creates opportunity, as existing infrastructure can be adapted for cleaner energy production [6]. Effective governance is essential for enabling, facilitating, and accelerating energy transitions at local, national, regional, and global levels [2]. Governance mechanisms often involve state-led approaches, substantial government control over the energy sector, and, in some cases, external support from international bodies such as the European Union [7]. A shift towards co-creative governance is crucial, incorporating the dynamic interplay between power relations and political structures that underpin governance functionality [8]. Governance has a substantial impact on the success of energy transition initiatives. The ability of government institutions to encourage innovation and change benefits urban sustainable energy transitions, emphasizing the importance of both state power and municipal governance capacity [9]. The outcomes of transitions are impacted by multilayered governance structures, underscoring the need to fortify multilateral institutions and adjust governance methodologies both internally and externally [2]. Furthermore, the strategic positioning and relationships among intermediaries are central to coordinating actors effectively, requiring adaptive strategies and dynamic collaboration to overcome conflicts and accelerate progress [10]. This paper is structured to ensure clarity and rigor. The Literature Review synthesizes existing studies to identify trends and gaps. The Research Question defines the scope and focus of the review, while the Materials and Methods describe the systematic approach adopted. The Results and Findings present the key outcomes, followed by the Conclusion, which discusses implications and future research directions.

2. Literature Review

The literature on energy transition and governance presents a complex landscape shaped by political structures, socio-economic dynamics, technological advancement, and environmental priorities. A dominant trend in recent studies is the focus on how various models of governance, i.e. egalitarian, centralized, cooperative, or multi-level, affect the speed and sustainability of energy transitions. For instance, Soysa et al. [11] conducted a comparative analysis across 46 industrialized nations and found that although egalitarian democracies invest heavily in environmental R&D and renewable energy, they paradoxically maintain higher CO_2 emission intensities. This indicates a discrepancy between environmental investments and current climate gains, possibly due to policy commitments in consensus-based political systems. Similarly, Zhao et al. [12] examined governance effects in China and the USA and revealed divergent outcomes, which is positive in China, negative in the USA, highlighting the importance of political culture and administrative structures. Li et al. [13] further contextualized governance in Arctic nations, identifying economic policy uncertainty as a significant hindrance to renewable energy transition, despite high environmental technology and governance standards. These studies collectively emphasize that the form and stability of governance directly affect both the ambition and effectiveness of energy transition policies.

Emerging economies face unique governance challenges and opportunities in their energy transitions, often shaped by centralized state power and economic dependencies. In Kazakhstan, Neafie et al. [14] explored a state-led strategy seeking international investment in green technologies, but found tensions between centralized policymaking and local sustainability goals. Governance centralization facilitates decisive action and investment direction, yet risks alienating local stakeholders whose participation is essential for long-term policy success. Similarly, the study by Al-Rawashdeh et al. [15] on E7 countries affirmed that effective governance and public awareness campaigns contribute positively to Sustainable Development Goals (SDGs) when aligned with carbon finance and renewable electricity sources like water and solar energy [16], focusing on Europe's mineral trade under stress from geopolitical and economic volatility, showed how governance continuity and risk management directly influence the import dynamics of critical energy transition minerals. In each case, governance structures either bolster or impede strategic goals, underlining the importance of adaptive yet stable governance mechanisms in resource-reliant and politically diverse regions.

Several recent investigations emphasize the importance of participatory and decentralized governance models in achieving effective and inclusive energy transitions. van Dijk et al. [17] analyzed governance capacities in the Eindhoven Metropolitan Region and identified social learning and path dependence as foundational mechanisms for building resilient energy transition governance. Their findings suggest that shared intentions among governance actors and historical policy trajectories shape present capabilities. A parallel theme is observed in the work of Kaze et al. [18], who developed a multi-level governance (MLG) framework tailored to Nigeria, highlighting the need for bottom-up governance and community renewable energy (CRE) models. These approaches are essential to mitigate carbon lock-in and to adapt global strategies to local political and infrastructural realities. Complementing these perspectives, Van Opstal et al. [19] examined cooperative governance in Belgium's smart grid projects. Their study highlighted the potential of cooperative structures in overcoming market failures and integrating circular economy strategies, although regulatory support remains crucial for widespread success. Across diverse contexts, these studies demonstrate that inclusive, multi-actor governance models are better suited for fostering innovation, equity, and resilience in energy transitions.

The reliability and validity of global energy transition indices and frameworks have also drawn scrutiny. Rayman-Bacchus and Walsh [20] evaluated the World Energy Council's Energy Transition Index (ETI) and identified substantial uncertainties stemming from structural assumptions and lack of contextual adaptation. Using principal component analysis and internal consistency testing, they found that energy equity and governance are strongly interdependent dimensions that policymakers often overlook when using global indices for national policy design. Their research advocates for a re-evaluation of how global benchmarking tools are applied in governance settings, suggesting that failing to consider country-specific institutional and infrastructural realities may lead to ineffective policy prescriptions. Furthermore, their findings align with observations by Soysa et al. [11] and Zhao et al. [12], who emphasized that governance quality cannot be universally evaluated through a single typology, given the variegated effects observed in countries like the USA, China, and various European democracies. Such analytical divergences reinforce the necessity for more nuanced, flexible, and region-specific governance assessment tools.

Notwithstanding the increasing comprehension, significant deficiencies remain within the existing body of work. Many studies fail to reconcile the contradiction between policy rhetoric and actual emissions outcomes, a theme highlighted by Soysa et al. [11]. Others, like Li et al. [13], suggest that governance responses to economic shocks are under-explored, particularly in volatile regions such as the Arctic. Furthermore, limited longitudinal analyzes weaken the ability to evaluate whether governance transformations have long-term impacts on energy transition efficacy. Al-Rawashdeh et al.

[15] noted the ETI's insufficient sensitivity to temporal and material complexities in energy transitions. Meanwhile, studies on cooperative governance, such as those by Van Opstal et al. [19], offer strong theoretical promise but require empirical scaling beyond niche smart grid projects. Additionally, case studies from Africa and Central Asia, although insightful, remain underrepresented in cross-national meta-analyses, a concern partially addressed by Neafie et al. [14] and Kaze et al. [18]. Finally, the geopolitical dimension, such as in the work of Mariev and Islam [16] who studied on mineral trade in Europe, deserves deeper integration into mainstream governance frameworks to reflect the full spectrum of risks facing global energy transitions.

Future research must prioritize methodological consistency while embracing multi-contextual flexibility. Comparative studies using disaggregated indicators are essential to understand how governance interacts with resource endowments, technological readiness, and social equity goals. Stakeholder-informed research like that by Neafie et al. [14] and van Dijk et al. [17] should be expanded to cover diverse governance scales and sectors, from municipal to transnational. Integration of community voices, such as through CRE models in Nigeria [18], is critical to building inclusive governance structures. In addition, further scrutiny of institutional accountability mechanisms is necessary to distinguish between symbolic and substantive environmental policies [21]. The intersection of governance and economic uncertainty, particularly in the context of geopolitical instability and mineral dependency, warrants detailed exploration to support long-term policy resilience [13,16]. With governance acting both as a catalyst and constraint, a multi-dimensional approach that includes technological, economic, social, and institutional variables is indispensable for advancing the energy transition agenda.

3. Research Questions

Defining the research questions (RQs) is the cornerstone of the planning phase and the backbone of any systematic literature review (SLR), guiding and shaping the entire review process from start to finish [22]. Given that the objective of this SLR is to identify and assess the current state of knowledge in the field, the PICo framework, proposed by Lockwood et al. [23] was employed to formulate precise and structured research questions, comprising three key elements: Population (P), which identifies the specific group, sector, or community under investigation; Interest (I), representing the central phenomenon, issue, or topic of exploration, such as a process, intervention, behavior, or challenge of concern; and Context (Co), which encompasses the broader setting in which the population and interests are situated, including geographical, cultural, political, or environmental dimensions. By clearly articulating these components, researchers can establish a precise and coherent foundation for inquiry, ensuring that the study remains focused and contextually grounded. By systematically collapsing these components, the PICo framework ensures that research questions are clear, well-defined, and aligned with the study's objectives. This clarity not only facilitates a focused literature search but also supports a coherent study design. Following this approach, the present study formulated the following three research questions:

First – How do sustainable financing instruments and macro-economic risk factors influence renewable energy investment and energy-justice outcomes in low- and middle-income countries during energy transitions?

Second – To what extent do different governance interventions and policy instruments (national/sub-national) affect energy security, equity and local participation in the energy transition?

Third – How do ESG rating mechanisms and AI-enabled information systems influence corporate green innovation, disclosure quality, and firm-level energy efficiency during the energy transition?

4. Materials and Methods

When carrying out a systematic literature review, the PRISMA framework (Preferred Reporting Items for Systematic Reviews and Meta-Analyses), described by Page et al. [24], is widely regarded as the gold standard for ensuring clarity, rigour, and consistency across every stage of the review. Adhering to PRISMA guidelines helps researchers bring greater precision and rigour to their work, using structured steps to identify, screen, and select relevant studies. The framework also highlights the importance of randomised studies, acknowledging their power to minimise bias and strengthen the evidence base. To ensure a broad and credible evidence base, the present review utilised both Web of Science and Scopus.

The PRISMA process is structured into four main stages: identification, where comprehensive searches are conducted to capture all potentially relevant literature; screening, which applies predefined criteria to exclude irrelevant or low-quality studies; eligibility, involving detailed evaluation to ensure the remaining studies meet inclusion requirements; and data abstraction, which entails systematically extracting and synthesising data from the final set of studies. This systematic approach facilitates a high level of methodological integrity, producing dependable findings that can inform future research directions and practical applications.

4.1. Identification

Within the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework, the identification stage serves as the foundation of a systematic literature review (SLR). At this point, the research landscape is explored in full, mapping the available scholarship to capture the scope and ensure coverage of the relevant research domain. Employing a dual-database strategy, we conducted an exhaustive search within two of the most authoritative bibliographic repositories, Scopus and the Web of Science (WoS), targeting the keywords “energy transition” and “governance”. Based on Table 1, This search yielded 1,864 records from Scopus and 1,482 records from WoS, resulting in a combined total of 3,346 unique entries prior to deduplication. The inclusion of both databases was methodologically deliberate. Scopus, with its extensive indexing of peer-reviewed journals, conference proceedings, and emerging fields, provides broad coverage across multidisciplinary contexts, whereas WoS offers a long-standing curation of high-impact journals and an established citation indexing system that facilitates bibliometric analysis. By leveraging both platforms, the search strategy mitigates database-specific biases and maximizes recall, ensuring the capture of diverse perspectives spanning political science, environmental studies, economics, and engineering, disciplines integral to the energy transition–governance nexus. The substantial yield at this stage reflects the growing scholarly attention to the role of governance in shaping energy transition pathways, particularly as governments, industries, and communities grapple with decarbonization targets, renewable energy adoption, and socio-political complexities in the post-Paris Agreement era.

Beyond the descriptive figures, the dataset size itself offers several interpretive insights into the state and maturity of the research field. First, the large corpus, over three thousand records, demonstrates that the intersection of energy transition and governance is no longer a niche scholarly interest but has emerged as a mainstream, cross-cutting research agenda. The emergence in publication volume is likely driven by escalating climate imperatives, policy innovations, and the need for governance frameworks capable of integrating the technological, economic, and social dimensions of energy transitions. Second, the variance in yield between Scopus (n = 1,864) and WoS (n = 1,482) underscores the complementary nature of the two databases, with Scopus potentially capturing a broader spectrum of regional and applied research, while WoS tends to emphasize high-impact, globally recognized journals. This difference reinforces the methodological necessity of multi-database searches to avoid systematic

exclusion of relevant literature, an omission that could skew thematic mapping, trend analysis, and evidence synthesis in subsequent SLR stages. From an epistemological standpoint, the combined total means a rich yet heterogeneous knowledge base, one that necessitates rigorous screening and quality appraisal to distill high-relevance, methodologically robust studies from the broader pool. In this regard, the identification step is not merely a mechanical aggregation of records but a strategic act of research boundary-setting, laying the groundwork for an evidence base that can meaningfully inform theoretical advancement, policy formulation, and practice in energy governance.

Table 1. The search string.

Scopus	TITLE-ABS-KEY (“Energy Transition” AND “Governance”) AND PUBYEAR > 2024 AND PUBYEAR < 2027 AND (LIMIT-TO (DOCTYPE , “ar”)) AND (LIMIT-TO (LANGUAGE , “English”)) AND (EXCLUDE (SUBJAREA , “SOCI”) OR EXCLUDE (SUBJAREA , “ENER”) OR EXCLUDE (SUBJAREA , “ENVI”) OR EXCLUDE (SUBJAREA , “ENGI”) OR EXCLUDE (SUBJAREA, “MATH”) OR EXCLUDE (SUBJAREA , “BUSI”) OR EXCLUDE (SUBJAREA , “COMP”) OR EXCLUDE (SUBJAREA , “EART”) OR EXCLUDE (SUBJAREA , “DECI”) OR EXCLUDE (SUBJAREA , “MEDI”) OR EXCLUDE (SUBJAREA , “ARTS”) OR EXCLUDE (SUBJAREA , “AGRI”) OR EXCLUDE (SUBJAREA , “PSYC”) OR EXCLUDE (SUBJAREA , “PHYS”) OR EXCLUDE (SUBJAREA , “MULT”) OR EXCLUDE (SUBJAREA , “PHAR”) OR EXCLUDE (SUBJAREA , “MATE”) OR EXCLUDE (SUBJAREA , “CHEM”) OR EXCLUDE (SUBJAREA , “CENG”)) Date of Access: August 2025
So's	“Energy Transition” AND “Governance” and 2025 (Publication Years) and Article(Document Types) and English (Languages) and Article (Document Types) and Environmental Sciences Ecology or Science Technology Other Topics or Environmental Sciences Ecology or Science Technology Other Topics or Energy Fuels or Government Law or Public Administration or Geography or Engineering or International Relations or Meteorology Atmospheric Sciences or Operations Research Management Science or Social Sciences Other Topics or Thermodynamics or Urban Studies or Construction Building Technology or Geology or Architecture or Computer Science or Nuclear Science Technology or Physics or Sociology or Transportation (Exclude – Research Areas) Date of Access: August 2025

4.2. Screening

Following the comprehensive identification phase, the systematic literature review progressed to the screening stage, wherein the initial corpus of 3,346 records underwent a series of exclusionary filters to ensure methodological rigor and relevance to the research objectives. Post-screening, the dataset was reduced to 481 records, comprising 284 from Scopus and 197 from the Web of Science (WoS). The primary screening criteria were designed to maintain linguistic consistency, temporal relevance, and document type appropriateness (see Table 2). Specifically, we excluded non-English publications, works published before 2025, and document types inconsistent with our analytical focus, namely conference proceedings, book chapters, review papers, and in-press articles. This process eliminated 2,865 records, thereby refining the dataset to those contributions most likely to offer peer-reviewed, original empirical or theoretical insights into the intersection of energy transition and governance. The exclusion of non-English studies was guided by the need to ensure interpretive accuracy and methodological comparability across the corpus, while the removal of pre-2025 publications reflected the review’s intention to capture the most recent scholarly discourse and policy-relevant findings, aligning the evidence base with contemporary debates shaped by recent geopolitical, technological, and regulatory shifts.

An additional and critical element of the screening process was the removal of duplicate entries, a common occurrence in multi-database searches. Cross-referencing between Scopus and WoS identified 143 duplicate records, which were eliminated to avoid over-representation of individual studies and the

consequent bias in thematic and bibliometric analyses. This meticulous deduplication is particularly important in a field such as energy governance, where high-impact studies are often indexed in multiple repositories. The marked reduction from 3,346 to 481 records underscores the dual function of the screening stage: to improve the precision of the dataset by aligning it with pre-defined inclusion criteria, and to preserve the breadth of coverage while removing extraneous, outdated, or redundant material. Beyond its procedural necessity, this stage also offers epistemological clarity, by focusing on contemporary, peer-reviewed, and methodologically sound contributions, the resulting dataset is better positioned to reveal nuanced trends, governance challenges, and emerging policy mechanisms relevant to accelerating the global energy transition. In effect, the screening process transforms a diffuse and heterogeneous body of literature into a curated knowledge base, one capable of supporting a robust synthesis that is both academically rigorous and policy relevant.

Table 2. The selection criterion is searching.

Criterion	Inclusion	Exclusion
Language	English	Non-English
Timeline	2025-2026	< 2025
Literature type	Journal (Article)	Conference, Book, Proceeding
Publication Stage	Final	In Press
Country	Final	In Press

4.3. Eligibility

In the eligibility phase of the PRISMA process, the refined dataset of 481 records from the screening stage was further assessed for full-text availability and substantive relevance to the research scope. Of these, 382 articles were successfully retrieved for full-text review, representing those that had initially passed the title–abstract screening. At this stage, a deeper examination was undertaken to ensure each study not only addressed the keywords “energy transition” and “governance” but also aligned thematically with the conceptual and analytical boundaries of this review. This step moved beyond superficial keyword matching and engaged with the substantive focus, methodological orientation, and contextual framing of the literature. Articles were excluded if they were determined to be out of field (e.g., governance studies unrelated to energy systems, or energy studies without governance dimensions), if the titles indicated insufficient thematic relevance, or if full-text access was not possible despite exhaustive retrieval efforts. The inability to access certain full texts, due to subscription limitations or archival restrictions, was a methodological constraint, although its potential impact was mitigated by the broad coverage of accessible materials. In total, 357 articles were excluded during this stage, resulting in a final corpus of 25 primary studies that met all inclusion criteria.

This eligibility process served a critical role in ensuring that the final dataset represented a body of literature with both conceptual precision and empirical depth. The rigorous culling from 3,346 initial records to just 25 final studies reflects the high degree of thematic specificity required to investigate the intersection of energy transition and governance meaningfully. While the exclusion of many studies might suggest a fragmented or diffusely defined research field, it equally underscores the importance of maintaining analytical integrity in systematic reviews. Many works that superficially intersected with the topic were excluded because they lacked sufficient engagement with governance structures, decision-making processes, or institutional frameworks, dimensions essential for the present synthesis. By focusing only on studies with clear, relevant, and accessible contributions, the resulting evidence base is both manageable in scope and rich in analytical potential. This deliberate narrowing not only

enhances the coherence of the synthesis but also ensures that conclusions drawn are rooted in high-quality, contextually relevant, and methodologically sound research, thereby providing a credible foundation for advancing scholarly understanding and informing policy discourses on energy governance in the era of rapid transition.

4.4. Data Abstraction and Analysis

With a focus on quantitative methods, this study used integrative analysis as a primary evaluation technique to systematically review and synthesize various research designs (refer Figure 2). Finding and classifying pertinent themes and subthemes in the literature was the main objective. The first stage of the thematic development process was data collection. The authors carefully reviewed 25 chosen publications, as shown in Table 3, extracting statements and supporting data that were directly related to the focus of this study. Subsequently, the body of significant studies addressing energy transition and governance was critically appreciated, with attention given to both the methodologies employed and the substantive findings reported. After that, the writers worked together to develop themes based on the collected empirical data. A log was kept during the analysis to document observations, interpretive insights, emerging questions, and other reflections relevant to data interpretation. Finally, the identified themes were cross-compared to detect any inconsistencies in their formulation. To ensure analytical coherence and consensus, the authors deliberated and resolved any conceptual disagreements that arose.

Table 3. Number and details of primary studies.

No.	Research Teams	Research Focus	Publication (Scopus/WoS)
1	Liu Y., Dong K., Nepal R.	Sustainable finance and energy justice in developing Asia	Global Finance Journal (Scopus)
2	Kushawaha D.	Public Debt and Donor Funding for Renewable Energy	Finance Research Letters (Scopus)
3	Liu X., Jia Y., Zhu C., Wang C., Yao J.	Policy-Driven Innovation in Corporate Renewable Energy Technologies	International Review of Financial Analysis (Scopus)
4	Wang Y., Wang Y., Chen Z., Shen H.	ESG Rating Discrepancies and Corporate Energy Efficiency	Applied Economics Letters (Scopus)
5	Chen L., Jiang N.	Government Intervention and Energy Justice in China	Structural Change and Economic Dynamics (Scopus)
6	Wang Y., Liao W., Zhao X., Lian P.	Green Innovation Quality and Energy Transition Policy	Finance Research Letters (Scopus)
7	Liu T., Ling T., He H.	Oil Price Uncertainty and Renewable Energy Transitions	Applied Economics (Scopus)
8	Imtiaz A., Yuanying C., Shahzad M.F., Raheel A., Sabah F., Sarwar R.	Intellectual Structure of Green Economy and Sustainability Research	Cogent Social Sciences (Scopus)
9	Mariev, O.; Islam, M.M.	Governance, Geopolitics, Financial Stress, and Energy Transition Mineral Trade in Europe	Energy Economics (WoS)
10	Zhang, W.; Zhang, Y.J.; Lan, X.L.; Song, M.L.	Artificial Intelligence and Energy Transition Structure in BRICS	Energy Economics (WoS)
11	Ren, X.H.; Hong, K.Y.; Tao, L.Z.	Climate Finance Aid and Renewable Energy Transition in Developing Countries	Economic Analysis and Policy (WoS)
12	Fan, M.; Shira, R.K.; Hunjra, A.I.; Zhao, S.K.	Climate Governance, Financing Constraints, and Green	Research in International Business and Finance (WoS)

		Transformation of Energy-Intensive Firms	
13	Ranville, A.	Member Participation, Governance, and Community Energy in French Cooperatives	Annals of Public and Cooperative Economics (WoS)
14	Rao, A.; Kumar, S.; Gupta, P.	Decarbonization, Energy Security, and Equity in Emerging Economies	Energy Economics (WoS)
15	Bainton, N.; Skrzypek, E.E.; Lèbrec, E.	Climate Vulnerability and Energy-Extractives in the Pacific	World Development (WoS)
16	Ghouse, G.; Iqbal, M.; Cucchiella, F.	Productive Capacity, Organizational Sustainability, and ESG in Next-11 Countries	Baltic Journal of Management (WoS)
17	Zhang, Q.; Du, D.B.; Yang, Y.; Hu, S.L.; Chen, Y.L.; Ding, J.F.; Xia, Q.F.	Traditional and renewable energy interests under economic sanctions	Energy Economics (WoS)
18	Girón, A.	Global Energy Projects and Finance in China	Journal of Economic Issues (WoS)
19	Nyiwul, L.; Hu, Z.N.; Koirala, N.P.; Wasson, H.	Renewable energy investment amid economic uncertainty	International Economics and Economic Policy (WoS)
20	Zhao, X.; Tong, Y.S.; Lee, H.; Shahzad, U.	AI-driven corporate environmental disclosure for energy transition and sustainability	Energy Economics (WoS)
21	Allen, F.; Barbalau, A.; Chavez, E.; Zeni, F.	Financial strategies of multinational firms in climate action	Journal of International Business Studies (WoS)
22	Kano, L.; Grogaard, B.; Ciravegna, L.; Adarkwah, G.K.	Multinational enterprises' role in environmental crisis response.	Journal of International Business Studies (WoS)
23	Chen, Ling; He, Lingyun; Liu, Rongyan; Fu, Yating	Risk transmission in China's energy industry chain	Economic Analysis and Policy (WoS)
24	Murshed, Muntasir	Internet access and carbon emissions from unclean energy in South Asia.	Mineral Economics (WoS)
25	Zuo, Qiang; He, Jiale; Iqbal, Atif; Wan, AnPing; AL-Bukhaiti, Khalil; Cheng, Xiaomin; Ji, Xiaosheng; Rafiq, Muhammad	Sustainability impact of renewable energy in achieving carbon neutrality.	International Journal of Energy Sector Management (WoS)

4.5. Quality of Appraisal

After choosing the primary studies, original research articles or documents that are directly included in the systematic review as key sources of evidence, we must assess the calibre of the research they present and conduct a quantitative comparison in accordance with Kitchenham and Charters' guidelines [25] Specifically, we use the six-quality assessment (QA) criteria from the work of Abouzahra et al. [22] as the quality assessment technique for our systematic literature review (SLR). A three-level scoring system is used to grade each criterion: "Yes" (Y) equals 1 if it is fully satisfied, "Partly" (P) equals 0.5 if it is partially met but has flaws, and "No" (N) equals 0 if it is not met at all.

- QA1: Is the purpose of the study clearly stated?
- QA2: Is the relevance and usefulness of the work clearly demonstrated?
- QA3: Is the study methodology well-defined and appropriate?
- QA4: Are the key concepts and theoretical framework clearly explained?

- QA5: Does the study compare and measure its results against similar research?
- QA6: Are the limitations of the study explicitly acknowledged?

The quality assessment process involves three experts independently evaluating each study based on these criteria, scoring each as Y, P, or N. The purpose of each criterion is as follows:

1. Clear articulation of the study's objectives to guide the research focus.
2. Demonstration of the study's significance and potential impact.
3. Clear and suitable methodology ensuring validity and reproducibility.
4. Well-defined theoretical concepts and approach.
5. Benchmarking against existing literature to contextualize contributions.
6. Transparent discussion of any study limitations.

Only studies that receive a total score of more than 3.0 advance to the next round, which is determined by adding the scores of the three experts. Only papers that satisfy an acceptable quality criterion are included for additional analysis.

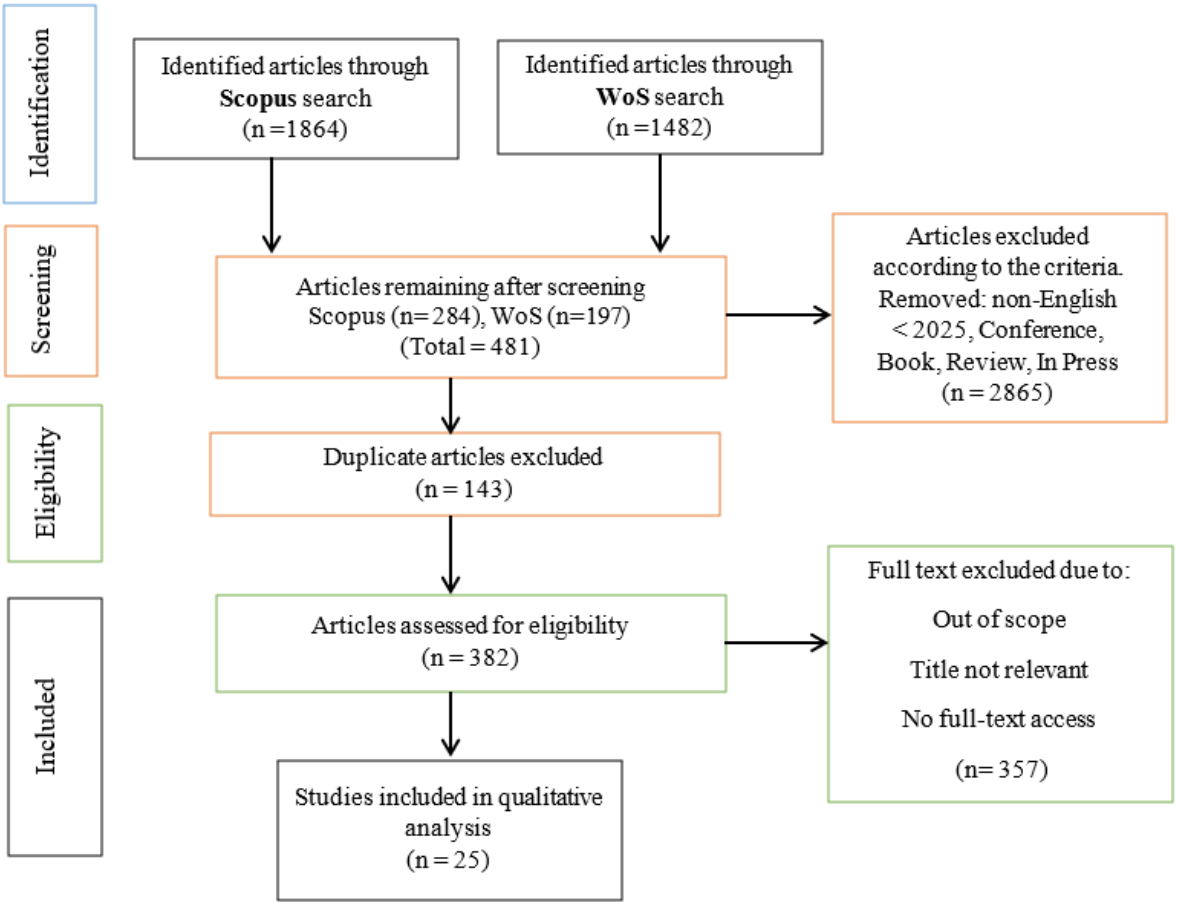

Figure 2. Diagram showing the proposed study search process (Moher D, Liberati A, Tetzlaff J, 2009).

5. Results and Findings

The quality assessment of the 25 reviewed studies based on Table 4 indicates that most papers performed well, with total marks ranging mainly between 3.5 and 5.5 (58.3%–91.7%). All studies

clearly articulated their research purpose (QA1) and highlighted the importance and relevance of their work (QA2). Methodological clarity (QA3) and conceptual definitions (QA4) were generally well addressed, although some studies only partially met these criteria. Comparison with similar work (QA5) and explicit discussion of limitations (QA6) were less consistently covered, with many studies scoring partial or no marks in these areas. Despite these minor shortcomings, no paper failed outright, and the overall quality is solid, reflecting a strong foundation in energy transition research. To further strengthen the literature, future studies should improve on comparative analyzes and more clearly recognize limitations. Here is the quality assessment table for the selected papers.

Table 4. The quality assessment of the 25 reviewed studies.

No.	Author(s)	QA1	QA2	QA3	QA4	QA5	QA6	Total Mark	Percentage (%)
1	Chen & Jiang [26]	Y	Y	Y	Y	Y	P	5.5	91.7
2	Kano et al. [27]	Y	Y	P	P	Y	N	4.0	66.7
3	Murshed [28]	Y	Y	Y	Y	P	P	5.0	83.3
4	Liu et al. [29]	Y	Y	P	P	P	N	3.5	58.3
5	Girón [30]	Y	Y	P	P	P	N	3.5	58.3
6	Fan et al. [31]	Y	Y	Y	P	P	N	4.5	75.0
7	Bainton et al. [32]	Y	Y	P	P	N	N	3.0	50.0
8	Rao et al. [33]	Y	Y	Y	Y	P	P	5.0	83.3
9	Kushawaha [34]	Y	Y	Y	P	P	N	4.5	75.0
10	Ren et al. [35]	Y	Y	Y	P	P	N	4.5	75.0
11	Nyiwul et al. [36]	Y	Y	Y	Y	P	N	4.5	75.0
12	Wang et al. [37]	Y	Y	Y	Y	Y	P	5.5	91.7
13	Zhang et al. [38]	Y	Y	Y	Y	P	N	4.5	75.0
14	Allen et al. [39]	Y	Y	P	P	P	P	3.5	58.3
15	Chen et al. [40]	Y	Y	Y	Y	P	N	4.5	75.0
16	Imtiaz et al. [41]	Y	Y	Y	Y	P	P	5.0	83.3
17	Ghouse et al. [42]	Y	Y	Y	Y	N	P	4.5	75.0
18	Ranville [43]	Y	Y	Y	Y	N	N	4.0	66.7
19	Liu et al. [44]	Y	Y	Y	Y	P	N	4.5	75.0
20	Zuo et al. [45]	Y	Y	Y	Y	P	P	5.0	83.3
21	Liu et al. [46]	Y	Y	Y	Y	P	N	4.5	75.0
22	Wang et al. [47]	Y	Y	Y	P	P	N	4.0	66.7
23	Zhang et al. [48]	Y	Y	Y	Y	P	P	5.0	83.3
24	Mariev and Islam [16]	Y	Y	P	P	P	N	3.5	58.3
25	Zhao et al. [49]	Y	Y	Y	Y	P	P	5.0	83.3

5.1. Financing, Economic Drivers, and Market Risks in Energy Transition

The literature on financing, economic drivers, and market risks in energy transition emphasizes the complex interplay between governance quality, financial mechanisms, economic conditions, and geopolitical factors in shaping renewable energy development trajectories. Sustainable financing emerges as a crucial driver for just and inclusive energy transitions, particularly in developing Asian countries. Liu et al. [29] illustrated that regions characterized by advanced transitions and strong financial infrastructure yield the largest returns, with enhancements in governance quality and human

capital serving to intensify these outcomes. Ren et al. [35] extended this perspective by demonstrating that climate finance, especially mitigation funds, significantly bolsters renewable energy development in politically well-governed countries, although negative spatial spillovers can occur in neighbouring states. Zuo et al. [45] similarly highlighted the importance of targeted governance frameworks to maximize the mediating role of foreign direct investment (FDI), stressing that without adequate infrastructure and institutional support, FDI's potential to advance sustainability is constrained.

Economic uncertainty is another persistent challenge for renewable energy investments. [36] find a consistently negative relationship between economic uncertainty and renewable investment flows, with the impact intensifying under low economic growth, weak institutional quality, and limited financial absorption capacity. This aligns with the result of Kushawaha [34], who revealed that high public debt significantly deters donor financing for renewable energy in low- and middle-income countries, with corruption control playing a partial mitigating role. Rao et al. [33] added that governance stability is essential to balancing decarbonization goals with energy security, as ineffective governance or overly stringent policies may disrupt energy supply in the short term, despite long-term sustainability gains.

The complexity of renewable energy transitions is further shaped by the volatility of commodity prices and disruptions stemming from geopolitical events. Liu et al. [46] identified a non-linear, N-shaped relationship between oil price uncertainty and renewable transitions, particularly in OECD countries, where advanced economies accelerate renewable adoption in response to oil price shocks. Despite financial strain, fluctuating mineral prices, and geopolitical turmoil, Europe's energy transition mineral commerce remains resilient. However, during periods of acute volatility, such as the Russia-Ukraine conflict, such stress might limit imports [16]. Zhang et al. [38] further demonstrated that economic sanctions disproportionately harm traditional energy more than renewable energy interests, with governance capacity, economic freedom, and technological advancement playing critical buffering roles.

Large-scale actors, both public and private, are pivotal in mobilizing financial and technological resources for energy transitions. Girón [30] illustrated China's dual role as a global renewable leader and coal-dependent economy, showing how state-led investment, corporate governance, and institutional finance have facilitated structural transformation while revealing trade-offs between growth and sustainability. Allen et al. [39] highlighted that multinational enterprises, despite contributing to climate problems, possess governance, financing, and technological capabilities that can circumvent country-specific barriers to decarbonization when properly incentivized. These insights align with the work of Liu et al. [29], whose findings underscore the indirect benefits of sustainable financing through green innovation, further reinforcing the need for strategic alignment between governance structures and investment flows.

5.2. Governance, Policy, and Justice in Energy Transition

Governance, policy design, and justice considerations emerge as critical determinants in shaping effective energy transition strategies. Several studies emphasize the significance of government initiatives in fostering fair and groundbreaking change. Chen and Jiang [26] demonstrate that government action dramatically improves energy justice in China, primarily by improving energy accessibility and adjusting credit allocation mechanisms. Due to disparities in resource endowments and economic systems, these effects are more pronounced in northern provinces, and spill over to neighbouring regions through demonstration and competition effects. Additionally, through government incentives and R&D investments and corporate governance enhancements, policy-driven initiatives like the Renewable Energy Development Initiative promote industry innovation in renewable energy technology [44]. Wang et al. [37] further showed that targeted local environmental policies like

the New Energy Pilot City Policy improve green innovation quality, with impacts moderated by governance structures and regional economic capacity. Together, these studies highlighted that governance frameworks, when coupled with tailored policy instruments, can promote both technological advancement and equitable access in the energy transition process.

The integration of governance mechanisms into corporate and community-level energy transition efforts also receives attention. Fan et al. [31] found that climate governance actions, implemented through climate-adaptive city building pilots, enhance the green transformation of energy-intensive enterprises by easing financing constraints and bolstering supply chain resilience. Ranville [43] explored the participatory dimension, showing that effective governance of energy cooperatives relies on the interplay between ecological motivation and the socio-economic resources of members, promoting a democratic energy transition management. Liu et al. [44] reinforced the role of corporate governance in fostering technological innovation across diverse renewable energy sources, while Wang et al. [37] emphasized that strong governance at the firm level can amplify the innovation-enhancing effects of policy measures. These findings together indicate that governance at multiple organizational levels is essential to embed sustainability goals into both business operations and community initiatives.

Governance in the energy transition is also shaped by transnational and extractive industry dynamics. Bainton et al. [32] warned that the global demand for minerals needed for the energy transition may exacerbate environmental and social problems in regions already vulnerable to climate change, like the Pacific Islands. This leads to "compound exposure" as the effects of mining and climate change overlap. Kano et al. [27] challenged reductionist perspectives that frame multinational enterprises solely as environmental liabilities, arguing instead for coordinated multilateral governance where MNEs can act as leaders in sustainability collaborations. Chen et al. [40] added that understanding risk transmission along energy industry chains is vital for industrial governance, particularly under extreme market conditions, to prevent systemic vulnerabilities from undermining transition goals. These perspectives stress that governance in energy transition must account for global supply chain pressures, cross-border institutional cooperation, and resilience planning within industrial systems.

At the intersection of governance, policy, and environmental justice, digitalisation and financial accessibility emerge as supplementary enablers. Murshed [28] showed that expanding internet access in South Asia can mitigate CO_2 emissions by reducing reliance on unclean natural resources and moderating their environmental impact, although unexpectedly, good governance indicators in this context were associated with increased emissions. This counterintuitive finding suggests that governance quality must be coupled with targeted energy and environmental policies to ensure alignment with decarbonization goals. Chen and Jiang [26] similarly highlighted that governance reforms without specific sectoral focus may not yield intended justice outcomes. Moreover Fan et al. [31] indicated that easing financing constraints via governance-led policy interventions can accelerate green transformation in resource-dependent enterprises. Collectively, these studies imply that governance effectiveness depends on its ability to integrate technological, financial, and social policy tools within a coherent energy transition framework.

5.3. Technological Innovation, ESG, and Data-Driven Solution

The literature on technological innovation, ESG considerations, and data-driven solutions in the context of energy transition demonstrates an increasing integration of digital technologies, environmental governance mechanisms, and strategic policy frameworks to accelerate sustainability goals. A prominent area of research involves the application of artificial intelligence (AI) in facilitating cleaner energy systems, enhancing governance structures, and improving

corporate disclosure quality. Zhang et al. [48] showed that AI significantly advances both explicit and implicit energy transitions in BRICS economies, although its uneven development can generate negative spillover effects. Similarly, Zhao et al. [49] highlighted AI's dual role in improving corporate environmental information disclosure through internal control optimization and external supervision strengthening, which in turn supports low-carbon transformation. [46] further suggested that technological and human capital investments, coupled with green innovation, can moderate the sensitivity of renewable energy transitions to oil price uncertainty, underlining the broader role of digital and technological enablers in achieving sustainable energy governance.

The role of ESG frameworks in shaping energy efficiency and sustainability outcomes is equally emphasized across multiple studies. Wang et al. [37] found that discrepancies between third-party ESG ratings can hinder improvements in corporate energy efficiency, though green innovation and shifts toward cleaner production can counterbalance these negative effects. Ghouse et al. [42] extended the discussion by showing that ESG can transform the relationship between productive capacity and organizational sustainability from an inverted U-shape to a U-shape, suggesting that governance quality can stabilize long-term sustainability outcomes. The intersection of ESG and technological innovation emerges as a critical pathway for maintaining efficiency gains while mitigating unintended environmental or organizational drawbacks, reinforcing the need for harmonized ESG evaluation standards and innovation-driven transition strategies.

From a macro-governance and policy perspective, bibliometric mapping by Imtiaz et al. [41] identified critical thematic clusters in global green economy research, renewable energy transitions, policy governance, and economic decarbonization, while also exposing significant geographic and thematic disparities. These disparities particularly affect social equity and the participation of low-income regions, indicating that digital solutions such as AI-driven governance and blockchain for transparency could bridge knowledge and implementation gaps. Complementing this, [46] and [38] demonstrate that differentiated policy design, based on country-specific characteristics and resource dependencies, is essential for maximizing the effectiveness of technological interventions in energy transition.

Several studies converge on the insight that technological tools, particularly AI, act as amplifiers of governance capacity, but their effects are contingent on supporting conditions such as institutional quality, innovation ecosystems, and equitable access to digital infrastructure. Zhang et al. [38] noted that natural resource dependence can undermine AI's positive effects on the energy transition, while knowledge production has a reinforcing influence. Similarly, Zhao et al. [49] showed that AI's benefits for environmental disclosure are stronger in large, mature, and technologically advanced corporations. When combined with ESG frameworks, as in the works of Wang et al. [47] and Ghouse et al. [42], technological innovation serves not only as a driver of efficiency but also as a stabilizer against market, governance, and environmental uncertainties.

In summary, the reviewed literature indicates that the synergy between technological innovation, ESG governance, and data-driven solutions is a decisive factor in advancing sustainable energy transitions. AI emerges as both a technical enabler and a governance catalyst, while ESG mechanisms function as both performance benchmarks and adaptive moderators of organizational and systemic change. Policy pathways emphasize interdisciplinary integration, standardization of ESG metrics, targeted technological implementation, and inclusive participation in global research networks. These combined approaches are necessary for bridging existing disparities, sustaining innovation-driven progress, and aligning energy transition strategies with broader sustainable development objectives.

6. Conclusion

This systematic literature review aimed to synthesize contemporary research on the intersection of energy transition and governance, focusing on studies published between 2025 and 2026. Using the PRISMA framework and PICo methodology, the review examined 25 high-quality articles selected from Scopus and Web of Science databases. The primary research questions addressed the influence of sustainable financing, governance interventions, and technological mechanisms, particularly ESG and AI, on energy justice, security, and innovation outcomes across diverse geopolitical and economic contexts.

The review identified three dominant thematic domains: (1) Financing, Economic Drivers, and Market Risks, (2) Governance, Policy, and Justice, and (3) Technological Innovation, ESG, and Data-Driven Solutions. Key findings reveal that while financial instruments and technological advancements are increasingly integrated into energy transition strategies, governance coherence and equity frameworks remain underdeveloped. Existing research consistently emphasizes the significance of flexible governance, public engagement, and inter-agency collaboration for successful and robust energy shifts that benefit everyone. Methodologically, the studies employed a mix of econometric, spatial, and qualitative approaches, contributing to a nuanced understanding of policy effectiveness and institutional dynamics.

This review contributes to the field by consolidating fragmented insights into a structured synthesis, offering novel perspectives on the role of governance in mediating financial, technological, and social dimensions of energy transition. It introduces a multi-dimensional framework that aligns investment flows, policy instruments, and digital innovations with equity and sustainability goals. The analysis also highlights the need for region-specific governance assessments and the integration of community-based models to enhance local participation and justice outcomes.

Practically, the findings offer actionable guidance for policymakers, industry stakeholders, and institutional actors. Evidence suggests that targeted governance reforms, including financing mechanisms, and standardized ESG metrics can significantly improve energy transition outcomes. AI-enabled systems and digital infrastructure further enhance transparency, innovation, and decision-making capacity, especially when embedded within robust institutional frameworks.

However, the review acknowledges several limitations. The exclusion of non-English literature and reliance on recent publications may have omitted relevant longitudinal insights. Additionally, underrepresentation of certain regions, such as Africa and Central Asia, limits the generalizability of findings. Future research should expand cross-national meta-analyses, incorporate longitudinal designs, and explore the geopolitical dimensions of energy governance, particularly in resource-dependent and politically volatile contexts.

In closing, systematic reviews such as this are essential for advancing theoretical clarity and guiding empirical inquiry in the rapidly evolving field of energy transition governance. By synthesizing diverse perspectives and identifying critical gaps, this study lays a foundation for more integrated, equitable, and evidence-based approaches to managing the global shift toward sustainable energy systems.

Declaration of Conflict of Interest

The authors declared no conflict of interest with any other party on the publication of the current work.

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