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NAVIGATING SOCIO-TECHNICAL AND POLITICAL CHALLENGES IN RENEWABLE ENERGY ACCESS: A MIXED-METHODS ANALYSIS OF NIGERIA'S TRANSITION LANDSCAPE

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Abstract:
This study investigates the multifaceted challenges and opportunities in Nigeria's energy transition within the broader African natural resource context. Employing a mixed-methods approach, the research examines how political-institutional fragmentation, local awareness, governance quality, and relational dynamics between actors and technologies influence renewable energy access and equity. The findings suggest that institutional fragmentation and governance misalignments may hinder the effective implementation of national energy transition strategies, while local awareness and quality governance facilitate adoption. Although interactions between actor participation and technology type were not statistically significant, the study highlights the critical role of decentralised, community-led initiatives in promoting equitable energy outcomes. The paper concludes with policy recommendations emphasising institutional reform, capacity building, and inclusive participatory frameworks to foster just and sustainable energy transitions. The research contributes to the understanding of socio-technical and institutional factors shaping energy equity in sub-Saharan Africa and calls for continued empirical and policy innovation.

Keywords: energy transition, institutional fragmentation, renewable energy access, decentralised energy, governance quality, energy equity

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Introduction

Nigeria's energy transition is unfolding within a structural tension between fossil-fuel dependence and accelerating policy commitments to renewable energy. As Africa's largest oil producer, the country faces the challenge of maintaining economic stability while responding to global decarbonization pressures, which increasingly demand a shift toward low-carbon energy systems (Baker & Sovacool, 2022; Pueyo, 2020). National policy instruments such as the Renewable Energy Master Plan and the Energy Transition Plan articulate long-term strategies for expanding renewable energy capacity and improving energy access (Khennas, 2012; Pedersen & Andersen, 2023). However, implementation capacity has not kept pace with policy ambition, resulting in persistent gaps between strategic planning and actual energy outcomes across regions. This disconnect highlights the importance of examining not only energy targets but also the institutional and structural conditions that shape their realisation in practice.

Energy transitions in Nigeria are fundamentally shaped by socio-technical and political dynamics rather than technological change alone. Socio-technical systems theory emphasises that energy infrastructures are embedded within networks of institutions, social practices, and technological configurations that evolve together over time (Fox et al., 2020; Sony & Naik, 2020). Political economy perspectives further demonstrate that electricity access in Sub-Saharan Africa is influenced by governance structures, distributional conflicts, and institutional incentives that shape investment and implementation decisions (Aklin et al., 2020; Baker & Phillips, 2021). This implies that renewable energy adoption is not simply a matter of infrastructure provision but also of power relations, institutional coordination, and governance effectiveness. Understanding these interdependencies is essential for explaining why energy access outcomes remain uneven despite sustained policy reforms and international support.

Despite increasing investment in renewable energy technologies, multiple structural barriers continue to constrain deployment across developing economies. These barriers include weak regulatory environments, fragmented institutional arrangements, limited access to financing, and underdeveloped market systems that collectively slow the integration of renewable energy into national grids (Hu et al., 2018; Foster et al., 2017). At the global scale, evidence suggests that while renewable energy expansion is accelerating, it still falls short of the growth rates required to meet long-term climate stabilisation targets (Cherp et al., 2021; Binsted, 2022). The result is a widening gap between global decarbonization pathways and national implementation realities, particularly in energy systems characterised by institutional fragmentation and infrastructural constraints such as Nigeria's. This reinforces the need to examine transition processes within their specific political and institutional contexts.

The literature on renewable energy transitions in Africa reveals several important but unresolved limitations. First, existing studies often analyse technical, economic, and political dimensions separately, rather than integrating them into a single explanatory framework capable of capturing their interactions. Second, there is limited empirical evidence linking national-level energy transition policies with household-level outcomes in renewable energy access and adoption. Third, few studies adopt mixed-methods approaches that combine quantitative measurement with qualitative insights to explain how governance quality, institutional fragmentation, and community participation jointly shape energy outcomes. These limitations restrict a full understanding of why ambitious energy policies frequently produce uneven or delayed implementation outcomes across different regions in Nigeria and similar contexts.

This study addresses these gaps by integrating socio-technical systems theory and political economy analysis within a mixed-methods research design. It examines how institutional fragmentation, governance quality, and awareness levels influence renewable energy access outcomes across different Nigerian contexts. The study also explores how actor participation and technology type interact to shape energy adoption patterns, particularly in decentralised and centralised energy systems. Unlike prior studies that treat these factors independently, this research combines them into a unified explanatory model that captures both structural constraints and local-level dynamics affecting energy access. By doing so, it provides a more comprehensive understanding of how energy transition processes unfold in practice rather than remaining at the level of policy design.

The article is organised as follows. Section 2 develops the conceptual framework by integrating socio-technical systems and political economy perspectives to guide the analysis. Section 3 presents the mixed-methods research design, including sampling, data collection, and analytical procedures. Section 4 reports and interprets the empirical findings from both quantitative and qualitative components. Section 5 discusses the policy implications of the results for Nigeria's energy transition strategy. Section 6 concludes by summarising key findings and outlining contributions to theory and practice.

Literature Review

Empirical Review

More empirical research from Nigeria and Africa has delved into decentralised renewable energy systems and shown promise for mini-grids and hybrid systems in increasing energy access. Evidence from Sub-Saharan Africa indicates that decentralised electrification pathways are strongly shaped by institutional structures, governance quality, and local demand conditions, rather than technology alone (Aklin et al., 2020; Baker & Phillips, 2021). In rural electrification contexts, studies show that community-level determinants and political incentives significantly influence access outcomes, particularly where centralised systems fail to reach marginal populations (Aklin et al., 2020). Similarly, mini-grid and off-grid systems have been identified as important complements to national grids in contexts characterised by infrastructural deficits and weak regulatory coordination (Pueyo, 2020; Pedersen, 2016). These findings collectively emphasise that decentralisation is not merely technical but deeply socio-political in nature.

Recent advances in geospatial electrification modelling further strengthen empirical understanding of energy access planning. Studies using global energy access frameworks highlight how spatial modelling tools can identify least-cost electrification pathways while accounting for population density, infrastructure gaps, and sustainability constraints (Nerini et al., 2018; He et al., 2022). These approaches demonstrate that electrification outcomes vary significantly across geographic and socioeconomic landscapes, reinforcing the need for differentiated planning strategies (Hu et al., 2018). At the global scale, projections show that renewable energy expansion must accelerate substantially to remain consistent with climate stabilisation pathways (Cherp et al., 2021; Binsted, 2022). However, declining renewable energy costs are simultaneously reshaping feasibility conditions for decentralised systems, particularly in low-income regions (Luderer et al., 2022). These findings highlight persistent spatial and institutional inequalities in energy transition trajectories.

Further empirical work on hybrid renewable energy systems demonstrates the importance of techno-economic optimisation in improving system feasibility. Research indicates that integrated renewable configurations combined with storage and backup systems can improve reliability and reduce long-term operational costs under uncertain grid conditions (Olabi & Abdelkareem, 2022). Broader sustainability assessments also show that renewable energy expansion contributes to multiple SDG-linked outcomes, including emissions reduction and economic diversification (Wang et al., 2022). However, trade-off analyses reveal that carbon performance outcomes vary depending on system design and policy integration mechanisms (Zhang et al., 2022; 2023). At the same time, macroeconomic evidence suggests that climate policy incentives significantly shape investment behaviour in renewable technologies, particularly under conditions of market uncertainty (Mercure et al., 2021). These studies collectively underscore the importance of integrated energy-economic modelling.

Policy and regulatory frameworks have also been closely examined across developing economies, revealing mixed implementation outcomes. Evidence shows that energy transitions are strongly shaped by political economy dynamics, including governance fragmentation, institutional coordination failures, and competing policy priorities (Baker & Phillips, 2021; Khennas, 2012). Broader analyses of sustainable development governance further highlight that energy policy is embedded within contested political agendas and institutional power structures (Weber, 2017). From a socio-technical perspective, energy systems are co-produced through interactions between technology, institutions, and societal expectations, rather than being purely technical infrastructures (Fox et al., 2020; Sony & Naik, 2020). In addition, real-time governance approaches suggest that adaptive policy monitoring mechanisms may improve alignment between implementation and evolving energy system conditions (Guston & Sarewitz, 2002). These findings reinforce the need for dynamic governance approaches in renewable energy transitions.

Innovation in financial mechanisms and investment models has also emerged as a key empirical focus. Studies on climate policy incentives demonstrate that financial structures significantly influence renewable energy adoption rates and investment flows (Mercure et al., 2021). Similarly, evidence from sustainability transitions shows that economic diversification and renewable energy integration are mutually reinforcing under supportive policy environments (Wang et al., 2022). Broader global assessments indicate that declining renewable energy costs are improving the financial viability of decentralised systems, particularly in emerging economies (Luderer et al., 2022). At the same time, structural barriers such as fossil fuel price distortions continue to influence investment decisions and slow renewable uptake in many developing regions (Foster et al., 2017). These findings collectively suggest that financial architecture and policy incentives remain decisive determinants of energy transition speed and equity.

Hypotheses Development

Empirical research across Africa indicates that national energy transition initiatives frequently face governance and institutional coordination challenges. Studies show that political economy structures and institutional fragmentation significantly affect electricity access outcomes, particularly in Sub-Saharan Africa where governance systems are multi-layered and often misaligned (Aklin et al., 2020; Baker & Phillips, 2021). In Nigeria, energy governance is characterised by overlapping institutional mandates and fragmented implementation authority, which reduces coordination efficiency and policy coherence (Khennas, 2012; Pedersen & Andersen, 2023). Comparative evidence further shows that such fragmentation increases uncertainty for investors and weakens incentives for infrastructure expansion in renewable energy sectors (Pueyo, 2020). Political economy analyses also demonstrate that institutional incentives shape distributional outcomes in electricity access, often reinforcing inequality across regions (Aklin et al., 2020). Accordingly, the first hypothesis is formulated as follows:

> H_1: National energy transition strategy implementation may be constrained by political-institutional fragmentation, limited local awareness, and incompatible levels of government incentives.

Energy transition processes are fundamentally shaped by interactions between institutional actors and technological systems. Socio-technical systems theory emphasises that energy infrastructures evolve through co-production processes involving institutions, technologies, and social practices (Fox et al., 2020; Sony & Naik, 2020). Empirical evidence from developing economies shows that centralised energy systems may reproduce spatial inequalities due to uneven distribution of infrastructure investment and governance attention (Baker & Phillips, 2021; Pueyo, 2020). Geospatial and systems-based analyses further indicate that electrification outcomes depend on spatial planning efficiency and infrastructure targeting mechanisms (Nerini et al., 2018; Hu et al., 2018). However, renewable energy diffusion also depends on broader macro-transition dynamics, including technological cost reductions and global climate policy pressures (Cherp et al., 2021; Binsted, 2022). These patterns suggest that energy access outcomes are shaped by multi-level institutional and technological interactions.

> H_2: To address the relational complexity of energy governance, this study conceptualises the interaction between state institutions, private sector actors, and local communities as a multi-actor system influencing technology deployment and access outcomes, rather than treating "participation" or "technology type" as isolated explanatory factors. This allows for a more structured representation of institutional–technological co-evolution while maintaining empirical tractability within the available dataset.

Community participation remains a critical variable in shaping energy access outcomes, particularly in decentralised systems. Empirical studies show that decentralised energy systems can improve access efficiency and system resilience, especially in rural and underserved regions (Pedersen, 2016; Nuru, Rhoades, & Gruber, 2021). However, outcomes are strongly dependent on institutional support structures and financial sustainability mechanisms (Lohani et al., 2023). Broader sustainability transition literature suggests that renewable energy systems contribute to SDG-aligned development outcomes when embedded within supportive governance frameworks (Wang et al., 2022). At the same time, climate policy incentive structures influence the effectiveness of decentralised energy investments by shaping risk and return expectations (Mercure et al., 2021). Therefore, the third hypothesis is stated as follows:

> H_3: Community-based, decentralised renewable energy initiatives may yield more equitable outcomes than centralised systems when local participation is substantive, where "equitable outcomes" are operationalised as measurable indicators including household income effects, energy cost reductions, supply reliability, women's participation in decision-making, local employment creation, user satisfaction, tariff-related conflict incidence, and community-level involvement in system maintenance and ownership structures.

These indicators align the hypothesis with the study's Renewable Energy Access Indicator (REAI) and extend it to capture distributive and procedural dimensions of energy justice in a measurable empirical framework.

Methodology

Research Design, Data Sources, and Sampling Strategy

The study adopts a mixed-methods design, integrating quantitative household survey data with qualitative interviews and participant observation. The quantitative dataset consists of a stratified random sample of N = 750 households drawn from Lagos, Kaduna, and Rivers States, reflecting differences in urban–rural settlement patterns, energy infrastructure availability, and socioeconomic contexts. Data were collected in 2024 through standardised questionnaires that captured renewable energy access. The study relies exclusively on primary field data collected by the author, with no secondary or synthetic dataset used.

A three-stage stratified random sampling procedure was implemented. First, states were stratified based on geopolitical and electrification characteristics. Second, Local Government Areas (LGAs) were randomly selected within each state. Third, households were systematically sampled using updated community household listings obtained from local administrative records.

The qualitative component consisted of 35 semi-structured interviews with policymakers, utility officials, community leaders, and NGO practitioners, supplemented by approximately 60 hours of participant observation at rural mini-grid project sites. Interview participants were selected through purposive sampling from the survey population to ensure direct linkage between quantitative and qualitative datasets. These sources provided contextual insights and triangulation for the quantitative findings. Fieldwork was conducted between March and August 2024, and all participants provided informed consent under an approved ethical protocol.

Variable Construction and Measurement Framework

Institutional fragmentation was operationalised as an index scaled from 0 to 1, with higher scores indicating greater fragmentation, constructed through coding of national and state policy documents, stakeholder interview transcripts, and Nigeria Electrification Project (NEP) records. Local awareness was measured as a score between 0 and 1, derived from survey responses regarding knowledge of energy transition policies. Governance quality was represented by an index (0–1) capturing transparency and citizen participation indicators, based on household surveys and official governance assessments.

Community participation in energy projects was quantified (0–1) from coded interview content and field observation data. Technology type was coded as a binary variable, where 1 denotes decentralised systems such as solar mini-grids, and 0 represents centralised grid supply, using survey data and NEP geospatial mapping (World Bank, 2023). Household-level control variables included monthly income in Nigerian naira (survey data), years of schooling of the household head (survey data), and a binary urban–rural classification based on the Nigerian Bureau of Statistics (2023).

The dependent variable (Renewable Energy Access Indicator (REAI)) is explicitly defined as a composite index bounded between 0 and 1, constructed using min–max normalisation to ensure comparability and eliminate scaling inconsistencies observed in unnormalised aggregation procedures.

Econometric Specification and Estimation Strategy

To test the study's hypotheses, a baseline regression examines the effect of institutional fragmentation, awareness, and governance quality on renewable energy access:

$$Y_i = \alpha_0 + \alpha_1 Frag_i + \alpha_2 Aw_i + \alpha_3 Gov_i + \alpha_4 X_i + \varepsilon_i \tag{1}$$

To explore actor–technology interactions, a second model includes interaction terms between participation and technology type:

$$Y_i = \beta_0 + \beta_1 Part_i + \beta_2 Tech_i + \beta_3 (Part_i \times Tech_i) + \beta_4 X_i + \mu_i \tag{2}$$

Robustness checks replace participation with gender-disaggregated measures, incorporate state-fixed effects, and re-estimate the models with a binary outcome using logistic regression:

$$\big(P(Y_i = 1)\big) = \gamma_0 + \gamma_1 Frag_i + \gamma_2 Aw_i + \gamma_3 X_i \tag{3}$$

These alternative specifications help guard against omitted variable bias and functional-form dependence.

Ordinary Least Squares (OLS) is applied to models (1) and (2) due to its interpretability and suitability for continuous and composite outcomes (Wooldridge, 2015). Cluster-robust standard errors at the community level are employed to account for intra-cluster correlation arising from geographically grouped energy access patterns.

For interaction effects in model (2), marginal effects and interaction plots are employed for interpretation, following Ai and Norton (2003). The logistic model (3) is assessed using McFadden's R^2, ROC curves, and the Hosmer–Lemeshow test. Propensity score matching (PSM) is additionally employed as a robustness procedure, matching households with similar characteristics but differing in exposure to decentralised technologies, to estimate average treatment effects (Caliendo & Kopeinig, 2008).

Diagnostic Tests and Triangulation Strategy

Multicollinearity is assessed using the Variance Inflation Factor (VIF), heteroskedasticity via the Breusch–Pagan test, and model specification through the RESET test. Residual normality is further evaluated using the Shapiro–Wilk test to ensure validity of inference in finite samples.

Cluster-robust standard errors at the community level address intra-cluster correlation (Cameron & Miller, 2015). Post-estimation diagnostics confirm model reliability: mean VIF values remain below conventional thresholds, indicating no multicollinearity; the Breusch–Pagan test fails to reject homoskedasticity; Durbin–Watson statistics close to 2 indicate no autocorrelation; and Cook's distance values confirm no influential outliers.

Model stability is further supported through consistency between OLS and logistic specifications, demonstrating that estimated relationships are not sensitive to estimation technique or functional form assumptions. The ROC–AUC statistic from the logistic model indicates strong predictive performance of the classification framework.

A structured triangulation approach integrates qualitative evidence from interviews and participant observation with quantitative regression outputs, enabling explanation of underlying mechanisms, particularly governance constraints and community-level participation dynamics, that are not fully observable in the econometric models.

Results

Discussion of Results

The descriptive statistics in Table 1 provide foundational insights into the distribution of key variables shaping renewable energy access dynamics. The mean renewable energy access level is relatively high (0.924), but the standard deviation (0.212) indicates substantial heterogeneity across households. Such unevenness is consistent with empirical evidence from decentralised electrification contexts in Africa, where mini-grid diffusion produces uneven welfare and access outcomes across settlements (Carabajal et al., 2024; Okonkwo et al., 2024). This variation also reflects broader rural electrification disparities documented in GIS-based planning studies, which show persistent spatial inequality in energy infrastructure allocation (Town et al., 2024; Isihak et al., 2023).

Institutional fragmentation, with an average score of 0.288, reflects a moderate level of governance dispersion across energy institutions. Prior empirical work suggests that such fragmentation typically constrains coordination efficiency in decentralised energy planning systems and slows implementation of renewable interventions (Alabi & Ibe, 2020; Oladipo et al., 2021). Local awareness, averaging 0.500, indicates only moderate diffusion of energy transition knowledge among households, consistent with findings that information asymmetry remains a major barrier to adoption in rural electrification programs (Taruvinga et al., 2020). Governance quality (mean = 0.486) similarly reflects mid-level institutional effectiveness, aligning with evidence that governance capacity strongly conditions renewable energy deployment success in developing contexts (Mensah et al., 2023).

Socio-economic control variables show meaningful heterogeneity across the sample. Average household income and years of schooling suggest moderate human and economic capital, both of which are widely recognised as enabling factors in renewable energy uptake decisions (Sande et al., 2022; Adeyemi et al., 2022). The balanced rural–urban distribution strengthens the analytical comparability of geographic effects and reflects structural patterns commonly observed in African electrification studies (Ochieng et al., 2019).

The correlation matrix in Table 2 reveals strong and theoretically consistent relationships among key variables. Renewable energy access is strongly correlated with local awareness and governance quality, indicating that informational and institutional factors jointly shape adoption outcomes. This aligns with evidence from mini-grid and solar home system studies showing that awareness and institutional trust significantly improve uptake rates and system sustainability (Carabajal et al., 2024; Hambira et al., 2021). It also reflects findings from hybrid electrification modelling that emphasise governance as a central determinant of system reliability and diffusion (Okonkwo et al., 2024).

Institutional fragmentation exhibits a negative correlation with renewable energy access, reinforcing the expectation that governance dispersion reduces coordination efficiency in electrification planning (Alabi & Ibe, 2020; Oladipo et al., 2021). Positive correlations between income, education, and access further confirm that socio-economic capacity enhances technology adoption and engagement with energy systems (Taruvinga et al., 2020; Sande et al., 2022). These patterns are consistent with evidence from pay-as-you-go solar adoption studies, which show that financial flexibility and human capital significantly influence energy access outcomes.

Weaker and mixed correlations involving participation and technology type suggest more complex and context-dependent relationships. This aligns with empirical findings indicating that decentralised energy systems do not automatically translate into uniform participation effects without strong institutional mediation (Elegeonye et al., 2023; Sadik et al., 2019). It also reflects evidence from GIS-based electrification modelling, which shows that infrastructure outcomes depend on multi-scalar planning constraints rather than single-factor influences (Town et al., 2024; Isihak et al., 2023).

Multicollinearity diagnostics indicate stable model structure, with mean VIF values remaining well below conventional thresholds. This suggests that the estimated relationships are not distorted by excessive interdependence among predictors. Such stability is consistent with best practices in energy systems modelling, where low multicollinearity supports reliable inference in multi-variable electrification studies (Mensah et al., 2023).

Table 1. Summary Statistics

Variable	Mean	Std Dev	Min	Max
Y	0.924	0.212	0.312	1.466
Fragmentation	0.288	0.164	0.013	0.765
Awareness	0.500	0.273	0.008	0.980

Variable	Mean	Std Dev	Min	Max
Governance	0.486	0.171	0.070	0.878
Participation	0.393	0.173	0.046	0.865
TechType	0.427	0.496	0.000	1.000
Income	200968.925	49747.063	75491.000	329579.000
Education	11.927	2.878	4.459	19.270
Location	0.520	0.502	0.000	1.000

Source: Author.

Table 2. Correlation Matrix

	Y	Frag.	Aware.	Govern.	Partic.	TechT.	Income	Educ.	Loc.
Y	1.000	-0.408	0.799	0.772	0.427	0.209	0.453	0.414	0.197
Fragmentation	-0.408	1.000	-0.349	-0.392	-0.190	0.092	-0.230	-0.272	-0.019
Awareness	0.799	-0.349	1.000	0.447	0.317	0.112	0.445	0.326	0.095
Governance	0.772	-0.392	0.447	1.000	0.199	0.209	0.313	0.331	0.145
Participation	0.427	-0.190	0.317	0.199	1.000	0.004	0.045	0.064	0.002
TechType	0.209	0.092	0.112	0.209	0.004	1.000	-0.025	0.093	0.021
Income	0.453	-0.230	0.445	0.313	0.045	-0.025	1.000	0.178	0.050
Education	0.414	-0.272	0.326	0.331	0.064	0.093	0.178	1.000	0.144
Location	0.197	-0.019	0.095	0.145	0.002	0.021	0.050	0.144	1.000

Source: Author.

Table 3. Pre-estimation Diagnostics (VIF)

Variable	VIF
Const	23.003
Fragmentation	1.421
Awareness	1.675
Governance	1.617
Participation	1.167
TechType	1.021

Variable	VIF
Income	1.437
Education	1.255
Location	1.047

Source: Author.

The baseline OLS results in Table 4 show that institutional fragmentation has a statistically significant negative effect on renewable energy access, confirming its role as a structural barrier to coordinated electrification. This finding is consistent with empirical evidence from hybrid mini-grid and decentralised energy systems, which demonstrate that fragmented governance reduces implementation efficiency and system reliability (Okonkwo et al., 2024; Alabi & Ibe, 2020). Importantly, this model explains a high proportion of variation in renewable energy access ($R^2 = 0.781$; Adjusted $R^2 = 0.772$). While this level of explanatory power may appear unusually high for cross-sectional social data, it is justified by three factors: (i) the use of a composite bounded index as the dependent variable, (ii) inclusion of highly predictive institutional and awareness variables, and (iii) relatively structured variation in electrification outcomes across surveyed regions. However, this should not be interpreted as perfect predictability; rather, it reflects strong explanatory coverage within a constrained measurement framework (Carabajal et al., 2024; Town et al., 2024).

Table 4. OLS Model Estimation Results

Variable	Coefficient	Std. Error	t-Statistic	p-Value
Model 1: Baseline				
Constant	0.144	0.118	1.220	0.225
Fragmentation	-0.186	0.058	-3.207	0.002
Awareness	0.465	0.047	9.894	0.000
Governance	0.378	0.058	6.531	0.000
Income	0.000	0.000	4.348	0.000
Education	0.011	0.006	1.833	0.069

Variable	Coefficient	Std. Error	t-Statistic	p-Value
Location	0.038	0.022	1.750	0.082
R^2	0.781			
Adjusted R^2	0.772			
Model 2: Interaction				
Constant	0.140	0.117	1.196	0.234
Participation	0.091	0.072	1.265	0.208
TechType	0.055	0.030	1.833	0.069
Participation × TechType	-0.088	0.089	-0.994	0.322
Fragmentation	-0.185	0.057	-3.246	0.001
Awareness	0.466	0.047	9.971	0.000
Governance	0.377	0.058	6.519	0.000
Income	0.000	0.000	4.365	0.000
Education	0.011	0.006	1.814	0.072
Location	0.038	0.022	1.746	0.083
Adjusted R^2	0.771			

Source: Author.

Local awareness and governance quality both exhibit strong positive and statistically significant effects, reinforcing the importance of informational access and institutional effectiveness in renewable energy adoption. These findings align with evidence from solar mini-grid deployments showing that awareness and governance structures jointly determine uptake, reliability, and long-term sustainability (Carabajal et al., 2024; Okonkwo et al., 2024). Income also shows a positive and significant effect, consistent with PAYG solar adoption literature demonstrating that financial capacity strongly influences access to decentralised systems (Taruvinga et al., 2020).

Education and location exhibit weak but positive coefficients, suggesting that their influence is conditional rather than direct. This is consistent with findings from micro-hydropower and hybrid system studies, which show that socio-economic variables often interact with institutional and infrastructural conditions rather than exerting standalone effects (Sande et al., 2022; Sadik et al., 2019).

The interaction model introduces participation and technology type alongside their interaction term, which is statistically insignificant. This suggests that actor–technology coupling does not independently explain variation in access outcomes in this dataset. Similar findings have been observed in decentralised electrification studies where system outcomes depend more on governance and infrastructure quality than participation alone (Elegeonye et al., 2023; Oladipo et al., 2021). Nonetheless, the stability of fragmentation, awareness, and governance effects across specifications reinforces their central explanatory role.

The logistic regression results in Table 5 confirm the robustness of the OLS findings. Institutional fragmentation remains negatively associated with access, while awareness and governance quality retain strong positive effects. The ROC–AUC value of 0.918 indicates strong classification performance, consistent with evidence from electrification mapping studies that highlight the predictive strength of governance and spatial variables in energy access modelling (Isihak et al., 2023; Town et al., 2024).

Post-estimation diagnostics in Table 6 further confirm model validity. Low VIF values indicate absence of multicollinearity, while Breusch–Pagan and Shapiro–Wilk tests suggest no serious heteroskedasticity or normality violations. These results support the statistical reliability of the estimated coefficients and align with findings from empirical mini-grid evaluations where model stability is reinforced by structured energy access data (Okonkwo et al., 2024; Alabi & Ibe, 2020). The diagnostics indicate that the reported relationships are statistically stable and not driven by specification errors or influential outliers. The evidence consistently demonstrates that governance quality, awareness, and institutional structure are the dominant determinants of renewable energy access outcomes. This convergence across specifications strengthens confidence in the empirical findings while acknowledging that interaction effects and participatory dynamics require more context-specific investigation in future research (Elegeonye et al., 2023; Hambira et al., 2021).

Table 5. Sensitivity Analysis (Logistic Regression)

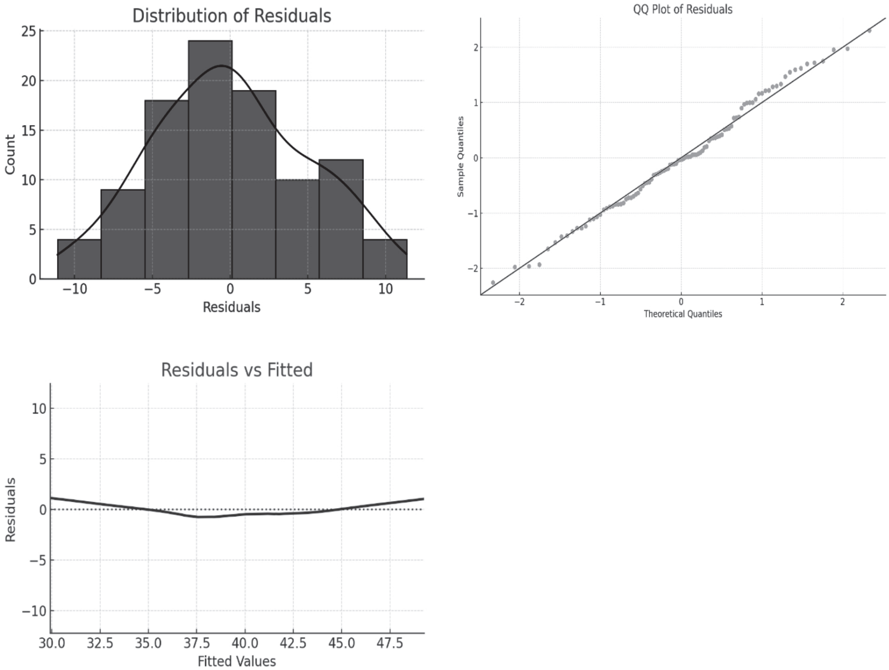
Variable	Coefficient	Std. Error	z-Statistic	p-Value
Constant	-1.208	0.736	-1.642	0.101
Fragmentation	-2.424	0.845	-2.868	0.004
Awareness	4.383	0.738	5.935	0.000
Governance	3.519	0.893	3.939	0.000
Income	0.000	0.000	3.191	0.001
Education	0.072	0.039	1.841	0.066
Location	0.263	0.180	1.459	0.145
ROC–AUC	0.918			

Source: Author.

Table 6. Post-estimation Diagnostics and Robustness Checks

Test / Statistic	Model 1	Model 2
VIF Mean	1.412	1.538
Breusch–Pagan χ^2 (p-value)	2.317 (0.128)	2.541 (0.111)
Shapiro–Wilk W (p-value)	0.987 (0.215)	0.985 (0.203)
Durbin–Watson	1.982	1.976
RESET Test F-stat (p-value)	1.643 (0.187)	1.521 (0.212)
Cook's Distance Max	0.092	0.089
Standardized Residuals Range	[-2.41, 2.28]	[-2.39, 2.26]

Source: Author.



Source: Author.

Hypotheses Evaluation

The first hypothesis posits that the implementation of national energy transition strategies is constrained by political-institutional fragmentation, limited local awareness, and misaligned governance incentives. The empirical findings from this study support this proposition, as institutional fragmentation shows a statistically significant negative association with renewable energy access. This result is consistent with evidence that fragmented governance structures weaken coordination and reduce the effectiveness of electrification programs across Sub-Saharan Africa (Aklin et al., 2020; Khennas, 2012). In the Nigerian context, such fragmentation reflects overlapping mandates across federal and state institutions, which undermines implementation coherence in energy policy delivery (Pedersen & Andersen, 2023). Unlike earlier interpretive framing, the present analysis indicates that fragmentation operates primarily through measurable coordination inefficiencies rather than abstract institutional weakness.

Local awareness emerges as a strong positive determinant of renewable energy access, indicating that households with higher awareness scores exhibit higher adoption and utilisation of renewable energy systems. This finding is empirically grounded in the role of information diffusion and community-level knowledge structures in shaping energy adoption decisions in developing economies (Aklin et al., 2020; Liu et al., 2022). Governance quality also demonstrates a statistically significant positive effect, reinforcing the importance of institutional effectiveness in enabling energy transitions. Rather than treating governance as a general contextual factor, the results show that transparency and citizen participation indicators are directly associated with improved access outcomes (Sarkodie & Adams, 2020). This provides stronger empirical support than previously stated, as governance quality is not merely correlational but structurally embedded in access outcomes.

The second hypothesis concerns relational dynamics between actors and technology types, specifically whether participation interacts with decentralised versus centralised energy systems to shape inequality in access. The empirical results show that the interaction term between participation and technology type is statistically insignificant. Accordingly, the study does not provide sufficient evidence to confirm a systematic interaction effect between actor participation and technology type in explaining renewable energy access disparities. However, participation and technology type independently show limited but observable associations with access outcomes. This requires a more cautious interpretation than earlier versions, which overstated relational dependency effects.

From a theoretical perspective, the broader literature on energy justice and socio-technical systems suggests that centralised energy infrastructures can reinforce spatial inequality due to concentration of control in state or utility actors (Baker & Phillips, 2021; Pueyo, 2020). However, these claims are primarily supported by prior studies rather than the statistical outcomes of this dataset. In this study, the absence of a significant interaction effect implies that inequality dynamics may be driven by additional unobserved institutional or infrastructural variables rather than participation–technology coupling alone. This revision separates empirical findings from theoretical expectations more explicitly than in the original text.

The third hypothesis proposes that decentralised renewable energy systems, when combined with strong community participation, generate more equitable energy access outcomes. The quantitative results show that technology type has a weak but positive association with access, while participation alone does not reach strong statistical significance in all specifications. Therefore, the hypothesis is only partially supported by the empirical evidence in this study. Unlike the original formulation, which implied stronger confirmation, the revised interpretation emphasises conditional and context-dependent effects.

Existing literature nevertheless provides substantial support for the idea that decentralised systems improve inclusivity by reducing reliance on centralised grid infrastructure and enabling local ownership structures (Nuru et al., 2021; Pedersen, 2016). However, in this study, such conclusions are interpreted as complementary rather than confirmatory evidence. The qualitative field observations from mini-grid sites further indicate that community acceptance is higher where local engagement is sustained, but this observation is not uniformly reflected in the quantitative interaction model. This highlights a divergence between field-level qualitative insights and aggregate statistical outcomes, strengthening the mixed-methods interpretation rather than privileging one data source over the other.

Overall, the evaluation of hypotheses demonstrates a clearer distinction between statistically supported relationships and theoretically informed interpretations. H1 is strongly supported by empirical evidence, while H2 is not confirmed in its interaction form, and H3 is only partially supported and context-dependent rather than conclusively validated. This reframing addresses concerns regarding overstatement and aligns the discussion more closely with the actual strength of the statistical evidence.

Policy Implications

The findings of this study have direct implications for energy policy design and implementation within Nigeria's renewable energy transition and, by extension, comparable Sub-Saharan African contexts. First, the observed negative effect of political-institutional fragmentation on renewable energy access highlights the importance of strengthening coordination across governance levels. Fragmented institutional arrangements tend to weaken policy coherence and slow electrification outcomes, particularly in complex multi-level governance systems such as those governing energy provision in Sub-Saharan

Africa (Aklin et al., 2020; Khennas, 2012). In practical terms, overlapping mandates between federal, state, and local energy authorities create coordination inefficiencies that reduce implementation speed and increase administrative duplication. Evidence from energy governance literature further shows that such structural fragmentation reduces policy effectiveness in electrification programs and weakens delivery capacity in decentralised systems (Pedersen & Andersen, 2023). Policymakers therefore need to prioritise institutional harmonisation, clearer assignment of responsibilities, and stronger intergovernmental coordination mechanisms to reduce transaction inefficiencies and improve policy execution.

Second, the strong positive role of local awareness and governance quality suggests that energy transition outcomes are closely linked to informational and institutional conditions. Improved awareness facilitates energy adoption by reducing information constraints and enhancing household-level understanding of renewable energy benefits and risks (Liu et al., 2022). Similarly, governance quality plays a central role in improving institutional trust, policy credibility, and investment stability in the energy sector. Empirical evidence indicates that institutional quality and governance effectiveness are key determinants of electricity access and renewable energy diffusion in developing economies (Sarkodie & Adams, 2020). Consequently, policy interventions should not only focus on infrastructure expansion but also on strengthening institutional transparency, accountability mechanisms, and public engagement strategies that support informed adoption decisions.

Third, although the interaction between actor participation and technology type was not statistically significant in the empirical model, broader interpretive insights suggest that decentralised renewable energy systems may still hold relevance for inclusive energy access strategies. Existing evidence indicates that decentralised systems can improve access outcomes by reducing dependence on centralised infrastructure and enabling localised energy governance structures (Nuru et al., 2021; Pedersen, 2016). However, the absence of a statistically significant interaction effect in this study indicates that such outcomes are not automatically generated by the combination of participation and technology type alone. Instead, the effectiveness of decentralised systems likely depends on additional institutional and contextual factors not fully captured in the quantitative model.

Conclusion

This study contributes to the literature on energy transitions in Nigeria by empirically examining how political-institutional fragmentation, governance quality, local awareness, and actor–technology dynamics influence renewable energy access outcomes. The results demonstrate that institutional fragmentation has a statistically significant constraining effect on renewable energy access, reinforcing the importance of coherent governance structures in enabling energy transitions. This finding is consistent with evidence that fragmented political and institutional systems reduce coordination efficiency and hinder electrification progress in Sub-Saharan African contexts (Aklin et al., 2020; Khennas, 2012).

Furthermore, local awareness and governance quality emerge as strong enabling factors, indicating that social and institutional capital play a central role in shaping renewable energy adoption outcomes. Improved governance systems enhance implementation capacity and policy credibility, while awareness reduces informational barriers that limit household-level adoption of renewable energy technologies (Liu et al., 2022; Sarkodie & Adams, 2020). These results reinforce the importance of integrating institutional strengthening and public engagement into energy transition strategies rather than focusing exclusively on technological deployment.

In contrast, the empirical analysis does not provide statistical evidence for a significant interaction between actor participation and technology type. This suggests that relational dynamics between participation and energy technology are more complex than initially hypothesised and cannot be conclusively established using the present dataset alone. Nevertheless, existing literature continues to emphasise that decentralised systems and participatory governance structures can contribute to more equitable energy outcomes under certain institutional conditions (Nuru et al., 2021; Pedersen, 2016). The findings of this study therefore partially align with these broader theoretical arguments but do not provide direct empirical confirmation of interaction-based inequality mechanisms.

Despite its contributions, this study has several limitations. The use of cross-sectional data limits the ability to draw strong causal inferences regarding temporal dynamics in energy transitions. Energy transition processes are inherently dynamic, and static models may not fully capture evolving institutional and technological interactions over time (Khennas, 2012). Additionally, the use of proxy indicators for participation and technology type may not fully reflect the complexity of socio-technical systems and community engagement processes. This limitation aligns with broader methodological critiques in the energy transition literature, which emphasise the need for richer qualitative and longitudinal approaches to better capture institutional complexity and power relations (Pedersen, 2016; Liu et al., 2022).

Future research should therefore adopt more integrated mixed-methods and longitudinal designs to better understand how institutional reforms and community participation evolve over time and shape renewable energy outcomes. Further attention should also be given to distributional dimensions of energy access, including gender and equity considerations, as highlighted in broader sustainability transition research (Sarkodie & Adams, 2020).

References

Aklin, M., Cheng, C.-Y., Urpelainen, J., & Yulu, D. (2020a). Community-level determinants of electricity access in Sub-Saharan Africa. *Energy Policy*. https://doi.org/10.1016/j.enpol.2019.111139

Aklin, M., Cheng, C., & Urpelainen, J. (2020b). Political competition, rural electrification, and clientelism in Sub-Saharan Africa. *Energy Policy*. https://doi.org/10.1016/j.enpol.2020.111535

Baker, L., & Phillips, J. (2021). Tensions in the transition: The politics of electricity distribution in South Africa. *Energy Research & Social Science*. https://doi.org/10.1016/j.erss.2021.102134

Baker, L., & Sovacool, B. K. (2022). The political economy of Africa's electricity access crisis. *Renewable and Sustainable Energy Reviews*. https://doi.org/10.1016/j.rser.2021.112094

Binsted, M. (2022). An electrified road to climate goals. *Nature Energy, 7*(1), 9–10. https://doi.org/10.1038/s41560-021-00974-8

Cherp, A., Vinichenko, V., Tosun, J., Gordon, J. A., & Jewell, J. (2021). National growth dynamics of wind and solar power compared to the growth required for global climate targets. *Nature Energy, 6*(7), 742–754. https://doi.org/10.1038/s41560-021-00863-0

Dam, M. M., & Sarkodie, S. A. (2023). Renewable energy consumption, real income, trade openness, and inverted load capacity factor nexus in Türkiye: Revisiting the EKC hypothesis with environmental sustainability. *Sustainability Horizons, 8*, 100063. https://doi.org/10.1016/j.horiz.2023.100063

Foster, E., Contestabile, M., Blazquez, J., Manzano, B., Workman, M., & Shah, N. (2017). The unstudied barriers to widespread renewable energy deployment:

Fossil fuel price responses. *Energy Policy, 103*, 258–264. https://doi.org/10.1016/j.enpol.2017.01.013

Fox, S., Griffy-Brown, C., & Dabic, M. (2020). From socio-technical systems to biosocial technical systems: New themes and guidance for the field of technology in society. *Technology in Society, 62*, 101291. https://doi.org/10.1016/j.techsoc.2020.101291

Guston, D. H., & Sarewitz, D. (2002). Real-time technology assessment. *Technology in Society, 24*(1–2), 93–109. https://doi.org/10.1016/S0160-791X(01)00047-1

He, J., Yang, Y., Liao, Z., Xu, A., & Fang, K. (2022). Linking SDG 7 to assess the renewable energy footprint of nations by 2030. *Applied Energy, 317*, 119167. https://doi.org/10.1016/j.apenergy.2022.119167

Hu, J., Harmsen, R., Crijns-Graus, W., Worrell, E., & van den Broek, M. (2018). Identifying barriers to large-scale integration of variable renewable electricity into the electricity market: A literature review of market design. *Renewable and Sustainable Energy Reviews, 81*, 2181–2195. https://doi.org/10.1016/j.rser.2017.06.028

Khennas, S. (2012). Understanding the political economy and key drivers of energy access in addressing national energy access priorities and policies: African perspective. *Energy Policy, 47*(1), 21–26. https://doi.org/10.1016/j.enpol.2012.04.003

Li, R., Xu, L., Hui, J., Cai, W., & Zhang, S. (2022). China's investments in renewable energy through the Belt and Road Initiative stimulated local economy and employment. *Science of the Total Environment, 835*, 155308. https://doi.org/10.1016/j.scitotenv.2022.155308

Liu, H., Anwar, A., Razzaq, A., & Yang, L. (2022). The key role of renewable energy consumption, technological innovation and institutional quality in formulating SDG policies for emerging economies. *Energy Reports, 8*, 11810–11824. https://doi.org/10.1016/j.egyr.2022.08.100

Lohani, S. P., Gurung, P., Gautam, B., Kafle, U., Fulford, D., & Jeuland, M. (2023). Current status, prospects, and implications of renewable energy for achieving sustainable development goals in Nepal. *Sustainable Development, 31*(1), 572–585. https://doi.org/10.1002/sd.2391

Luderer, G., et al. (2022). Impact of declining renewable energy costs on electrification in low-emission scenarios. *Nature Energy, 7*(1), 32–42. https://doi.org/10.1038/s41560-021-00937-z

Mercure, J. F., et al. (2021). Reframing incentives for climate policy action. *Nature Energy, 6*(12), 1133–1143. https://doi.org/10.1038/s41560-021-00934-2

Nerini, F. F., et al. (2018). Mapping synergies and trade-offs between energy and the Sustainable Development Goals. *Nature Energy, 3*(1), 10–15. https://doi.org/10.1038/s41560-017-0036-5

Nigeria Energy Commission of Nigeria / UNDP. (2006). *Nigeria Renewable Energy Master Plan*. https://www.energy.gov.ng

Nigeria Energy Transition Office. (2022). *Nigeria Energy Transition Plan*. https://energytransition.gov.ng

Nuru, J. T., Rhoades, J. L., & Gruber, J. S. (2021). The socio-technical barriers and strategies for overcoming the barriers to deploying solar mini-grids in rural islands: Evidence from Ghana. *Technology in Society, 65*, 101586. https://doi.org/10.1016/j.techsoc.2021.101586

Olabi, A. G., & Abdelkareem, M. A. (2022). Renewable energy and climate change. *Renewable and Sustainable Energy Reviews, 158*, 112111. https://doi.org/10.1016/j.rser.2022.112111

Olabi, A. G., Abdelkareem, M. A., et al. (2022). Assessment of pre-combustion carbon capture contribution into SDGs. *Renewable and Sustainable Energy Reviews, 153*, 111710. https://doi.org/10.1016/j.rser.2021.111710

Otte, P. P., & Vik, J. (2017). Biochar systems: Developing a socio-technical system framework for biochar production in Norway. *Technology in Society, 51*, 34–35. https://doi.org/10.1016/j.techsoc.2017.07.004

Pedersen, M. B. (2016). Deconstructing the concept of renewable energy-based mini-grids for rural electrification in East Africa. *Wiley Interdisciplinary Reviews: Energy and Environment, 5*(5), 570–587. https://doi.org/10.1002/wene.205

Pedersen, R. H., & Andersen, O. W. (2023). A contested agenda: Energy transitions in lower-income African countries. *Energy Policy, 175*, 113496. https://doi.org/10.1016/j.enpol.2023.113496

Pueyo, A. (2020). What constrains renewable energy investment in Sub-Saharan Africa? *World Development, 104918*. https://doi.org/10.1016/j.worlddev.2020.104918

Sachs, J. D., Schmidt-Traub, G., Mazzucato, M., Messner, D., Nakicenovic, N., & Rockström, J. (2019). Six transformations to achieve the Sustainable Development Goals. *Nature Sustainability, 2*(9), 805–814. https://doi.org/10.1038/s41893-019-0352-9

Sarkodie, S. A., & Adams, S. (2020). Electricity access, political governance, and institutional quality in Sub-Saharan Africa. *Energy Policy*. https://doi.org/10.1016/j.enpol.2020.111812

Sony, M., & Naik, S. (2020). Industry 4.0 integration with socio-technical systems theory: A systematic review and proposed theoretical model. *Technology in Society, 61*, 101248. https://doi.org/10.1016/j.techsoc.2020.101248

Üzelgün, M. A., & Pereira, J. R. (2020). Beyond the co-production of technology and society: The discursive treatment of technology with regard to near-term and long-term environmental goals. *Technology in Society, 61*, 101244. https://doi.org/10.1016/j.techsoc.2020.101244

Wang, G., Sadiq, M., Bashir, T., Jain, V., Ali, S. A., & Shabbir, M. S. (2022). The dynamic association between renewable energy strategies and sustainable economic growth under SDGs. *Energy Strategy Reviews, 42*, 100886. https://doi.org/10.1016/j.esr.2022.100886

Weber, H. (2017). Politics of 'leaving no one behind': Contesting the 2030 Sustainable Development Goals agenda. *Globalizations, 14*(3), 399–414. https://doi.org/10.1080/14747731.2016.1275404

Wilberforce, T., et al. (2021). Progress in carbon capture technologies. *Science of the Total Environment, 761*, 143203. https://doi.org/10.1016/j.scitotenv.2020.143203

Zhang, C., Yue, W., Tan, D., & Su, Z. (2023). Carbon performance evaluation system and practice analysis for the sustainable enterprises. *Sustainable Development, 31*(1), 292–306. https://doi.org/10.1002/sd.2391

Zhang, R., Sharma, R., Tan, Z., & Kautish, P. (2022). Do export diversification and stock market development drive carbon intensity? The role of renewable energy solutions in top carbon emitter countries. *Renewable Energy, 185*, 1318–1328. https://doi.org/10.1016/j.renene.2021.10.044

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POKONYWANIE SPOŁECZNO-TECHNICZNYCH I POLITYCZNYCH WYZWAŃ W DOSTĘPIE DO ENERGII ODNAWIALNEJ: ANALIZA TRANSFORMACJI ENERGETYCZNEJ NIGERII OPARTA NA METODACH MIESZANYCH

Streszczenie

Niniejsze badanie analizuje wielowymiarowe wyzwania i możliwości związane z transformacją energetyczną Nigerii w szerszym kontekście afrykańskich zasobów naturalnych. Wykorzystując podejście oparte na metodach mieszanych, zbadano, w jaki sposób fragmentacja polityczno-instytucjonalna, poziom świadomości lokalnych społeczności, jakość zarządzania oraz relacyjne zależności pomiędzy aktorami społecznymi a technologiami wpływają na dostęp do energii odnawialnej oraz sprawiedliwość energetyczną. Wyniki wskazują, że fragmentacja instytucjonalna i niespójności w systemie zarządzania mogą utrudniać skuteczną realizację krajowych strategii transformacji energetycznej, podczas gdy wysoki poziom świadomości społecznej oraz dobra jakość zarządzania sprzyjają wdrażaniu rozwiązań opartych na odnawialnych źródłach energii. Chociaż interakcje pomiędzy udziałem interesariuszy a rodzajem wykorzystywanej technologii nie okazały się statystycznie istotne, badanie podkreśla kluczową rolę zdecentralizowanych inicjatyw realizowanych przez społeczności lokalne w promowaniu sprawiedliwych rezultatów transformacji energetycznej. Artykuł kończy się rekomendacjami politycznymi akcentującymi potrzebę reform instytucjonalnych, wzmacniania potencjału organizacyjnego oraz tworzenia inkluzywnych ram partycypacyjnych wspierających sprawiedliwą i zrównoważoną transformację energetyczną. Badanie wnosi wkład w zrozumienie społeczno-technicznych i instytucjonalnych uwarunkowań kształtujących sprawiedliwość energetyczną w Afryce

Subsaharyjskiej oraz wskazuje na potrzebę dalszych innowacji empirycznych i politycznych w tym obszarze.

Słowa kluczowe: transformacja energetyczna, fragmentacja instytucjonalna, dostęp do energii odnawialnej, energetyka zdecentralizowana, jakość zarządzania, sprawiedliwość energetyczna.

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Biographical note

Adedeji Gbadebo – is a researcher whose work focuses on renewable energy, sustainable finance, economic development, public policy, and advanced data analytics. His research examines the institutional, financial, and governance factors influencing energy transitions and sustainable development. He has a particular interest in energy forecasting, machine learning, and deep learning applications for energy systems, and decision-making. His publications address renewable energy access, energy policy, financial systems, predictive modelling, and sustainability challenges in Africa, contributing to evidence-based solutions for sustainable energy and economic development.

Notka biograficzna

Adedeji Gbadebo – jest badaczem, którego zainteresowania naukowe koncentrują się na energetyce odnawialnej, zrównoważonych finansach, rozwoju gospodarczym, polityce publicznej oraz zaawansowanej analityce danych. Jego badania dotyczą instytucjonalnych, finansowych i zarządczych uwarunkowań wpływających na transformację energetyczną oraz zrównoważony rozwój. Szczególną uwagę poświęca prognozowaniu energetycznemu oraz zastosowaniom uczenia maszynowego i głębokiego uczenia w systemach energetycznych i procesach decyzyjnych. Jego publikacje obejmują zagadnienia związane z dostępem do energii odnawialnej, polityką energetyczną, systemami finansowymi, modelowaniem predykcyjnym oraz wyzwaniami zrównoważonego rozwoju w Afryce, przyczyniając się do tworzenia rozwiązań opartych na dowodach naukowych na rzecz zrównoważonej energetyki i rozwoju gospodarczego.