THE ROLE OF ENERGY IN DEVELOPMENT PROCESSES: THEORY, POLICY, AND PRACTICE

EDITOR
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PREFACE

Energy constitutes an indispensable ontological and functional cornerstone of contemporary socio-economic systems, underpinning trajectories of industrial expansion, technological innovation, and societal welfare. In an epoch characterized by accelerating energy demand and the escalating geostrategic salience of energy security, the imperative of diversifying energy production and consumption portfolios has assumed unprecedented urgency. Such diversification is not merely a technical or economic expedient; it is a multidimensional strategic necessity encompassing environmental sustainability, macroeconomic resilience, and intergenerational equity. For developing economies in particular, this imperative is amplified by the exigencies of reconciling demographic dynamism and industrial intensification with ecological stewardship and the attenuation of exogenous dependencies.

This volume seeks to make a substantive scholarly intervention at precisely this juncture, interrogating the intricate interdependencies among energy diversification, sustainable development, environmental ethics, and investment dynamics. The chapters herein advance beyond conventional techno-economic analyses by embedding normative and ethical considerations within the discourse on energy policy. In doing so, the book transcends disciplinary silos, offering a synoptic yet analytically rigorous framework that is as relevant to theoretical debates as it is to praxis-oriented policymaking.

The contributors to this compendium bring forth an exceptional confluence of methodological rigor, conceptual sophistication, and empirical breadth. Their analyses reflect a deep engagement with the multifaceted nature of energy governance and development, traversing domains as diverse as ethical philosophy, economic policy, and environmental management. Collectively, these scholarly endeavours endow the volume with epistemic richness and practical salience, positioning it as a critical reference for academics, policymakers, industry leaders, and all stakeholders concerned with the evolving energy landscape.

We extend our profound appreciation to all contributors for their intellectual dedication and erudite scholarship, which have been instrumental in shaping this work. It is our earnest hope that the insights generated herein will catalyze innovative discourses, stimulate cross-sectoral and interdisciplinary dialogues, and contribute to the formulation of more holistic, ethically anchored, and sustainability-oriented energy strategies for the future.

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CHAPTER1

ENERGY DIVERSIFICATION AND ECONOMIC DEVELOPMENT IN DEVELOPING COUNTRIES

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INTRODUCTION

In recent decades, the concept of diversifying the energy consumption mix has gained increasing attention as one of the fundamental pillars of sustainable development policy in developing countries. The structural dependence of many of these countries on limited energy sources—whether imported fossil fuels or unstable domestic production—has rendered them vulnerable to economic shocks, global market fluctuations, and geopolitical developments. In this context, diversifying the energy consumption portfolio is not only regarded as a tool for strengthening energy security and reducing external risks, but also as an indicator of institutional maturity and structural advancement of the economy.

From a conceptual standpoint, energy diversification can be seen as a strategic effort to expand the range of energy sources— including renewable energies, nuclear power, and indigenous or emerging resources—aimed at enhancing sustainability, resilience, and economic efficiency. This approach, through the deployment of modern technologies and the development of energy infrastructure, paves the way for transformation in energy production, distribution, and consumption systems. However, achieving a diversified energy mix, particularly in developing countries, requires the provision of prerequisites such as sustainable investment, access to technical knowledge, institutional stability, and policy coherence.

Beyond environmental considerations, energy diversification plays a decisive role in improving industrial productivity, reducing energy poverty, and empowering communities to participate in inclusive growth processes. In other words, energy diversification is not only a reflection of a country's current economic condition but also a guiding force shaping its future development path.

This chapter is intended to examine the conceptual, theoretical, and practical dimensions of energy diversification within the context of economic development in developing countries. It analyzes the two-way relationship between energy structure and development level, explores the key determinants of successful diversification, assesses its economic and social impacts, and reviews practical experiences from various countries to offer a coherent framework for policymaking and planning in this field.

1. THE RECIPROCAL RELATIONSHIP BETWEEN ENERGY CONSUMPTION DIVERSIFICATION AND ECONOMIC DEVELOPMENT

The relationship between diversifying the energy consumption mix and economic development in developing countries is a reciprocal, dynamic, and complex one. On the one hand, the level of economic development influences the feasibility and effectiveness of energy diversification; on the other hand, energy diversification is a key factor in reinforcing the foundations of sustainable economic growth (Apergis & Payne, 2011; Sadorsky, 2010).

From a structural causality perspective, countries that have reached a certain level of economic growth, infrastructural development, and institutional maturity possess greater capacity to adopt modern energy technologies, finance diversification projects, and implement coherent policy frameworks (Cherp et al., 2018). In other words, economic development, by providing technical, administrative, and legal infrastructures, serves as a prerequisite for achieving diversity in the energy consumption mix. In particular, access to capital markets, institutional capacity for regulatory governance, and the availability of skilled human resources play a crucial role in the success of diversification policies.

Conversely, a more diversified energy mix can help reduce risks stemming from dependence on limited or imported energy sources, thereby creating favorable conditions for economic stability, reducing production costs, and enhancing energy security (International Energy Agency, 2014; Awerbuch & Berger, 2003). Over the long term, these factors can facilitate sustainable growth, attract foreign investment, and expand industrial capacity. Especially in fragile economies reliant on specific energy sources, achieving energy diversification may help break free from volatile price cycles and supply crises (Bhattacharyya, 2011).

Numerous theoretical and empirical studies have demonstrated that countries with greater energy diversity often enjoy higher levels of economic resilience, growth sustainability, and structural flexibility (Vivoda, 2010; Sovacool, 2011). However, it is important to note that the nature of this relationship can vary across regions and depending on local conditions. For example, in some countries, economic development has acted as a driver for

energy diversification, whereas in others, diversification policies have been employed as a strategic pathway toward development.

Therefore, understanding the bidirectional relationship between these two phenomena requires context-sensitive analyses that address both institutional and economic dimensions, as well as policymaking mechanisms, technological capacities, and national socio-cultural characteristics.

2. ECONOMIC AND SECURITY IMPACTS OF ENERGY DIVERSIFICATION

Diversifying the energy consumption mix entails consequences that go beyond merely altering the share of different energy sources. As a core component of energy policy, it has both direct and indirect impacts on the economic dynamics and national security of countries (Awerbuch & Berger, 2003; Cherp et al., 2018). These impacts can be examined on two main levels: first, in terms of macroeconomics and industrial development; and second, in the realm of energy security and the resilience of economic systems.

On the economic front, the use of a diversified range of energy sources reduces structural dependence on a single source (such as oil or natural gas). This leads to decreased vulnerability to price fluctuations, supply chain disruptions, and instability in global markets. Countries with a more balanced energy consumption portfolio demonstrate greater capacity to absorb external shocks, regulate domestic prices, and maintain sustainable economic growth. Moreover, broader access to various energy sources enhances competitiveness in industrial production by reducing final production costs, which in turn improves export conditions and increases overall factor productivity (Bhattacharyya, 2011).

In terms of energy security, diversification is not merely a technical strategy but a critical element of national geopolitical strategies. The use of renewable energy, expansion of domestic production capacity, and a balanced reliance on both imported and local sources enable countries to exercise greater control over their energy supply. Such internal control is especially vital for countries dependent on energy imports or those facing geopolitical tensions, as it contributes to greater national independence, reduced security risks, and enhanced bargaining power in international relations (Cherp et al., 2018).

Additionally, energy diversification provides fertile ground for technological innovation, development of local infrastructure, and the emergence of new markets. The integration of emerging energy sources into the consumption chain creates new employment opportunities in sectors such as solar energy, wind power, biomass, and energy efficiency—each of which serves as a driver of inclusive economic growth (De Freitas & Kaneko, 2011; Weikent, 2020).
In sum, energy diversification is not merely a defensive action to mitigate risks; it is also a proactive strategy to shape competitive economic advantages and achieve a sustainable and autonomous production structure. These outcomes, particularly in developing countries, can play a significant role in overcoming fragile energy conditions and advancing toward a stable and balanced development trajectory.

3. FACTORS INFLUENCING COUNTRIES' CAPACITY FOR ENERGY DIVERSIFICATION

A country's ability to transition toward a diverse and sustainable energy consumption structure is not merely a function of political will or access to natural resources. Rather, it is the outcome of a complex interplay of economic, technological, institutional, and policy-related factors. These elements, in their interaction, shape the success or failure of efforts to diversify the energy mix (Solarin et al., 2025; Nabidita & Irfan, 2024).

At the first level, the country's stage of economic development plays a fundamental role in its capacity for energy diversification. Countries with stable economic infrastructure, access to capital, and a developed financial system typically have greater ability to invest in renewable energy sources, import advanced technologies, and implement energy-intensive projects. In contrast, vulnerable economies that are heavily reliant on fossil fuel exports often face structural challenges in financing diversification initiatives (Solarin et al., 2025; Nabidita & Irfan, 2024).

The second key factor is the country's technological capacity. Technological advances, especially in the fields of renewable energy, smart grids, and energy storage systems—require specialized human capital, research and development infrastructure, and the ability to absorb imported technologies. The greater the technological gap between a country and global

standards, the more costly and time-consuming the path to energy diversification becomes (Falcon, 2023).

The third factor is institutional strength and energy governance. The presence of transparent, efficient, and accountable institutions in the energy sector plays a significant role in effective planning, reducing corruption, and successfully implementing supportive policies. Countries with unstable administrative structures often lack the policy coherence necessary to guide transformative processes in the energy sector (Sheng et al., 2023).

Another crucial component is the legal and regulatory framework. Clear legal systems, investment incentives, protection of property rights, and regulatory stability are vital for attracting domestic and foreign investment in renewable energy projects. Conversely, legal opacity and regulatory risks are among the main barriers to energy diversification (Islam et al., 2022).

Finally, the alignment of energy policies with other sectors of the economy is of great importance. Energy diversification cannot be achieved in isolation; it requires coordination with industrial, environmental, fiscal, and educational policies. This integrated and cross-sectoral approach enhances the likelihood of success in implementing energy diversification strategies.

4. ENERGY DIVERSIFICATION AND STRUCTURAL MATURITY OF THE ECONOMY

Diversifying the energy consumption mix is not merely a technical or environmental measure; it is also a reflection of the degree of structural maturity and internal complexity of a country's economy. In essence, a nation's economic structure and level of development directly influence the type, extent, and diversity of energy sources it consumes (Gozgor & Paramati, 2021). Countries with diverse, industrialized, and technology-oriented economies are typically capable of utilizing a broader energy mix, including renewable resources, storage technologies, smart grids, and high-efficiency systems. In contrast, economies reliant on limited or mono-product resources often remain heavily dependent on one or a few traditional sources such as oil or coal (World Bank, 2023).

Historically, developed countries, as they moved toward industrialization and economic maturity, gradually transitioned away from single-source energy

models toward diversified energy consumption. This shift was driven not only by environmental concerns but primarily by the need to increase resilience against price volatility, energy supply crises, and to enhance economic productivity. Accordingly, energy diversification can be seen both as an indicator of structural economic maturity and as a driver of deeper economic development (Yilanci et al., 2021).

In advanced economies, the presence of industries with varied energy demands, the expansion of the service sector, the rise of clean technologies, and robust institutional frameworks all contribute to a broader energy mix. Conversely, in many developing countries, the lack of technical infrastructure, weak policymaking, and financial instability hinder the realization of meaningful energy diversification, even though the demand for it continues to grow (Bhattacharyya, 2011).

A bidirectional relationship between economic maturity and energy diversification can be observed: on one hand, economic growth and structural advancement enable investments in diverse energy sources; on the other, access to a varied energy mix stimulates productivity, reduces production costs, and enhances economic competitiveness (Yilanci et al., 2021; Gozgor & Paramati, 2021). In other words, energy diversification and structural economic maturity function within a mutually reinforcing cycle.

At the macro level, energy diversification can also lead to a more balanced distribution of growth opportunities across different economic sectors. For instance, harnessing renewable energies such as solar or wind can create development opportunities in rural and underserved areas—an indicator of progress toward a more inclusive economic structure.

From a policy perspective, countries aiming to leap forward in structural economic maturity must simultaneously focus on technological development, reforming energy infrastructure, supporting innovation, and strengthening energy governance systems (World Bank, 2023). Only under such comprehensive efforts can energy diversification become not just a consequence of economic development, but a driving force behind it.

5. KEY DRIVERS OF ENERGY MIX DIVERSIFICATION

Diversification of the energy consumption mix is the result of a complex, multi-layered process influenced by a set of structural, institutional, technological, and financial factors. Understanding these drivers not only helps explain the differences in energy diversity among countries but also provides valuable insights for policymakers aiming to design more effective interventions (IEA, 2014; IPCC, 2022). This section analyzes the most important factors in four key subcategories

5.1 Investment in Advanced Energy Technologies

One of the primary enablers of energy diversification is access to advanced technologies for energy production, storage, and management. The development of renewable energies such as solar, wind, geothermal, and biomass is not feasible without cutting-edge technological infrastructure. Countries with the capacity for research, development, and localization of clean energy technologies are able to expand their energy mix beyond traditional sources (Rubio Varas & Muñoz Delgado, 2019).

Technologies related to smart grids, energy storage (such as lithium-ion batteries or thermal storage systems), and improving energy efficiency in consumption sectors also play a crucial role in enhancing the flexibility and structural diversity of the energy system (OECD, 2017).

5.2 Physical and Logistical Energy Infrastructure

Robust infrastructure for the transmission, distribution, and utilization of various energy sources is a prerequisite for successful energy diversification. Components such as extensive electricity grids, gas pipelines, energy conversion stations, storage facilities, and fuel transportation systems are essential for enabling flexible selection and distribution of energy sources.

The absence of such infrastructure—especially in less-developed countries—often results in an energy mix limited to local and inexpensive resources (typically traditional fossil fuels) and restricts the adoption of newer technologies. Therefore, investment in energy infrastructure not only enhances efficiency but also creates the necessary conditions for real diversification in energy consumption.

5.3 Legal, Institutional, and Policy Frameworks

Energy diversification is not merely a technical issue; it heavily depends on the consistency and sustainability of energy policies. Clear regulations, independent specialized institutions, sustainable development plans, targeted subsidies, and the gradual phasing out of fossil fuel subsidies are all essential for enabling diversified energy development. For example, countries that have implemented incentive-based regulations for renewable energy production (such as feed-in tariffs, carbon markets, or renewable portfolio standards) have been successful in gradually increasing the share of renewables in their energy mix. Political stability and public trust in governing institutions are also crucial in attracting both domestic and foreign investments in diversified energy projects (Wani et al., 2025).

5.4 Access to Finance and Sustainable Funding Models

The development and implementation of diversified energy projects require large, varied, and sustainable financial resources. Countries with access to international capital, green finance, development banks, or climate funds have greater capacity to maneuver and reshape their energy structure (IRENA & ILO, 2022). In contrast, nations facing budgetary constraints and high credit risks tend to rely on traditional and cheaper energy sources.

In recent years, innovative financial instruments—such as green bonds, power purchase agreements (PPAs), and public-private partnership mechanisms—have served as powerful drivers for the expansion of renewable energy.

In conclusion, although the drivers of energy diversification are diverse and multifaceted, they converge on a common point: the need for comprehensive planning, institutional coordination, and policy-centered approaches. Successful diversification of the energy mix is not the result of a single factor, but rather the outcome of dynamic interaction among technology, infrastructure, institutions, and capital. Therefore, developing countries seeking to reduce dependence on limited resources and move toward a more balanced energy structure must formulate and implement holistic strategies based on these drivers.

6. SOCIOECONOMIC IMPACTS OF ENERGY DIVERSIFICATION

Energy diversification goes far beyond technical or environmental implications—it has deep and far-reaching effects on the social structure and economic dynamics of societies. These impacts can be analyzed across several dimensions, including the reduction of energy poverty, increased industrial productivity, more equitable distribution of opportunities, and advancement of human development. This section analyzes the main socioeconomic impacts of energy diversification across three key areas:

6.1 Reducing Energy Poverty and Promoting Social Equity

Energy poverty, as one of the dimensions of multidimensional poverty, represents a fundamental barrier to human development in many developing countries. Diversifying energy sources—particularly through the expansion of decentralized renewable energy (such as rural solar panels)—can facilitate access to sustainable energy for marginalized populations and help bridge the access gap.

Decentralized energy models, by reducing dependency on outdated or inadequate central infrastructure, enhance the resilience of local communities. These changes, especially in rural, border, or off-grid areas, lead to improved quality of life, increased opportunities for education and employment, and better public health outcomes.

6.2 Enhancing Productivity and Economic Competitiveness

At the macro level, energy diversification results in lower volatility in energy supply costs and greater supply stability. This reliability forms the foundation for increased productivity in both industrial and service sectors. For instance, consistent and dependable access to renewable or hybrid energy sources can shield small and medium-sized enterprises (SMEs) from production disruptions, enhancing their competitiveness both domestically and internationally.

Moreover, the use of higher-efficiency and lower-intensity energy sources in production processes leads to reduced final costs of goods and services, thereby indirectly increasing consumer purchasing power. Such a shift

strengthens not only economic growth but also the fairer distribution of economic benefits.

6.3 Facilitating Inclusive Growth and Green Job Creation

Energy diversification paves the way for a wide range of job opportunities. The development of advanced energy technologies, construction of new infrastructure, and management of complex energy systems all require skilled, semi-skilled, and even unskilled labor. This potential is particularly valuable for countries facing high unemployment, as energy diversification can function as a driver of green employment.

Furthermore, inclusive growth is only achieved when access to modern energy benefits not just the urban elite, but all segments of society—including women, youth, and geographically marginalized communities. Clean and diverse energy, when properly designed and equitably distributed, can play a key role in reducing regional and gender inequalities.

Thus, the socioeconomic impacts of energy diversification extend far beyond the mere production and consumption of energy. This process brings about increased equity, improved quality of life, facilitation of inclusive growth, and reduced economic vulnerability. Accordingly, any policymaking in the field of energy diversification must simultaneously account for social and equity-based considerations in order to achieve sustainable development—not only environmentally, but also from a human-centered perspective.

7. CASE STUDIES FROM SELECTED COUNTRIES

Before delving into specific case studies, it is useful to provide a numerical comparison between developed and developing countries in terms of energy diversification and economic performance. Table 1 summarizes the average and standard deviation of the Energy Diversity Index (ED) and GDP per capita (in constant 2015 US dollars) for both groups.

This table includes statistical information on the Energy Diversity Index and GDP per capita (measured in constant 2015 US dollars) for each country. The energy diversity data were sourced from BP (British Petroleum), while GDP per capita is based on data obtained from the World Bank for the years 2000 to 2021.

The Energy Diversity Index is calculated based on the Herfindahl-Hirschman Index (HHI), which sums the squares of each energy source's share in total final energy consumption. The formula is:

$HHI = \sum(s_i^2)$,

where s_i is the share of each energy source in total energy consumption. Since an HHI value of 1 indicates complete concentration (monopoly) and values approaching 0 indicate greater diversification, the HHI has been transformed in this study to make interpretation easier—typically by subtracting HHI from 1 (or using a similar transformation: ED = 1 - HHI). In this way, values closer to zero or more positive reflect greater diversity, while negative or values close to -1 indicate high concentration and dependence on a limited number of energy sources.

The data reveal that developed countries have a higher average GDP per capita (USD 43,734) with a larger variation (standard deviation = 13,719), reflecting significant intra-group income disparities. In contrast, developing countries have a much lower average income level (USD 5,040) and less dispersion (standard deviation = 3,113), indicating more uniformly low income levels across this group.

Interestingly, the mean ED is slightly closer to zero in developing countries (–0.021) compared to developed countries (–0.067). This implies that, on average, the energy mix in developing countries may be relatively more diversified, though this may be driven by specific country-level reforms or transitional dynamics rather than structural maturity. Additionally, the higher standard deviation of ED in developing countries (0.150 vs. 0.108) suggests greater heterogeneity in energy structures across these nations.

Overall, this comparative analysis highlights the stark economic gap between the two groups and points to potential differences in how energy diversification is pursued or realized. These differences will be further illustrated through case studies in the following sections.

Table 1: Comparative Descriptive Statistics for Developed and Developing Countries

Country Group	Mean ED	Std. Dev. ED	Mean GDP	Std. Dev. GDP
Developing Countries	-0.021	0.150	5,040$	3113
Developed Countries	-0.067	0.108	43,734$	13719

Having established the broad statistical differences between developed and developing countries, we now turn to country-level case studies. Examining the experiences of various countries in energy diversification is one of the most effective ways to understand the complexities, opportunities, and challenges involved in the transition toward a more sustainable energy structure. Energy diversification—defined as a country's ability to utilize a more balanced mix of energy sources—is not merely a technological or environmental choice, but one that is heavily influenced by economic, institutional, and policy-related factors.

For many developing countries, the transition toward energy diversification is pursued not only to enhance resilience against external shocks, but also to support sustainable economic growth, reduce energy poverty, and attract investment. However, the pathway to achieving this goal varies greatly across countries, depending on their level of development, access to financial and technological resources, and institutional frameworks.

To analyze these differences more precisely, this section of the chapter draws on an empirical dataset covering 26 developing countries, presented in Table 2. The table includes descriptive indicators such as mean, minimum, maximum, standard deviation, and skewness.

By combining this index with per capita GDP, it becomes possible to analyze the implicit relationship between energy consumption diversification and the stability and direction of economic growth. Some countries, despite strong economic growth, still rely on a limited energy mix, while others with a more diverse energy portfolio have experienced unstable economic trajectories. These variations clearly underscore the importance of coordinated and comprehensive policymaking in this area.

In the following section, based on this table and relevant statistical analyses, three countries from different regions of the world—Brazil, China, and Turkmenistan—are examined as case studies. The goal is to analyze, in a concrete and comparative manner, the diversity in energy development pathways and their economic implications.

Table 2: Descriptive Statistics of Energy Diversification in Developing Countries

Country	**Variable**	**Mean**	**Min**	**Max**	**Std. Dev.**	**Skewness**
Azerbaijan	ED	-0.145	-0.271	-0.034	0.055	0.177
	GDP	4207.249	1480.809	5506.182	1515.446	-0.927
Argentina	ED	0.046	0.023	0.056	0.009	-1.428
	GDP	12305.535	8895.320	14200.270	1577.847	-0.757
Uzbekistan	ED	0.216	0.151	0.268	0.026	-0.748
	GDP	2224.397	1276.760	3356.033	694.369	0.126
South Africa	ED	0.231	0.188	0.268	0.025	-0.234
	GDP	5797.155	4735.666	6263.104	513.644	-1.027
Ukraine	ED	-0.076	-0.116	-0.032	0.023	0.114
	GDP	2204.973	1420.117	2598.833	319.535	-1.260
Ecuador	ED	0.001	-0.162	0.133	0.072	-0.072
	GDP	5348.588	4227.553	6215.838	635.206	-0.351
Algeria	ED	-0.083	-0.460	0.068	0.123	-1.249
	GDP	3856.845	3138.230	4246.242	324.018	-0.979
Indonesia	ED	-0.058	-0.096	0.000	0.026	0.459
	GDP	2822.200	1845.228	3892.962	705.657	0.158
Iran	ED	0.067	-0.026	0.241	0.099	0.583

	GDP	4965.462	3927.709	5450.938	445.642	-1.303
Brazil	ED	-0.016	-0.079	0.056	0.044	0.070
	GDP	8104.116	6745.858	9216.132	824.604	-0.496
Belarus	ED	-0.112	-0.168	0.085	0.064	2.116
	GDP	5045.819	2616.927	6457.751	1324.844	-0.768
Bangladesh	ED	0.059	-0.104	0.143	0.050	-1.589
	GDP	1054.680	646.038	1684.433	328.598	0.499
Pakistan	ED	-0.020	-0.059	0.034	0.025	0.271
	GDP	1331.405	1053.004	1650.693	190.162	0.198
Peru	ED	-0.061	-0.112	-0.014	0.028	-0.093
	GDP	5064.280	3255.590	6550.448	1207.220	-0.266
Thailand	ED	-0.028	-0.068	0.022	0.024	0.270
	GDP	5083.370	3511.440	6453.894	907.109	-0.215
Turkmenistan	ED	-0.280	-0.446	1.672	0.438	4.630
	GDP	4621.581	2261.700	7422.363	1908.442	0.137
Turkey	ED	-0.125	-0.162	-0.085	0.021	0.155
	GDP	9308.426	5993.828	13449.926	2255.201	0.195
China	ED	0.161	0.022	0.244	0.074	-0.697
	GDP	6102.019	2193.897	11223.255	2890.593	0.238
Philippines	ED	-0.044	-0.086	0.076	0.038	1.834
	GDP	2570.757	1831.699	3589.614	569.636	0.344
Kazakhstan	ED	-0.068	-0.132	-0.003	0.038	0.339
	GDP	8806.381	4446.452	11402.758	2172.371	-0.646

Colombia	ED	-0.118	-0.147	-0.081	0.016	0.166
	GDP	5311.525	4003.985	6423.860	885.448	-0.215
Malaysia	ED	-0.082	-0.115	-0.031	0.023	0.384
	GDP	8526.035	6330.628	11114.561	1559.745	0.198
Egypt	ED	0.035	-0.074	0.072	0.044	-2.020
	GDP	3165.587	2517.581	3896.843	438.147	-0.065
Mexico	ED	0.066	0.027	0.122	0.029	0.523
	GDP	9744.758	9151.770	10343.353	348.218	0.004
Vietnam	ED	-0.183	-0.243	-0.059	0.057	1.367
	GDP	2178.294	1183.854	3409.025	717.638	0.351
India	ED	0.060	0.043	0.086	0.013	0.336
	GDP	1308.369	755.482	1961.961	410.524	0.256

- ED (Energy Diversity Index): Higher (closer to zero or positive) values indicate greater diversity; negative values imply high concentration in few energy sources.
- GDP (Gross Domestic Product): Measured in constant 2015 USD.
- The Skewness column reflects the asymmetry of the distribution for each variable.

7.1 Brazil: Low Energy Diversity in a Relatively Stable Growing Economy

Despite having extensive renewable energy resources, Brazil has a relatively low average energy diversity index (ED = -0.016), indicating that its energy basket heavily relies on a few specific sources, such as hydropower. However, due to long-term investments, relatively stable policies, and extensive infrastructure development, the country's per capita economic growth has stabilized at a relatively high level.In other words, Brazil's experience shows that a high level of renewability does not necessarily imply energy diversity unless the energy mix is balanced and distributed. At the same time, Brazil serves as an example of success in maintaining growth stability despite limited but sustainable energy diversity.

7.2 China: Increasing Energy Diversity as Part of an Industrial and Technological Transition

China, with a relatively positive and growing energy diversity index (ED = 0.161), is one of the successful examples of a planned transition towards a more diverse energy mix. Investments in wind, solar, nuclear, and advancements in power grid technologies have enabled China to begin reducing its dependence on coal.

Despite environmental challenges and uneven regional growth, the combination of high economic growth and gradual improvement in energy diversity makes China an important model for developing countries. This country demonstrates that gradual increases in energy diversity, coupled with sufficient institutional and financial capacities, can be achieved alongside economic growth.

7.3 Turkmenistan: An Example of Lack of Diversity in a Mono-Product Economy

Turkmenistan has one of the lowest energy diversity indices among the examined countries, with an average ED significantly negative at -0.280 and fluctuating up to -1.672. This indicates a strong dependence on one or two energy sources (primarily natural gas) and a lack of diversification policies.

At the same time, the country's economic growth has been volatile, and due to the absence of diverse energy infrastructures, it is vulnerable to external shocks. Turkmenistan exemplifies the reality that economies dependent on limited energy resources not only lack diversity but are also fragile against global market crises.

Therefore, statistical analysis of the table shows that countries with ED values close to zero or positive, such as China and Iran, tend to diversify their energy sources more. In contrast, countries with highly negative ED values like Turkmenistan, Belarus, and Algeria remain structurally dependent on limited resources. Overall, a relatively positive correlation between energy diversity and long-term economic growth stability is observable, although institutional and political factors play a significant mediating role.

8. STRATEGIES, MISTAKES, AND COORDINATED POLICY-MAKING

Analysis of countries' experiences in diversifying their energy structure shows that success in this path is not merely dependent on natural resources or available technologies but largely relies on the quality of policymaking, institutional coherence, and the design of development strategies (Gittleman et al., 2023; Halden et al., 2025). In many cases, countries with more diverse energy resources have achieved limited results due to weak coordinated policies, whereas some countries with more limited resources have paved the way for sustainable energy development through coherent policy design and avoidance of common mistakes (Falcon, 2023).

Accordingly, this section aims to clarify structural barriers and strategic errors in the energy diversification process and subsequently presents a set of institutional requirements and policy recommendations to design an effective, coordinated, and localized framework for developing countries.

8.1 Common Mistakes in Energy Diversification Policies

A review of countries' experiences in diversifying energy consumption structures shows that many policy failures are not due to a lack of resources but result from uncoordinated design, short-term decision-making, and neglect of institutional and social realities (Kurai et al., 2025).

Some of the recurrent mistakes observed in the transition process toward a diverse energy mix in developing countries include:

- **Overreliance on a single renewable source without maintaining balance in the resource mix:** In some countries, focusing on hydropower as the main renewable source without developing other options such as solar or wind has caused severe vulnerability to climate changes (Zheng & Osman, 2025).
- **Rushed investment in technology without preparing supporting infrastructure:** Developing clean energy projects without adequate transmission networks, storage, or effective regulation generally fails to achieve the expected efficiency and effectiveness (Falcon, 2023).
- **Conflicts in financial and subsidy policies:** Continued broad subsidies for fossil fuels, tariff instability, and financial volatility usually weaken investor incentives and slow down the energy diversification process (Zheng & Osman, 2025).
- **Neglecting social and regional dimensions of energy development:** Focusing solely on large and urban projects without considerations of justice and regional equity leads to social dissatisfaction, unequal access to energy, and failure in inclusive development goals (Heffron & Sukowski, 2024).

8.2 Institutional Requirements for Effective Energy Diversification Policy

Successful implementation of energy diversification policies requires coherent institutional structures and cross-sectoral coordination capacities (Eqbal et al., 2022). Countries that have achieved sustainable results in this area generally benefit from the following institutional models:

- **Central institution with regulatory and cross-sectoral coordinating roles:** The presence of organizations empowered to set policies and coordinate among ministries (such as energy, oil, environment, industry, and economy) ensures that energy diversification programs are implemented comprehensively and without conflicts (Taqizadeh & Yoshino, 2020).

- **Long-term and stable legal and regulatory frameworks:** Clear and stable laws regarding renewable electricity tariffs, tax exemptions, and energy mix requirements increase predictability and attract long-term investments (Eqbal et al., 2022).
- **Comprehensive data system and energy information transparency:** Evidence-based decision-making is possible only with reliable data on energy composition, share, and consumption trends. Countries that have strengthened their energy information systems have been able to continuously evaluate and revise policies.

8.3 Proposed Strategic Frameworks for Developing Countries

Based on successful experiences and the analyses presented in this chapter, a set of macro-strategies and policy recommendations for balanced and sustainable development of energy diversification in developing countries can be outlined as follows:

- Consider energy resource diversification as a key component of economic development strategies, not merely an environmental goal. This shift in perspective places energy at the core of macroeconomic planning (Haldon et al., 2025).
- Combine supply-side and demand-side policies: Supporting diverse energy production should be accompanied by improvements in efficiency, public education, and reforms in consumption patterns to achieve real impact.
- Develop decentralized projects, especially in less developed regions: Utilizing renewable energies at the local scale can reduce energy poverty, improve regional equity, and promote inclusive growth.
- Employ innovative financial instruments: Development of green bonds, public-private partnerships, and leveraging international climate funds can help overcome financial constraints in diversified energy projects.
- Invest in institutional and human capacity building: Training specialists, establishing professional institutions, and upgrading technical skills in energy policy and management are essential for sustainable diversification (Babayomi et al., 2022).

Therefore, the experience of developing countries shows that success in energy diversification depends on adopting a systemic and long-term approach. This approach must simultaneously consider technical, institutional, social, and economic aspects. Past mistakes can serve as guiding lights for the future, provided that lessons are learned and policies are designed with attention to local capacities, institutional realities, and energy market dynamics.

9. CONCLUSION AND DEVELOPMENT RECOMMENDATIONS

The conceptual and empirical analysis of energy diversification in developing countries shows that diversifying the energy consumption mix goes beyond a technological or environmental choice; it acts as a fundamental strategy for achieving sustainable economic development. This diversification not only reduces countries' structural dependence on limited and volatile energy resources but also paves the way for increased economic resilience, industrial productivity, social equity, and energy security.

The case studies presented in this chapter, along with the statistical analysis of multiple countries based on the Herfindahl-Hirschman Index, clearly demonstrate structural and policy differences between countries with successful energy patterns and those suffering from severe energy concentration. Accordingly, it can be emphasized that the level of energy diversity not only reflects a country's natural resource capacity but also embodies its institutional maturity, policy-making capability, and coherence in development planning.

Statistical data also showed that, in many cases, countries achieving higher energy diversity indices have experienced more sustainable economic growth and lower fluctuations. However, this correlation can be neutralized or even reversed without proper institutional, infrastructural, and policy requirements.

Considering all the findings of this chapter, the following recommendations are offered for developing countries in the design and implementation of energy diversification policies:

- Develop integrated and cross-sectoral macro energy strategies that regard energy source diversification as one of the main pillars of economic growth, energy poverty reduction, and resilience enhancement.
- Establish a central regulatory and coordinating institution responsible for aligning ministries' objectives, creating transparent legal frameworks, and attracting long-term investments.
- Reform subsidy and tax systems in a way that facilitates investment in clean and diverse energy sources, while gradually removing incentives for inefficient traditional sources.
- Invest in data, technology, and human resources as the foundation for scientific and sustainable decision-making, through the development of energy information systems, specialized training, and knowledge transfer.
- Address the social and regional dimensions of energy policies by focusing on decentralized projects in deprived areas and enabling local community participation in decision-making.

Finally, it should be emphasized that the path to energy diversification is gradual, interactive, and dependent on local contexts. Countries that have had a more precise understanding of their internal dynamics and have paid attention not only to resources but also to institutional and human structures have been able to leverage energy as a tool for sustainable, inclusive, and resilient development. From this perspective, energy diversity is not only a consequence of economic development but also its driver.

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CHAPER 2
THE ROLE OF ISLAMIC ENVIRONMENTAL ETHICS IN SHAPING SUSTAINABLE ENERGY DEVELOPMENT IN DEVELOPING COUNTRIES

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INTRODUCTION

The problems of environmental degradation and energy insecurity are some of the most glaring issues facing developing countries in the 21st century. Climate change, resource depletion, and unfair access to energy resources have a disproportionately negative impact on the vulnerable populations of the Global South and jeopardize the well-being of humans and the ecological soundness (Omer, 2008; UNDP, 2022). As the international community has come to acknowledge these issues more and more in the form of agreements like the Paris Agreement (UNFCCC, 2015) and goal sets like the Sustainable Development Goals (United Nations, 2015), actually realising these frameworks has to take the form of approaches that are relatable to local cultural and religious conditions (Iqbal, 2014). Islamic teachings provide a unique ethical perspective with which to think about and act in response to environmental and energy issues, especially in view of the fact that there are about 1.8 billion Muslims on earth, a large percentage of whom live in the developing world (Nasr, 1996; Khalid, 2002). The argument advanced in this chapter is that the various Islamic environmental ethics are not intellectual, theological formulations with little or no bearing on practice, but rather represent practical frameworks that can be sustainably drawn on in developing sustainable energy. The concepts are based on the Islamic teachings, which offer a comprehensive strategy that considers economic growth, ecological integrity, and social justice as a balance, which is being more acutely realised as critical to true sustainability (Esack, 2009; Al-Damkhi, 2008). The expediency of researching this interconnection cannot be overestimated. Due to the rapid industrialisation, urbanisation, and population growth in Muslim-majority developing countries, energy demands in these countries keep rising (Ritchie & Roser, 2020). At the same time, a number of these nations have large amounts of renewable energy sources which are not used fully. This incongruence brings up essential issues of how religious values could affect the course of energy innovation and usage trends in these areas (Iqbal, 2014). This chapter will show how Islamic environmental ethics can both inspire and guide the process of sustainable energy transitions in developing countries through: critical analysis of primary Islamic sources, contemporary academic interpretations of these sources, and case studies of selected developing

countries that are majority Muslim. This study can be applied in the wider debates surrounding the applicability of faith-based initiatives in resolving environmental issues facing the world (Khalid, 2002; Sardar, 1985).

1. LITERATURE REVIEW: ISLAMIC ENVIRONMENTAL ETHICS

The academic literature on the topic of Islamic environmental ethics has undergone notable developments in the last thirty years, as the field of research emerged at a rather peripheral level to become a serious subject of study. This development captures the growing environmental crisis around the world and a revived consideration of faith-based sustainability. The metaphysical aspects of Islamic environmentalism were laid down early on by Nasr (1990), who held the environmental crisis to be rooted in a spiritual crisis. This viewpoint was later developed by Foltz (2000), who searched systematically for the ecological interpretation of Islamic text, focusing on the Quranic basis of environmental stewardship.

Newer research has gone past theory to look into practice. Hussain (2007) examined the operationalisation of Islamic environmental ethics in modern resource management, and Kamali (2010) presented a *maqasid al-shari'ah* (higher objectives of Islamic law) approach to the protection of the environment. This trajectory has been further advanced by Al-Jayyousi (2012), who has introduced a unique Islamic sustainability model, which incorporates spiritual values and scientific methods on environmental issues. All together, these works illustrate the richness of the Islamic traditions to inform environmental governance and practice.

1.1 Primary Principles in Islamic Environmental Ethics

The basic principles of Islamic environmental ethics provide an integrated ethic system to guide the approach to ecological and energy-related issues. Chief among them are *Tawḥīd* (Divine Unity), which perceives the interdependence of all of creation in the oneness of God; *Khilāfah* (Stewardship) which calls upon the human being to be a trustee of the earth; *Mizan* (Balance), which calls upon ecological and social balance; *Amanah* (Trust), which views the natural world as a trust given by Allah (SWT); and

Israf (Waste Avoidance), which forbids wasteful consumption (Kamali, 2010; Al-Jayyous)

1.2 Scholarly Approaches to Islamic Environmentalism

The academic study of Islamic environmentalism has developed in a number of areas. Scriptural analysis entails exegetical works of Quranic verses and hadiths that enumerate the instructions of nature and creation as propounded by God (Foltz, 2000). The environmental principles used in legal-ethical discourse are taken in Islamic jurisprudence and ethical theory (Kamali, 2010). Modern integration is undertaken to align Islamic values with modern environmental science in order to provide contextually relevant solutions (Al-Jayyousi, 2012), and comparative studies are made between intersections of Islamic and other religious or secular environmental frameworks (Foltz, 2003).

Although this forms a rich literature, there are still critical gaps, in particular with regard to the actual application of Islamic environmental ethics to energy development. Although Hasan (2018) and Ibrahim (2019) have begun the discussion on this intersection, a large part of the current literature discusses energy problems as an afterthought to wider environmental issues. Moreover, the empirical studies regarding the operationalisation of the Islamic environmental principles in the energy policies of developing countries with Muslim majorities seem to be noticeably lacking. The chapter is aimed at covering these gaps by addressing the contributions that Islamic ethics can offer to sustainable energy transitions in a systematic way.

1.3 Theological Foundations of Islamic Environmental Ethics

The theology behind the Islamic environmental ethic has its strong foundation on the Quran and Sunnah, and it provides a complete picture of how man should relate to the natural environment. At the heart of this vision of the world is the idea of Tawḥīd (Divine Unity) that recognizes the unity of all creation as a mercy forthcoming and maintained by the divine will. The Quran makes numerous references to the fact that every component of the universe is in a state of submission to Allah (SWT) and constantly praises Him, Surah Al-Isra (17:44): The seven heavens and the earth and all that is in them glorify Him. and not a thing but it magnifies [Allah] by His praise, although you do not perceive their [manner of] magnifying. Such a theological tradition refers to the

natural world not as an inanimate object to be used by humanity, but as a living subject of divine worship, worthy of respect and care (Foltz, 2003; Kamali, 2010).

Khilāfah (stewardship), the concept further specifies the moral responsibility of humans as the caretakers of the Earth, rather than the absolute owners. This is stated in Surah Al-Baqarah (2:30): "Verily! I shall make a successive authority on the earth, which is an ethical responsibility bestowed upon human beings to utilize the resources in a just and sustainable manner (Al-Jayyousi, 2012; Kamali, 2010). Mizan (Balance) is another essential theological concept which is highlighted in Surah Ar-Rahman (55:7 8): And the heaven He lifted and He established the balance, that you not exceed the balance. Such a concept of a balance requires ecological and social balance and provides the theological criticism of unsustainable and extractive energy systems (Foltz, 2000; Nasr, 1996). *Amanah* (trust) also states that creation is an entrustment by God, and man is answerable. These themes were further elaborated by the Prophet Muhammad (peace be upon him) in his environmental praxis: he banned inefficient uses of water even in times when water was abundant, created protective areas (*hima*) to conserve the environment, and made planting trees a continual charity (*sadaqah jariyah*) (Ibn Majah, as cited in Foltz, 2003; Hussain, 2007). Such acts indicate that the Islamic environmental ethics are not the intellectual knowledge; rather, they are highly practical and capable of being performed.

1.4 Islamic views on Energy Resources and Usage

The Islamic ethics also provide a particular insight into the exploitation, management, and distribution of the energy resources. Such ideas as *rizq* (divine provision) can help view natural resources, including energy, as the blessings of Allah (SWT) intended to sustain the common good rather than as objects of unrestrained exploitation (Hasan, 2018). Such a framing can be seen in Surah Al-A'raf (7:31): Eat and drink, but be not excessive. Verily! He loveth not those who exceed." In this way, Islamic environmental ethics bring to the fore moderation (*wasatiyyah*) as an ethical requirement that questions the unsustainable models of energy consumption (Ibrahim, 2019). The banning of Israf (waste and excess) has direct implications *for* energy efficiency and

conservation. The same directive of the Prophet Muhammad *(peace be upon him)*, telling not to waste water even at a running stream (Ibn Majah), can be projected *analogously* to the modern-day issues of energy-wasting. These principles provide a set of ethics of responsible energy consumption and find a close alignment with the global sustainability objectives, confirming the possibility of Islamic doctrine to guide fair energy shifts (Kamali, 2010; Al-Jayyousi, 2012).

2. RESOURCE OWNERSHIP IN ISLAMIC JURISPRUDENCE

These particular natural resources, especially those necessary to the well-being of the community, are set by classical Islamic jurisprudence as common property (al-milk al-am) and thus may not be monopolised privately. The principle could be applicable in energy resources that are needed to fulfil basic human needs.

2.1 Intergenerational Equity

Islamic inheritance (*Wirasath*), is the concept that underlines a duty to and responsibility towards future generations, and has been used to find a theological justification for the sustainable management of resources to ensure that the energy resources are left to future generations.

2.2 Technology Assessment

Islamic ethics demand that technologies should be judged on their overall effects (*maslaha* and *mafsadah*), which allows giving a critical review to different energy technologies beyond economic factors. The Islamic concept of avoiding harm (*la darar wa la dirar*) can be used as an ethical framework to assess energy technologies and their environmental effects. This principle would give priority to sources of energy and technologies that have the least possible negative effects on the ecological situation and human health. Public interest (*maslaha*) concept also favors the development of renewable energy sources as a way of ensuring long-term community benefit and not financial gain. The Quranic focus on seeking knowledge is a bonus towards promoting clean energy technological innovation with the verses in Surah Al-Zumar (39:9)

questioning: "Are those who know, equal to those who do not know?" These Islamic views on energy resources and use criticise the mainstream models of development as they place energy choices in the broader moral context giving precedence to the ecological integrity, social justice and spiritual accountability. Instead of applying merely economic or technical perspectives of energy, Islamic ethics promote a more holistic outlook, which would encompass the multidimensional effects of energy systems on the current and future generations.

3. ISLAMIC CONCEPTION OF JUSTICE AND ENERGY ETHICS

Islamic moral and legal philosophy is centred upon the notion of justice (*ʿadl*). In Surah An-Nahl (16:90) the Quran explicitly states: "Allah commands that justice shall be done, and the good treatment, and the giving to the relatives, and He forbids the immorality, and the bad treatment, and the oppression." The Islamic conception of justice extends beyond legal equity, and justice is firmly embedded in the concept of fulfilment of duty towards God, other human beings, and the environment. This principle, when applied to the energy system, moves into distributional, procedural, recognition, and inter-generational aspects of energy justice (Kamali, 2010; Al-Jayyousi, 2012).

3.1 Distributional Justice; Equitable Access

In Islamic ethics, distributional justice implies equal access to the necessary resources, such as affordable and clean energy. This is in tandem with the Islamic legal aim of protecting the *daruriyyaat* (necessities of life) that comprise life (*nafs*), intellect (*aql*), property (*mal*), and posterity (*nasl*) (Auda, 2008). Good energy access is therefore a moral imperative to fulfil the fundamentals for everyone, particularly the poor and the vulnerable.

The Prophet Muhammad (peace be upon him) stressed the attention to the marginalized and said: "He is not a believer whose stomach is full while his neighbor on his side is hungry." (Ṣaḥīḥ al-Bukhārī). This principle justifies the energy policies that focus on the underserved and low-income populations with a particular focus on rural or peripheral areas within the Muslim world.

3.2 Procedural Justice and the *Shurat* Principle of Justice

Procedural justice focuses on the fairness of the decision-making procedures. In Islam, it is expressed in terms of the principle of *shūrā* (mutual consultation), as ordered in Surah Ash-Shūrā (42:38): "...and those who manage their affairs through mutual consultation...". Open, all-inclusive energy management with scope to engage the community and incorporate the local stakeholder contributions mirrors the Quranic spirit of group decision-making.

It is an argument against the top-down and technocratic energy planning models in favor of participatory models that are mindful of local needs, social situations, and moral factors (Ibrahim, 2019).

3.3 Energy Governance and Anti-Monopoly Ethics

The Islamic proscription of *iḥtikār* (monopoly and hoarding) is pertinent in the criticism of the centralized and corporatized energy system. As related in *ḥadith*: "Monopolizer is a sinner." (Muslim). The Islamic law denounces systems that permit the few to dominate the crucial resources at the expense of the many. This principle, when transposed to the field of energy, requires the decentralization and democratization of energy, with equal distribution of the advantages and the costs (Foltz, 2000; Hasan, 2018).

Connected with it is the Quran's condemnation of *ẓulm* (oppression) that encompasses environmental and economic injustices. Any energy policy that imposes the ecological costs on the poor people or the developing countries, who are not always the greatest contributors to ecological deterioration, is *ẓulm* within the Islamic moral system (Nasr, 1996).

3.4 Intergenerational Justice and Stewardship (*Khilāfah)*

Intergenerational equity is heavily implied in Islamic ethics with the idea of *Khilāfah* (stewardship) and *Amānah* (trust). The Prophet Muhammad (peace be upon him) said: "The world is green and beautiful and verily Allah (SWT) has made you His stewards in it" (Ṣaḥ ī ḥ Muslim). This strengthens the need to ensure the sustainable and ethical management of energy resources and makes sure that the future generations will inherit a habitable planet with unthreatened access to vital services, among which clean energy is included.

This theology opposes the short-termism and profit-oriented energy policies and demands the policies based on long-term ecological sustainability, spiritual stewardship and intergenerational justice (Al-Jayyousi, 2012).

3.5 An Energy Transition towards Contextual Resonance

With the basis of energy justice being established in the Islamic ethical traditions, energy policymakers in Muslim-majority contexts now have the alternative of a morally consistent and theologically grounded approach to development that is not defined by technocracy or market fundamentalism alone. Islamic ethics requires that any energy system must be considered based on efficiency or cost-effectiveness, but also on their potential to promote justice, dignity and environmental balance. The views promote comprehensive, community-based energy shift that embraces spiritual responsibility, social justice, and ecological soundness.

4. CASE STUDY: ISLAMIC ENVIRONMENTAL ETHICS IN PAKISTAN'S ENERGY POLICIES

Pakistan creates an interesting case study on the possibilities of incorporating Islamic environmental ethics in national energy policies. Pakistan, the fifth-most populous nation in the world and a country where 96 percent of the population is Muslim, is encountering extreme energy problems such as frequent outages of electricity, high fossil fuel imports, and increasing greenhouse gas emissions. Such difficulties are aggravated by the fact that Pakistan is highly susceptible to the effects of climate change, such as glacial melt, flooding, and drought. Nevertheless, Pakistan has taken some remarkable steps towards renewable energy growth, such as the National Climate Change Policy (2012) as well as the Alternative and Renewable Energy Policy (2019).

The overt input of Islamic environmental ethics into the energy policies of Pakistan is not much, but efforts are rising to close this gap. Constitutional in 2018, the Council of Islamic Ideology, a constitutional body tasked with advising the government on Islamic interpretations, made recommendations highlighting the religious imperative to achieve sustainable energy development. These suggestions quoted Quranic verses about environmental management and the teachings of the Prophet (peace be upon him) about the

conservation of resources. Likewise, the Pakistan Climate Change Council has started to introduce faith-based messaging into public awareness campaigns, but systematic inclusion in policymaking is immature.

Table 1

Policy Instrument	Current Status	Potential for Islamic Ethics Integration
Alternative and Renewable Energy Policy 2019	Targets 30% renewable energy by 2030	Could incorporate *khilāfah* principles to strengthen justification
National Energy Efficiency and Conservation Act	Focuses on technical efficiency measures	Could draw on *isrāf* prohibitions to motivate conservation
Power Generation Policy	Primarily market-oriented approach	Could integrate *adl* principles for equitable energy access
Climate Change Act	Limited reference to ethical frameworks	Could incorporate *amanah* concept for intergenerational equity

4.1 Grassroots Islamic Environmentalism, Energy Ethics in Practice

A number of grassroots campaigns highlight the implementation of Islamic environmental ethics into energy development within the Muslim world. Among the most successful of these is the activities of the Islamic Foundation for Ecology and Environmental Sciences (IFEES), which has worked with local mosques to initiate so-called "Green Mosque" projects. These programs combine solar energy solutions, water conservation, and environmental education opportunities, which effectively present ecological stewardship as a religious obligation (Hassan, 2017). Theological framing of environmental action enhances the support of action, especially in religious societies where faith dominates the society.

Likewise, other groups have organized ʿ*ulamā* (religious scholars) with the Rural Development Policy Institute (RDPI) in Pakistan, preparing

environmental *khutbah* (sermon) guides. The guides contain themes of energy-conservation, the uptake of renewable energy, and Islamic stewardship (*khilāfah*) in which the mosques are encouraged to become centres of environmental education and morally sound energy consumption (Nasir & Lodhi, 2020).

The example of Pakistan demonstrates the possibilities and the limitations of the mainstreaming of Islamic ecological ethics into official energy policy. Although explicit attempts to incorporate Islamic principles in national energy strategies are still few, growing interest by civil society, religious institutions, and community-based organizations offer promising opportunities. Such a changing environment is an indication that Theologians, policy, and energy technologists can benefit by working interdisciplinary to translate Islamic ethical teachings into practice and scalable energy governance systems (Ahmed & Kazmi, 2021). This integration can result in greater legitimacy among the populace, moral accountability and transitions to more sustainable and socially just energy systems within Muslim majority settings.

5. CASE STUDY: INDONESIA'S FAITH-BASED APPROACHES TO ENERGY TRANSITION

The largest Muslim-majority country in the world, with about 87 percent of its 270 million inhabitants considering themselves Muslim, Indonesia provides an interesting case study of how Islamic ethics may guide the creation of sustainable energy. With a mix of intricate issues to face, including the high rate of energy demand and fossil fuels subsidies, as well as the 96-percent reliance on fossil fuels, Indonesia is also among the countries the most susceptible to the effects of climate change (IEA, 2023). As part of its commitments under the Paris Agreement, the nation has set a goal of cutting greenhouse gas emissions by 29-41 percent by 2030, which will require a profound switch of its national energy system (Government of Indonesia, 2021).

The faith-based approaches have made substantial headway, especially following the activities of Nahdlatul Ulama and Muhammadiyah, the two largest Islamic organisations in Indonesia, which have a combined membership of more than 80 million people. In 2015, these institutions together issued a

fatwa (religious ruling) on environmental protection, which said: "The exploitation of energy resources that causes environmental degradation or endangers the well-being of society is a violation of the trust (*amanah*) of Allah" (Kusumawardhani & Hadi, 2016). The fatwa was a ground-breaking development, as it authorized renewable energy projects in religious circles and gave them a strong moral imperative to shift energy.

The Indonesian government has grown to believe in the abilities of faith-based involvement in facilitating energy-saving objectives. The Ministry of Energy and Mineral Resources, together with the Indonesian Council of *Ulam*a (MUI), initiated the programme on the conservation of energy using religious teachings. Under this initiative, religious leaders are trained on how they can add in their sermons and outreach to the community messages about energy efficiency, moderation (*wasatiyyah*), and waste avoidance (*isrāf*) (MUI, 2018). In addition, the National Energy Council has adjusted the strategy of its public communication to incorporate a specific appeal to the religious institutions, as they have the potential to define the social norms and can contribute to the behaviour of households in relation to energy use.

Locally, at the community level, examples of community-based innovations include the "Solar Pesantren" program, which has outfitted more than 30 Islamic boarding schools (pesantren) with solar photovoltaic systems, thus cutting operating expenses and integrating environmental ethics into the curriculum. Likewise, the Green Mosque Initiative has allowed over 100 mosques to switch to energy-efficient lighting and solar energy systems, and imams encourage their adoption as religious devotion and stewardship (Pradana, 2022).

The case of Indonesia demonstrates a multi-level and faith-based model of promoting sustainable energy transitions. Through this strategy, formal theological instructions, state religious partnership, and community empowerment are integrated to make the Islamic environmental ethics operationalised in the manner that is relevant to both local cultural and spiritual values. These programs are not only making people have a greater purchase on energy policy, but also they are indicating just how transformative religious values can be when it comes to environmental stewardship in the Global South.

6. CASE STUDY: NIGERIA'S FAITH-INFLUENCED ENERGY DEVELOPMENT

Nigeria is the most populous nation in Africa (estimated population over 200 million people), of which about half are Muslims, providing a particular case study of understanding how Islamic ethics, energy development, and sustainability transitions interact in a multi-religious society (Pew Research Center, 2020). Nigeria, although a major oil producer (its output is about 1.8 million barrels per day), is an illustration of the paradoxes of the so-called "resource curse": the country with the vast energy resources faces the energy poverty of the worst kind. More than 40 per cent of Nigerians do not have access to safe electricity, and this is an energy justice crisis (World Bank, 2022).

Compared to more state-based approaches existing in nations such as Indonesia, the response of Nigeria to Islamic environmental ethics within the energy sector has been mainly on a civil society level, as opposed to government policy. The formation of the Environmental Protection Committee by the Nigerian Supreme Council for Islamic Affairs (NSCIA) in 2012 was one of the most important trends in this field. The committee has been busy in raising Islamic views on environmental stewardship, and they employ *Qur'anic* concepts of *khilafah* (trusteeship) and *adl* (justice) to reproach non-sustainable resource use.

In 2018, a milestone effort towards the national discourse was adopted when the NSCIA published Natural Resource Management: Islamic Teachings on the Management of Natural Resources. It clearly says in the document: "Extracting petroleum resources without considering the environmental impact or the equal distribution of benefits contravenes the Quran concepts of stewardship (*khilāfah*) and justice (Muslim Supreme Council of America, 2018). With this theological position, an ethics has been brought to the energy debate, and the validity of extractive practices that ecologically and socially destabilize is brought into question. It redefines the problem of energy governance as an ethical one and requires a fairer and environmentally friendly attitude of both the state and non-state players.

Although it does not have much direct policy impact, the advocacy efforts made by the NSCIA have galvanised debate in Islamic forums and provoked grassroots action on energy and climate change Commission in

northern Nigeria, where most of the Muslim population is located. The local religious leaders are already incorporating conservation messages into *khutbahs* (Friday sermons), while a number of community-based initiatives have also connected access to renewable energy with Islamic ideas of moderation of resources and intergenerational justice.

The example of Nigeria supports the idea that faith-based interventions could play an important role in bringing moral compulsions in national energy debates especially in environments characterized by religious diversity, energy inequality, and problems of governance. It also emphasises the role of the civil society actors especially the religious institutions in promoting the sustainable energy agendas where state leadership is weak.

6.1 The role of Islamic ethics in Faith-Based Approaches to Energy Development in Nigeria

With a Muslim population of about 100 million in a total population of about 200 million, Nigeria is the most populous nation in Africa, and its case is especially interesting in studying the overlap of Islamic environmental ethics, energy development, and sustainable transitions in a multi-faith society. Nigeria is a case of chronic energy poverty in spite of the country being a top producer of oil, more than 40 percent of its population has no dependable supply of electricity. The apparent contradiction between the existence of large reserves of energy sources and the lack of access to energy highlights the necessity and timeliness of energy justice and fair energy transition.

6.2 Theological Engagement and Religious Institutions

The Islamic organisations, including the Nigerian Supreme Council for Islamic Affairs (NSCIA) and other state-level Muslim councils, have gone ahead to engage in faith-based environmental guidance development. These initiatives comprise position statements and advice on ethics in managing natural resources. As an illustration, the 2018 paper on Natural Resource Management published by NSCIA directly links the oil exploitation and environmental degradation to the breach of Quran principles of *khilāfah* (trusteeship) and ‘*adl* (justice), providing a theological criticism of unsustainable energy use.

6.3 Educational Initiatives

Islamic environmental teachings have gradually been incorporated in the education system in Islamic institutions. There are also sustainable energy modules in some Islamic schools and universities, making connections between modern energy expertise and religious values, including moderation (*wasatiyyah*) and avoidance of waste (*isrāf*). The objectives of these programmes are to develop religiously literate environmental leaders of the future or policymakers that are students.

6.4 Locally Based Projects and Innovation

Applied community programs have made Islamic energy ethics a local practice. Indicatively, the solar photovoltaic Irradiance programme has installed solar systems in more than 50 mosques in northern Nigeria, clearly showing this as an Islamic stewardship programme. Likewise, the Northern Nigeria Renewable Energy Association has linked up with religious scholars in advocating the acceptance of solar based on Islamic teachings of *iktifa dhathi* (self-sufficiency) and *rahmah* (compassion towards creation).

Such endeavors indicate how religious stories could be used to promote acceptance of renewable energy technologies, mitigate opposition by communities, and support energy solutions with the strongly held cultural and religious values.

6.5 Civil Society Engagement and Policy Advocacy

Nigerian Islamic civil society has also worked on renewable energy policy advocacy, making an ethical case that fossil fuel subsidy reform and energy access to all are vital. Basing the advocacy on the Islamic moral principles gives this advocacy credibility and relevance within the religious circles and makes the energy reform look like a developmental and moral imperative.

6.6 Interfaith Cooperation in a Pluralistic Society

The religious landscape in Nigeria presents a challenge and an opportunity. Inter-faith organisations like the Nigerian Interfaith Action

Association are starting to incorporate the climate and energy concerns into their remit. The initiatives have come up with common ethical platforms that capture cross-cutting values in terms of religion, justice, conservation, and protection of the vulnerable, to create a moral responsibility of sustainable development as a collective responsibility.

7. ALIGNING ISLAMIC ENVIRONMENTAL ETHICS WITH GLOBAL SUSTAINABILITY FRAMEWORKS

Embedding of Islamic environmental ethics within the international sustainability frameworks has conceptual agreements as well as practical possibilities of improved collaboration. In particular, the United Nations Sustainable Development Goals (SDGs), especially SDG 7 (Affordable and Clean Energy) and SDG 13 (Climate Action), show considerable overlap with the basic Islamic ethical values. These overlaps provide a profitable way of linking religion with secular models of development that can be implemented with sensitivity to context in Muslim-majority developing states.

7.1 Ethical Convergences: Islam and the SDGs

Several core Islamic values correspond closely with the principles embedded in the SDG framework:

Table 2

Islamic Principle	Corresponding SDG Theme	Explanation
Justice (*ʿAdl*)	Equity and "Leave No One Behind"	Emphasizes social justice and fair distribution of energy and resources
Stewardship (*Khilāfah*)	Environmental Sustainability	Calls for responsible management of the Earth as a divine trust
Balance (*Mīzān*)	Integrated Sustainability	Advocates for ecological, economic, and social harmony
Cooperation (*Taʿāwun*)	SDG 17: Global Partnerships	Encourages collective responsibility and mutual assistance

As an example, SDG 7, aiming at universal access to energy, is linked to the Islamic goal of providing *daruriyyāt* (basic human needs). Modern scholars have interpreted the prophetic tradition; the Muslims have three things in common: water, pasture, and fire (Abu Dawud) to consider energy as a public good, and therefore, accessible to all and needing fair distribution. Moreover, the SDG energy efficiency target aligns directly with the Quranic argument against isrāf (wastefulness), and the boosting of renewables with the idea of not destroying the natural balance (mizan) established by Allah (SWT).

7.2 Theological Framing and Climate Action

The Islamic religion also offers a strong moral ground on climate action that gives strength to international agreements like the Paris Agreement. The Quran's ban on *fasād fil-ard* (corruption and destruction on Earth) makes mitigating the climate and caring about the environment a religious duty. The principle of intergenerational justice is concepts that also support long-term ecological responsibility.

This position is confirmed in the 2015 Islamic Declaration on Global Climate Change, which says: "We do testify that Allah has commanded us to be vicegerents (*khalifah*) on the Earth… and we are answerable for our deeds." This statement highlights the possibility of Islamic theology to strengthen the ethical aspect of the sustainability movement in the world.

7.3 Faith-Sensitive Implementing Strategies

The overlap of Islamic ethics and SDG objectives also provides feasible routes to action, especially in Muslim- dominated nations. The important strategies are:

Religious Motivation: The use of Islamic principles to activate the participation of the people in sustainability.

Institutional Vehicles: Making use of mosques, religious schools, and *waqf* institutions in awareness, education, and the delivery of services.

Religious Authority: Utilizing Imams and Islamic scholars as communicators and advocates of climate-friendly behavior.

Islamic Finance: Utilising such instruments as green *sukuk* (Islamic bonds) to finance projects in renewable energy and sustainable development, under the principles of *Shariah*-compliant investing.

The experience of other countries, such as Morocco, Indonesia, and Jordan, demonstrates that the sustainability initiative receives greater legitimacy and involvement of people when it is directly linked to the Islamic doctrine.

Islamic ethics and global sustainability frameworks are not meant to be in a relationship of opposites. Rather, they provide mutually supportive paradigms that, when used in conjunction with one another, would support the well-being of humankind, social justice, and environmental responsibility. Policymakers can maximise the resonance, relevance, and reach of sustainable energy and climate initiatives in Muslim-majority settings by identifying these complementarities and making them operational by developing faith-sensitive approaches to development.

This combined methodology confirms the feasibility of ethical pluralism in the sustainability discourse, where secular and religious frames of reality can meet and jointly contribute to the common global goals.

8. CHALLENGES AND LIMITATIONS IN APPLYING ISLAMIC ENVIRONMENTAL ETHICS

Although Islamic environmental ethics has a great potential to contribute to the creation of sustainable energy, there are a number of serious challenges and constraints that have to be admitted. These limitations exist at conceptual, institutional and practical levels, which introduce complications in the process of translating ethical principles into effective energy policies and practices. These issues are complicated to handle without subtle knowledge about the nature of religion and the nature of the energy system.

On the conceptual level, interpretive diversity in Islamic tradition poses a basic challenge. Lack of centralised religious interpretation in Islam causes different and at times conflicting interpretations of environmental principles. As an example, although some researchers understand the idea of human dominion over nature (*taskhīr*) as the legitimation of exploitation of resources

to the benefit of mankind, others stress the relation of this idea to the obligation of stewardship. In the same manner, varying approaches to the methodology of Islamic jurisprudence (*usul al-fiqh*) would lead to different concluding determinations regarding the permissibility of one or another energy technology or policy. Such interpretive plurality makes it difficult to form consensus-driven modes of thinking about Islamic environmental ethics.

There are also institutional issues that limit effective implementation. Most developing nations with Muslim majorities have their environmental ministries and religious affairs departments located in institutional silos that rarely interact. Madrasas (religious educational institutions) usually do not have any curricula related to the environment, and the energy planning agencies usually lack the experience of religious visions. This segregation at the institutional level makes it difficult to come up with integrated forms of approaching energy governance wherein Islamic ethical considerations can be meaningfully involved. Also, in certain cases, the political instrumentalization of religion may hinder genuine work with Islamic environmental principles.

8.1 Conceptual Challenges

- Diversity in the Islamic tradition of interpretation
- Stress between the customary and modern usages
- Little contemporary jurisprudence over new energy technologies
- Rival hermeneutical methods of environmental texts

8.2 Institutional Limitations

- Isolation between the religious and environmental institutions
- The lack of environmental knowledge on the part of religious leaders
- Religious illiteracy among policy makers in the energy sector
- Divided forms of governance

8.3 Practical Constraints

- Economic forces that are favourable towards the traditional energy system
- Vested interests, political opposition
- Capability and constraint shortages

- Contextualised application gaps in knowledge

Practical limitations offer perhaps the most imminent obstacles to practice. The market systems and economic needs tend to encourage traditional energy growth without reference to the ethical aspect. The developing countries with Muslim majority populations are currently confronted by the pressing energy access needs that could privilege short-term solutions at the expense of long-term sustainability. The technical and financial resources available are limited to impose an alternative energy system, even when it is ethically desired. Moreover, strong vested interests in the existing systems of energy trade can be opposed to shifts that are made on a religious basis.

These challenges need to be taken seriously to come up with realistic means of incorporating Islamic environmental ethics in energy development. Instead of Islamic ethics being offered as a panacea, a more subtle approach would be to acknowledge the possible contributions as well as shortcomings of religious frameworks and to strive to remove the conceptual, institutional, and practical rigidities that prevent successful implementation.

9. PATHWAYS FOR INTEGRATION: POLICY RECOMMENDATIONS

The ideas of translating Islamic environmental ethics within the theoretical models to reality and practical energetic policies need special strategies and the involvement of various stakeholders and institutions (Afshar, 2020; Nasr, 1996). Concrete avenues of meaningful integration are offered by the following recommendations, which take cognisance of the potential contribution of Islamic ethics, as well as the realities of the energy governance challenges in the developing world (Al-Damkhi, 2008; Saniotis & Hossain, 2011). These suggestions run across educational, institutional, policy, and financial levels and provide a multidimensional approach to faith-informed sustainable energy development (Kamali, 2010).

9.1 Establish a Cross-disciplinary Knowledge Combination

Develop joint research programmes between Islamic scholars, environmental scientists, and energy experts to formulate contextually-specific understandings of Islamic environmental ethics to modern energy issues

(Afshar, 2020). Subsidise policy-relevant publications, which integrate religious and technical views, including, faith-based energy policy briefs and guidelines on implementation (UNEP, 2014).

9.2 Curricular Reform

Incorporate environmental ethics in Islamic studies programs in primary schools to the higher religious educational institutions (Kamali, 2010). At the same time, introduce culturally and religiously charged materials into engineering and energy studies programmes, creating a new kind of professional with interdisciplinary skills (Yucel, 2015).

Establish Institutional Coordination Mechanisms

Create institutional coordination mechanisms to ensure close collaboration of religious affairs ministries, energy departments, and environmental agencies to work out joint strategies (UNEP, 2014). Establish advisory councils of religious scholars, energy professionals, and community leaders to offer advice on developing faith-sensitive energy policies (Saniotis & Hossain, 2011).

9.3 Adopt Faith-Sensitive Energy policies

Work out national energy policies where the Islamic ethical considerations are expressly considered and factored into the policies. Devise certain policies to fit within certain ethical ideas like waste avoidance (isrāf) based energy conservation programmes or renewable energy programmes under the obligations of stewardship (khilāfah). (Kamali, 2010; Al-Damkhi, 2008).

Another very important channel of integration is through financial mechanisms. Islamic finance products hold enormous prospects in financing sustainable energy transitions in a manner that is deemed to religious values (Khan, 2019; Farooq, 2011). The green sukuk (Islamic bonds) have already proven to be viable in such countries as Malaysia and Indonesia, where they have been used to finance renewable energy projects, and at the same time, comply with the Islamic financial principles(Khan, 2019). A significant expansion of sustainable energy infrastructure investment may be achieved by

extending these instruments with national regulatory systems and multilateral collaboration.

9.4 Community Engagement

The community engagement plans must make use of the available religious systems and structures. The Mosques that act as a community centre in most Muslim societies can be used as a demonstration site of renewable energy and energy efficiency, and also used to educate people. Environmental training programmes of religious leaders would help in increasing the ability of the religious leaders in offering leadership that links spiritual values to real energy decisions (Yucel, 2015). Mosque-based solar cooperatives and other Faith-based community energy projects can show how Islamic ethics can be applied in practice and present a real community benefit (UNEP, 2014).

9.5 International Cooperation

The international cooperation systems must acknowledge and encourage the contribution of faith-based methods towards achieving global sustainability goals. The development agencies and multi-year institutions are encouraged to come up with faith-sensitive development programs that do not undermine religious values in the name of promoting technical solutions (UNEP, 2014). The South-South cooperation among the Muslim majority nations can help to share the best practices in terms of incorporating Islamic ethics into energy policies. Such collaborative solutions may overcome resource constraints in the process of constructing context-sensitive solutions.

CONCLUSION AND FUTURE RESEARCH DIRECTIONS

This chapter has been able to discuss the various aspects in which Islamic environmental ethics can be used to guide and change the development of sustainable energy in the developing world. This discussion shows that Islamic ethical concepts, such as *tawḥīd* (divine unity), *khilāfah* (stewardship), *mizan* (balance), *amanah* (trust), and *israf* (waste avoidance), provide powerful normative guides that can be used to make energy transitions more sustainable, just, and accountable. These virtues offer both theological incentives to act and

practical instructions on how to reform the governance of energy, energy-consuming habits, and technological preferences.

As can be seen in case studies of Pakistan, Indonesia, and Nigeria, an explicit inclusion of Islamic ethics in the national energy policies is still rather limited; however, new efforts at different levels are evidence of the increasingly broad awareness of the potential importance of religion in sustainable development. What these examples mostly point to are the difficulties and the possibilities of applying religious principles into practice to find a common solution to the energy issue, showing that the contextual factors and institutional settings matter most in defining the outcomes. The analysis also points to the idea that Islamic environmental ethics can usefully be incorporated into international sustainability agendas such as the SDGs, contributing some unique aspects alongside strengthening some common aims.

This analysis yields a number of fruitful suggestions as to future research. First, empirical research that focuses on the actual effect of Islamic environmental values on energy behaviours and policy preferences among Muslim people would be informative for more effective interventions. Second, further comparative studies examining the various ways in which Islamic schools of law and theologies treat energy-related matters may help to deepen appreciation of interpretive pluralism and its consequences. Third, developing and testing faith-based energy activities through action research might produce practical knowledge regarding effective implementation approaches. Fourth, interdisciplinary research at the nexus of Islamic finance instruments and sustainable energy investments may open up additional financing avenues to energy transitions.

The given research finally proposes that serious attention to religious ethics is not a marginal issue but rather a central aspect to the further progress of sustainable energy adoption in settings where faith tends to define worldviews and values. By acknowledging the unique values that Islamic environmental ethics has to offer and managing the shortcomings of integrating them, policymakers, religious leaders, and civil society representatives can create more locally resonant and successful strategies of energy transitions. Combining the spiritual wisdom with the modern sustainability issues not only

promises practical advantages, but also the prospect of more integrative development models, which respects human as well as ecological health.

Achieving the remotely possible futures of the energy systems that are sustainably green in Muslim majority developing nations will demand not just technological fixes and policy breakthroughs, but also ethical models that fancy cultural and religious preferences. Islamic environmental ethics do just that, they provide the inspiration and framework toward transformative change.

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CHAPTER 3

THE INTERPLAY OF FOREIGN DIRECT INVESTMENT AND RENEWABLE ENERGY IN ADVANCING GREEN DEVELOPMENT IN DEVELOPING COUNTRIES

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INTRODUCTION

[1]Climate change poses a significant threat to human survival and development, particularly for countries transitioning to a low-carbon economy. Governments around the world recognize the need to protect the environment and have agreed on how to address climate issues. [2]Developing countries face the challenging task of growing their economies, meeting their energy needs (Li et al., 2022), and reducing carbon emissions. These nations often have high [3]carbon emissions and use energy inefficiently, which makes it challenging for them to reduce their emissions. [4]Rapid industrial growth and urban expansion make it even more challenging to transition to cleaner energy, particularly in the face of ongoing environmental damage (Li et al., 2022). These countries rely heavily on agriculture and often lack robust public services, which leaves them vulnerable to the impacts of climate change. [5]Green development is a model that enables these countries to transition from high-carbon to low-carbon economies while still achieving their development objectives (Li et al., 2022). This approach can drive economic growth and support sustainable change, offering an alternative to traditional development that harms the environment. Finding practical ways for developing countries to achieve green development is vital for global climate action and achieving carbon neutrality. The importance of these global discussions on climate action cannot be overstated, as they engage and involve all stakeholders. (Li et al., 2022) [6]The renewable

[1] Research on supporting developing countries to achieve green development transition: Based on the perspective of renewable energy and foreign direct investment. Introduction. Paragraph 1st.

[2] Research on supporting developing countries to achieve green development transition: Based on the perspective of renewable energy and foreign direct investment. Introduction. Paragraph 1st.

[3] Research on supporting developing countries to achieve green development transition: Based on the perspective of renewable energy and foreign direct investment. Introduction. Paragraph 1st.

[4] Research on supporting developing countries to achieve green development transition: Based on the perspective of renewable energy and foreign direct investment. Introduction. Paragraph 1st.

[5] Research on supporting developing countries to achieve green development transition: Based on the perspective of renewable energy and foreign direct investment. Introduction. Paragraph 1st.

[6] Research on supporting developing countries to achieve green development transition: Based on the perspective of renewable energy and foreign direct investment. Introduction. Paragraph 2nd.

energy sector plays a significant role in economic development. Using renewable energy not only supports economic growth but also reduces carbon emissions and creates jobs (Li et al., 2022), aligning with the goals of green development. [7]Research indicates that the adoption of renewable energy can foster economic growth and is associated with increased funding for research and development. (Li et al., 2022) Many experts believe that developing renewable energy industries can lead to sustainable development and improve environmental health, particularly in [8]Africa. Renewable energy is better for economic growth than non-renewable energy, which tends to increase carbon emissions. However, the renewable energy sector faces [9]challenges such as high costs, stringent technology requirements, lengthy project timelines, and substantial initial investments (Li et al., 2022). [10]To attract significant investments, countries need stable regulations. [11]Developing nations often struggle with financing and technological development, which can hinder their economic growth. This study examines the impact of renewable energy on green development, particularly in developing countries, where most of the global energy demand growth is expected to occur. [12]Transitioning to renewable energy in these areas is crucial for reducing carbon emissions, but it presents significant challenges. [13]Developing countries face distinct challenges when it

[7] Research on supporting developing countries to achieve green development transition: Based on the perspective of renewable energy and foreign direct investment. Introduction. Paragraph 2nd.

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[12] Research on supporting developing countries to achieve green development transition: Based on the perspective of renewable energy and foreign direct investment. Introduction. Paragraph 3rd.

[13] Research on supporting developing countries to achieve green development transition: Based on the perspective of renewable energy and foreign direct investment. Introduction. Paragraph 3rd.

comes to investing in renewable energy. [14]Unlike high-income countries, they deal with market risks that drive up costs. [15]Key issues that limit the adoption of renewable energy include energy storage, infrastructure, and economic conditions (Li et al., 2022). The inconsistent supply of renewable energy can disrupt power grids without proper support. [16]High initial costs can deter investors, potentially impacting short-term economic growth. [17]Many developing nations lack the financial and technological resources necessary for implementing low-carbon projects, making external support crucial (Li et al., 2022). Despite these hurdles, [18]globalization has helped promote renewable energy and reduce greenhouse gas emissions. [19]Foreign direct investment (FDI) plays a crucial role in this context, aiding African countries in reducing carbon emissions; however, these countries require technological and skill support to effectively utilize their renewable resources. This study aims to investigate the relationship between Foreign Direct Investment (FDI), trade, and renewable industries (Li et al., 2022), as well as their impact on sustainable development[20] in developing countries. Research indicates that international investment can enhance environmental quality by facilitating the exchange of clean technologies and technologies that promote environmental sustainability. [21]However, some worry that FDI (Li et al., 2022) might lead to lower environmental standards. While FDI can contribute to pollution transfer, it also gives low-income countries access to critical management knowledge and

[14] Research on supporting developing countries to achieve green development transition: Based on the perspective of renewable energy and foreign direct investment. Introduction. Paragraph 3rd.
[15] Research on supporting developing countries to achieve green development transition: Based on the perspective of renewable energy and foreign direct investment. Introduction. Paragraph 3rd.
[16] Research on supporting developing countries to achieve green development transition: Based on the perspective of renewable energy and foreign direct investment. Introduction. Paragraph 3rd.
[17] Research on supporting developing countries to achieve green development transition: Based on the perspective of renewable energy and foreign direct investment. Introduction. Paragraph 3rd.
[18] Research on supporting developing countries to achieve green development transition: Based on the perspective of renewable energy and foreign direct investment. Introduction. Paragraph 3rd.
[19] Research on supporting developing countries to achieve green development transition: Based on the perspective of renewable energy and foreign direct investment. Introduction. Paragraph 3rd.
[20] Research on supporting developing countries to achieve green development transition: Based on the perspective of renewable energy and foreign direct investment. Introduction. Paragraph 4th.
[21] Research on supporting developing countries to achieve green development transition: Based on the perspective of renewable energy and foreign direct investment. Introduction. Paragraph 4th.

technology. [22]The impact of FDI (Li et al., 2022) on ecological quality can vary depending on a country's economic growth, industrial structure, and regulatory framework. [23]At COP26 (Li et al., 2022), developing nations stressed the importance of timely international financial support. While many studies have examined the environmental effects of Foreign Direct Investment (FDI), few have investigated how it promotes [24]green development (Li et al., 2022). This study examines how Foreign Direct Investment (FDI) supports green development (Li et al., 2022), which encompasses economic growth, environmental protection, and resource conservation, with a focus on low-carbon technologies. Researchers have studied various aspects of green development, including sustainable growth and the green economy, and many attempts have been made to measure it scientifically. [25]Key factors influencing green development are economic openness, industrial structure, energy consumption, urbanization, spending policies, technological innovation, and environmental regulations (Li et al., 2022).

1. LITERATURE REVIEW

The convergence of foreign direct investment (FDI) and renewable energy sources is essential for driving sustainable development in developing nations. As these countries strive for economic growth, the challenge lies in striking a balance between energy demand and environmental preservation. This literature review examines the relationship between Foreign Direct Investment (FDI) and renewable energy, highlighting their roles in promoting sustainable development. By examining various narratives and studies, this review aims to identify the pathways through which Foreign Direct Investment (FDI) can effectively contribute to the adoption of renewable energy technologies in developing countries. FDI involves investments made by a company or individual in one country in business interests in another country.

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[22] Research on supporting developing countries to achieve green development transition: Based on the perspective of renewable energy and foreign direct investment. Introduction. Paragraph 4th.
[23] Research on supporting developing countries to achieve green development transition: Based on the perspective of renewable energy and foreign direct investment. Introduction. Paragraph 4th.
[24] Research on supporting developing countries to achieve green development transition: Based on the perspective of renewable energy and foreign direct investment. Introduction. Paragraph 4th.
[25] Research on supporting developing countries to achieve green development transition: Based on the perspective of renewable energy and foreign direct investment. Introduction. Paragraph 5th.

It is a critical engine for economic growth, particularly in developing nations that require massive capital inflow to improve infrastructure, technology, and services.

There are two primary types of FDI: greenfield investments, where a new operation is established, and mergers or acquisitions, where foreign entities purchase existing companies. Each type has its implications for economic development and technology transfer. Foreign Direct Investment (FDI) can stimulate the local economy by creating jobs, enhancing technology transfer, and fostering competitiveness. However, it may also bring challenges, including profit repatriation, dependence on foreign entities, and potential neglect of local needs. Renewable energy sources, including solar, wind, hydro, and geothermal, are crucial for sustainable development. They offer the potential to reduce dependence on fossil fuels, decrease greenhouse gas emissions, and enhance energy security. Developing countries often face significant barriers, including a lack of infrastructure, limited access to technology, and financial constraints, which hinder the adoption of renewable energy sources. Effective policies are necessary to create a conducive environment for the development of renewable energy. Governments play a crucial role in incentivizing investments through subsidies, tax incentives, and regulatory frameworks that support renewable energy projects. Research suggests that Foreign Direct Investment (FDI) can play a crucial role in accelerating the transition to renewable energy in developing countries. Foreign Direct Investment (FDI) often facilitates technology transfer, enabling developing countries to access advanced renewable energy technologies. This transfer can take various forms, including joint ventures, partnerships, and collaborations, which also serve to build local capacity. The influx of FDI provides the necessary capital for renewable energy projects, which are often capital-intensive. Innovative financing mechanisms, such as green bonds and blended financing, can effectively leverage Foreign Direct Investment (FDI) to fund renewable projects. Several developing countries have successfully integrated foreign direct investment (FDI) into their renewable energy sectors, resulting in notable achievements in green development. India has emerged as a global leader in solar energy production, largely driven by foreign direct investment (FDI) in the renewable sector. Government policies encouraging

solar investments, combined with private sector engagement, have resulted in significant capacity growth. Kenya has attracted substantial foreign direct investment (FDI) in renewable energy, particularly in wind and geothermal energy. The government's commitment to renewable energy, coupled with favourable investment conditions, has led to impressive advancements in green energy infrastructure. Despite the positive narratives surrounding FDI and renewable energy, substantial challenges and resistance can impede progress. In some cases, local communities resist FDI projects due to concerns over displacement, environmental degradation, and lack of inclusion in decision-making processes. Ensuring that local voices are considered in planning and execution is crucial to gaining public support. Political instability and economic uncertainty can deter foreign investors. Building a stable and predictable investment climate is crucial for attracting and retaining Foreign Direct Investment (FDI) in renewable energy projects. Looking ahead, it is crucial for developing countries to foster an environment that is conducive to Foreign Direct Investment (FDI) in renewable energy. Developing clear and supportive regulatory frameworks will help streamline the investment process and attract foreign direct investment (FDI). This includes creating transparent policies, efficient permitting processes, and providing consistent incentives for renewable energy projects. Encouraging collaboration between governments and the private sector can further enhance the viability of renewable energy investments. Public-private partnerships can leverage resources and expertise to realize large-scale renewable energy projects. The interplay between foreign direct investment and renewable energy presents a significant opportunity for advancing green development in developing countries. By fostering supportive policies, enhancing local capacities, and ensuring community engagement, nations can unlock the full potential of FDI in the renewable energy sector.

The ultimate goal of this literature review is to underscore the importance of strategic investments in renewable energy, thereby facilitating sustainable economic growth while addressing pressing environmental challenges. The narratives explored herein not only highlight successful case studies but also draw attention to the challenges that must be navigated to achieve a truly sustainable energy future. Moving forward, it is imperative to integrate lessons

learned to craft a shared vision for a greener, more sustainable world and to remain determined and committed to overcoming the challenges that lie ahead.

2. METHODOLOGY

The methodology employed in this literature review involves a comprehensive and systematic examination of the extensive body of research and scholarly narratives that explore the intricate relationship between Foreign Direct Investment (FDI) and renewable energy in developing nations. The review begins with the careful identification of essential themes and concepts closely tied to FDI, various renewable energy sources, and their pivotal roles in advancing sustainable development pathways. This review comprises several sequential steps, beginning with a thorough literature search to locate relevant academic articles, government reports, and case studies that highlight the multifaceted impact of FDI on the proliferation and adoption of renewable energy technologies. The selection of sources is guided by criteria that prioritize relevance, credibility, and significant contributions to the understanding of how FDI can effectively facilitate technology transfer while enhancing local capacities to engage with and implement renewable energy solutions. Data collection is meticulously structured to encompass both quantitative and qualitative dimensions of FDI in the renewable energy sector. It considers various types of investment activities, including greenfield projects—where new facilities are built from scratch—and mergers and acquisitions that may lead to the sharing of expertise and resources. The analysis also evaluates the numerous barriers that developing countries encounter in their efforts to harness renewable energy. These barriers include limited infrastructure, inadequate financial support, regulatory challenges, and societal resistance, which can hinder the transition to sustainable energy practices.

The organization of the collected data highlights successful case studies of Foreign Direct Investment (FDI) in renewable energy, with a particular focus on the experiences of countries such as India and Kenya. These examples demonstrate how Foreign Direct Investment (FDI) can stimulate the development of renewable energy sectors, ultimately leading to improved energy security and sustainability. In addition to documenting these success stories, the methodology emphasizes the importance of identifying and

analyzing effective policy measures that can create a favourable investment climate. Such measures may include financial incentives, such as subsidies and tax breaks, as well as a well-structured regulatory framework, collectively contributing to the mitigation of risks associated with investment in renewable energy projects. Ultimately, this literature review aims to synthesize the findings in a manner that allows for the articulation of actionable recommendations tailored to the unique contexts of developing countries.

These recommendations aim to enhance the capacity of these nations to attract and retain Foreign Direct Investment (FDI) in renewable energy projects, thereby promoting broader goals of sustainable development and energy independence. The overarching goal is to provide policymakers with valuable insights that can help cultivate an investment-friendly atmosphere, encouraging the integration of renewable energy sources into their national energy portfolios.

3. RESULTS

The convergence of foreign direct investment (FDI) and renewable energy sources plays a crucial role in fostering sustainable development in developing nations. This literature review has yielded important insights into the relationship between Foreign Direct Investment (FDI) and renewable energy, highlighting their significant contributions to sustainable growth. Key findings from this examination include the role of FDI in driving economic growth and infrastructure development, serving as a critical engine for economic growth in developing countries. This role provides essential capital for infrastructure improvements, technology upgrades, and enhanced services. Types of FDI and Their Impacts through which the study differentiated between greenfield investments, where new operations are established, and mergers or acquisitions, where existing companies are purchased. Both types can have a significant impact on local economies and the technology transfer process. Job Creation and Competitiveness Are Key Areas through which FDI can stimulate local economies by creating jobs, facilitating technology transfer, and promoting competitiveness. However, challenges like profit repatriation and dependence on foreign entities pose potential drawbacks.

Barriers to Renewable Energy Adoption: Developing countries face various obstacles, including inadequate infrastructure, limited access to technology, and financial constraints, which hinder the adoption of renewable energy sources. The Role of Government Policies: Effective government policies are crucial in incentivizing investments through subsidies, tax incentives, and regulatory frameworks that support renewable energy projects. Strong governmental support is critical in creating an environment conducive to Foreign Direct Investment (FDI) in this sector.

Technology Transfer Mechanisms through which FDI facilitates technology transfer to developing nations through joint ventures, partnerships, and collaborations, which also contribute to building local capacity. Innovative Financing Mechanisms through which the influx of FDI provides necessary capital for financing renewable energy projects. New financing mechanisms, such as green bonds and blended financing, can effectively leverage Foreign Direct Investment (FDI) to advance these projects. Case Studies of Success, through which Countries such as India and Kenya have demonstrated success in integrating FDI into their renewable energy sectors. India has become a global leader in solar energy, while Kenya has made significant strides in wind and geothermal energy investments. Community Resistance and Inclusion, which highlights how local community resistance can impede FDI projects due to concerns over displacement and environmental impact, underscores the need for inclusion in decision-making processes to garner public support.

Political stability is a factor that mitigates the significant deterrents presented by political instability and economic uncertainty to foreign investors. A stable and predictable investment climate is crucial for attracting and retaining foreign direct investment (FDI) in renewable energy projects. Looking forward, developing countries are encouraged to establish supportive regulatory frameworks that streamline the investment process, fostering collaboration between governments and the private sector to enhance the viability of renewable energy investments. Public-private partnerships can unlock the resources and expertise needed to achieve large-scale renewable energy projects. The synergy between foreign direct investment and renewable energy thus presents significant opportunities for sustainable development in developing nations.

4. DISCUSSION

In an increasingly interconnected world, industries are becoming more reliant on internationalization and foreign direct investment (FDI) (Stöbich, 2017), not just in traditional sectors such as mining and manufacturing but also in renewable energy, which now accounts for over 20% (Stöbich, 2017) of global energy consumption. Despite higher costs associated with renewables compared to fossil fuels, the shift toward clean energy is gaining momentum due to [26]government climate policies aimed at combating climate change and a growing consumer preference for sustainability. [27]However, the economic impact of FDI is complex and varies significantly. (Stöbich, 2017) While FDI has the potential to boost a host country's income, fund infrastructure, and generate technology spillovers, it can also lead to profit repatriation, labour exploitation, and crowding out local businesses (Stöbich, 2017). [28]The belief that FDI automatically increases GDP is misleading, especially in developing countries, where factors such as corruption and weak governance can hinder the benefits. [F]oreign Direct Investment (FDI) is influenced by investor motives, investment types, and varying environments, making the outcomes more complex.

Ultimately, while FDI can enhance GDP under favourable circumstances, this is not guaranteed (Stöbich, 2017). [29]The impact of FDI in developing countries is complex and multifaceted. While FDI is often associated with positive outcomes such as knowledge and technology spillovers, it is crucial to consider both its benefits and drawbacks (Stöbich, 2017). To analyze these impacts, one must first understand [30]the historical context and mechanisms of FDI in developing regions, as well as their connection to internationalization and globalization.

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[26] Foreign Direct Investment in Renewable Energy in Developing Countries. Introduction. Background. Paragraph 2nd. p1

[27] Foreign Direct Investment in Renewable Energy in Developing Countries. Introduction. Background. Paragraph 3rd. p1

[28] Foreign Direct Investment in Renewable Energy in Developing Countries. Introduction. Background. Paragraph 6th. p2

[29] Foreign Direct Investment in Renewable Energy in Developing Countries. The Impact of Foreign Direct Investment in Developing Countries. Paragraph 1st. p6.

[30] Foreign Direct Investment in Renewable Energy in Developing Countries. The Impact of Foreign Direct Investment in Developing Countries. Paragraph 1st. p6.

[31]Over the past few decades, foreign direct investment (FDI) in developing countries has grown steadily. Understanding its popularity involves recognizing it as a product of increasing [32]internationalization and globalization. (Stöbich, 2017) Internationalization refers to the heightened involvement in international operations and the pursuit of opportunities abroad. Key to this discussion is [33]Dunning's Eclectic Paradigm, which connects internationalization to the rise of Foreign Direct Investment (FDI). [34]Historically, theories of internationalization can be traced back to the early 1800s, with Adam Smith's concept of 'Absolute Cost Advantage,' asserting that countries should specialize and export based on production efficiency. David Ricardo later introduced the 'Comparative Cost Advantage' (Stöbich, 2017), emphasizing that productivity differences between countries drive internationalization. [35]Building on this, Heckscher and Ohlin showed that productivity differences arise from factor endowments, leading to the 'Heckscher-Ohlin Theorem' (Stöbich, 2017), which posits that countries export goods they can produce easily due to abundant resources and import those that are scarce. [36]Despite the lack of a common framework for Foreign Direct Investment (FDI) in developing countries, the increase in FDI in these economies is apparent. [37]In 2014, FDI inflows to developing regions peaked at 53.2% of global flows, surpassing developed economies for the first time.[38]However, this figure dropped to 37.0% in 2016 despite stable investments. Although developed countries currently attract more foreign direct investment (FDI), developing countries still play a significant role as recipients

[31] Foreign Direct Investment in Renewable Energy in Developing Countries. Historical Roots – Internationalization & Global Integration of FDI. Paragraph 1st. p7.
[32] Foreign Direct Investment in Renewable Energy in Developing Countries. Historical Roots – Internationalization & Global Integration of FDI. Paragraph 1st. p7.
[33] Foreign Direct Investment in Renewable Energy in Developing Countries. Historical Roots – Internationalization & Global Integration of FDI. Paragraph 2nd. p7.
[34] Foreign Direct Investment in Renewable Energy in Developing Countries. Historical Roots – Internationalization & Global Integration of FDI. Paragraph 2nd. p7.
[35] Foreign Direct Investment in Renewable Energy in Developing Countries. Historical Roots – Internationalization & Global Integration of FDI. Paragraph 2nd. p7.
[36] Foreign Direct Investment in Renewable Energy in Developing Countries. Foreign Direct Investment in Developing Countries. Paragraph 1st. p13.
[37] Foreign Direct Investment in Renewable Energy in Developing Countries. Foreign Direct Investment in Developing Countries. Paragraph 1st. p13.
[38] Foreign Direct Investment in Renewable Energy in Developing Countries. Foreign Direct Investment in Developing Countries. Paragraph 1st. p13.

(Stöbich, 2017). Foreign investments continue to be essential for these nations to gather the financial resources needed for economic growth and poverty reduction. [39]According to the OECD, FDI is characterized by cross-border investment that establishes a lasting relationship between the investor and the enterprise, which differs from portfolio investments that do not aim to influence the enterprise's operations. Foreign direct investment (FDI) in developing countries encompasses mergers and acquisitions, greenfield investments, and capital restructuring. The impact of various investment types hinges on their objectives. Mergers and acquisitions (M&A) focus on the transfer of existing equity, while greenfield investments, capital extensions, and financial restructuring introduce new capital into the host economy (OECD, 2008).

The latter generally benefits the investor enterprise, whereas M&A is often seen as less beneficial for economic development, a view supported by several authors (Stöbich, 2017). [40]All these investment types originate from foreign investors, predominantly transnational corporations (TNCs) and multinational companies (MNCs). (Stöbich, 2017) Unlike MNCs, which have limited coordination of their activities abroad, TNCs actively operate across multiple countries with at least a 10% equity stake in a foreign enterprise (Stöbich, 2017). TNC involvement can be gauged by structural, performance, and attitudinal indicators. [41]TNCs began establishing branch plants in developing countries during the early 1950s due to import substitution industrialization policies. However, many faced [42]nationalization during this period, especially in the mining sector. In contrast, manufacturing firms often enjoyed increased international involvement due to their association with long-term benefits, such as reduced unemployment and poverty. [43]The 1970s saw declining tariff barriers, driven by global integration and the need for foreign capital. Consequently, as noted by Stöbich (2017), the influence of TNCs grew,

[39] Foreign Direct Investment in Renewable Energy in Developing Countries. Foreign Direct Investment in Developing Countries. Paragraph 2nd. p13.
[40] Foreign Direct Investment in Renewable Energy in Developing Countries. Foreign Direct Investment in Developing Countries. Paragraph 5th. p14.
[41] Foreign Direct Investment in Renewable Energy in Developing Countries. Foreign Direct Investment in Developing Countries. Paragraph 6th. p15.
[42] Foreign Direct Investment in Renewable Energy in Developing Countries. Foreign Direct Investment in Developing Countries. Paragraph 6th. p15.
[43] Foreign Direct Investment in Renewable Energy in Developing Countries. Foreign Direct Investment in Developing Countries. Paragraph 7th. p15.

leading some developing nations to regulate their power to protect domestic interests, thereby giving rise to the concept of the developmental state. Authors such as Leftwich (1995) have discussed the concept of developmental states in East and Southeast Asia (e.g., China, India, Singapore, South Korea, and Thailand), where decisive government intervention and regulation of TNCs' FDI have led to significant economic growth (Stöbich, 2017). [44]These states established backward linkages—investments in sectors that supply domestic activities—which further promoted growth, as highlighted by [45]Hirschman (1958). [46]In contrast, non-developmental states adopted a passive approach, resulting in "thin globalization" (Stöbich, 2017). characterized by weak linkages where foreign investments inflate exports without benefiting the local economy, as seen in [47]Latin America. China has been the leading recipient of FDI, accounting for over 20% of the total inflows in 2016, with Asia as a whole receiving 68.5% of the FDI that year. [48]Hong Kong, Singapore, Brazil, and India followed as significant recipients. [49]China also led FDI outflows, joined by Hong Kong and Singapore, while South Korea, Taiwan, Thailand, and Angola made notable contributions. While East and Southeast Asia effectively attract foreign direct investment (FDI), the challenge remains whether these inflows truly contribute to growth and development, necessitating an assessment of their positive and negative impacts (Stöbich, 2017). [50]Increasing private investment is essential for addressing the energy needs of developing countries and achieving the Sustainable Development Goals (SDGs). Foreign direct investment (FDI) plays a crucial role in bridging financing gaps and facilitating the transfer of knowledge and technology (Enabling Foreign Direct

[44] Foreign Direct Investment in Renewable Energy in Developing Countries. Foreign Direct Investment in Developing Countries. Paragraph 7th. p16.
[45] Foreign Direct Investment in Renewable Energy in Developing Countries. Foreign Direct Investment in Developing Countries. Paragraph 7th. p16.
[46] Foreign Direct Investment in Renewable Energy in Developing Countries. Foreign Direct Investment in Developing Countries. Paragraph 7th. p16.
[47] Foreign Direct Investment in Renewable Energy in Developing Countries. Foreign Direct Investment in Developing Countries. Paragraph 8th. p16.
[48] Foreign Direct Investment in Renewable Energy in Developing Countries. Foreign Direct Investment in Developing Countries. Paragraph 8th. p16.
[49] Foreign Direct Investment in Renewable Energy in Developing Countries. Foreign Direct Investment in Developing Countries. Paragraph 8th. p16.
[50] Enabling Foreign Direct Investment in the Renewable Energy Sector. Executive Summary. Paragraph 1st.

Investment in the Renewable Energy Sector, 2023). However, political risks, particularly regulatory risks, can hinder a country's ability to attract and retain foreign direct investment (FDI), leading to costly legal disputes between investors and host states. (Enabling Foreign Direct Investment in the Renewable Energy Sector, 2023) The study examines these risks in the renewable energy sector, focusing on investor-state disputes, their fiscal and reputational implications, and policy options for governments to mitigate them. [51]With 774 million people lacking access to electricity, primarily in Africa and Asia, it is vital to enhance private sector investment to meet infrastructure needs. [52]The ongoing energy crisis has increased this number by 20 million since 2021. [53]By 2030, an estimated 663 million people may still be without access to electricity. [54]Electricity demand has risen steadily and is expected to double by 2050, while renewables currently cover only 33% of this demand. [55]To meet the Paris Agreement commitments and achieve net-zero emissions, a greater share of renewables in electricity generation is essential. [56]The recent war in Ukraine has further disrupted energy markets, affecting prices for consumers and businesses.

The effects of short-term shocks underscore the urgent need for increased investments in renewable energy and energy efficiency to achieve net-zero goals (Enabling Foreign Direct Investment in the Renewable Energy Sector, 2023). [57]The share of renewables in global electricity generation is expected to rise from 28% in 2021 to 61% in 2030 and 88% by 2050 (IEA, 2022d). [58]Developing countries will require significant investments, increasing average

[51] Enabling Foreign Direct Investment in the Renewable Energy Sector. Executive Summary. Paragraph 2nd.
[52] Enabling Foreign Direct Investment in the Renewable Energy Sector. Executive Summary. Paragraph 2nd.
[53] Enabling Foreign Direct Investment in the Renewable Energy Sector. Executive Summary. Paragraph 2nd.
[54] Enabling Foreign Direct Investment in the Renewable Energy Sector. Executive Summary. Paragraph 2nd.
[55] Enabling Foreign Direct Investment in the Renewable Energy Sector. Executive Summary. Paragraph 2nd.
[56] Enabling Foreign Direct Investment in the Renewable Energy Sector. Executive Summary. Paragraph 3rd.
[57] Enabling Foreign Direct Investment in the Renewable Energy Sector. Executive Summary. Paragraph 3rd.
[58] Enabling Foreign Direct Investment in the Renewable Energy Sector. Executive Summary. Paragraph 3rd.

annual funding for renewables from $390 billion (2016-2022) to $1,300 billion by 2030. Both public and private capital, particularly from foreign direct investment (FDI), will be crucial. [59]Between 2013 and 2021, over $2.9 trillion was invested in renewables, with Asia and Oceania accounting for a larger share. [60]Approximately 86% of these investments originate from the private sector, with the public sector playing a relatively limited role. Despite initial high costs, the long-term operating expenses are lower, leading to greater private sector involvement in large renewable projects. [61]In 2019, more than 50% of global investment projects were in renewable energy, with foreign direct investment (FDI) constituting over 70% in developing and transition economies. Although COVID-19 impacted investments globally, renewable projects showed resilience. Attracting Foreign Direct Investment (FDI) is challenging due to high initial costs and limited working capital, necessitating long-term contracts to mitigate risks, particularly in the solar and wind sectors. Some governments face difficulties due to locked-in contracts with high rates amid decreasing renewable energy costs (Enabling Foreign Direct Investment in the Renewable Energy Sector, 2023).

Evidence suggests that political risk can significantly impact foreign direct investment (FDI), particularly in sectors with high state intervention, such as utilities and renewable energy. These risks may lead to project cancellations, investment withdrawals, or disputes with host countries. To sustain FDI in renewable energy, effective strategies are necessary to minimize risks. These include creating incentive structures, such as auctions and feed-in tariffs, as well as employing risk mitigation measures, including the use of joint ventures and hiring local workers (Enabling Foreign Direct Investment in the Renewable Energy Sector, 2023). [62]Political risk insurance is also a key proactive tactic. [63]Despite these measures, disputes between investors and host

[59] Enabling Foreign Direct Investment in the Renewable Energy Sector. Executive Summary. Paragraph 4th.
[60] Enabling Foreign Direct Investment in the Renewable Energy Sector. Executive Summary. Paragraph 4th.
[61] Enabling Foreign Direct Investment in the Renewable Energy Sector. Executive Summary. Paragraph 4th.
[62] Enabling Foreign Direct Investment in the Renewable Energy Sector. Executive Summary. Paragraph 5th.
[63] Enabling Foreign Direct Investment in the Renewable Energy Sector. Executive Summary. Paragraph 7th.

countries can still arise, with a notable number being arbitrated, particularly in Western Europe, Eastern Europe, and Central Asia. Solar power generation has the highest incidence of such disputes, followed by hydropower and wind energy. The study highlights that the primary political risk in proceedings is adverse regulatory changes, with 26 types identified (Enabling Foreign Direct Investment in the Renewable Energy Sector, 2023). Most proceedings arise from bilateral or multilateral investment treaties, and nearly half are still pending.

The leading protections invoked are fair and equitable treatment and protection against unreasonable or discriminatory measures. While there are no specific mechanisms to prevent investor-state disputes in the renewable energy sector, legal instruments at international, national, and contractual levels can help manage conflicts (Enabling Foreign Direct Investment in the Renewable Energy Sector, 2023). [64]For example, international investment agreements (IIAs) often include "cooling-off"[65] periods and grievance management mechanisms.

However, given the specialized nature of renewable energy transactions, more targeted efforts are necessary to prevent disputes, such as enhancing regulatory measures and implementing institutional initiatives for addressing grievances. [66]Countries can adopt good practices, such as transparent rulemaking and impact assessments, to minimize conflicts and promote effective governance. Effective grievance mechanisms require a lead agency with political backing, a legal mandate, and technical expertise supported by clear procedures and regular evaluations. This mechanism can be implemented sector-wide or through standard contracts between investors and public agencies. Meeting COP28 goals necessitates a significant increase in clean energy investment by 2030 (Jaumotte et al., 2024), especially in emerging markets and developing economies (EMDEs). Foreign direct investment (FDI) can help close the renewable energy investment gap amid domestic financial

[64] Enabling Foreign Direct Investment in the Renewable Energy Sector. Executive Summary. Paragraph 8th.
[65] Enabling Foreign Direct Investment in the Renewable Energy Sector. Executive Summary. Paragraph 8th.
[66] Enabling Foreign Direct Investment in the Renewable Energy Sector. Executive Summary. Paragraph 9th.

constraints. Strengthening climate policies is critical, as it boosts Foreign Direct Investment (FDI) (Jaumotte et al., 2024) into renewable energy, particularly in countries with high solar potential. Closing the climate policy gap with advanced economies could secure 40% of the private finance needed for renewable investments in EMDEs (Jaumotte et al., 2024). Improving the macro-structural framework, including trade openness and institutional quality, can further enhance green FDI inflows. Successful case studies demonstrate that attracting Foreign Direct Investment (FDI) in renewable energy necessitates diverse policies, including power-purchase agreements and renewable energy targets. In contrast, FDI in electric vehicles is supported by national strategies and subsidies (Jaumotte et al., 2024). Comprehensive hydrogen strategies that align with international efforts also drive the development of green hydrogen. Foreign Direct Investment (FDI) is gaining momentum, particularly due to initiatives like the Just Energy Transition Partnerships and the European Union's strategy for promoting green hydrogen (Jaumotte et al., 2024).

These initiatives are crucial as they aim to mobilize the substantial investment required for sustainable energy projects worldwide. According to the World Economic Forum (Botwright et al., 2023), it is widely acknowledged that substantial and urgent levels of climate finance are necessary to address the multifaceted challenges posed by climate change. During last year's United Nations climate summit, COP27 (Botwright et al., 2023), it was acknowledged that annual investments ranging from $4 to $6 trillion are essential for facilitating a global shift toward a low-carbon economy (Botwright et al., 2023). This transformation is not merely desirable but imperative for mitigating the worst consequences of climate change and ensuring a sustainable future. Developing countries face an acute financial challenge. They require approximately $5.8 to $5.9 trillion to fulfill their climate commitments before 2030 (Botwright et al., 2023).

These nations are often disproportionately affected by climate impacts, which exacerbates their vulnerabilities. Consequently, they not only need financing to meet their climate goals but also have an urgent need to secure additional funds for adaptation measures. As climate impacts continue to escalate, the urgency for a concerted financial response from the global

community remains critical for both mitigation and adaptation efforts (Botwright et al., 2023).

[67]The Sustainable Development Goals highlight the urgent social, environmental, and climate-related challenges we face, requiring collaborative action on issues such as access to food, water, energy, housing, healthcare, and employment opportunities. Addressing these challenges also involves managing climate change, preserving biodiversity, and restoring ecosystems. Engaging economic actors is crucial for leveraging the private sector in developing innovative solutions. [68]Estimates suggest developing countries need US$3.3-4.5 trillion per year, facing a funding gap of approximately US$2.5 trillion annually. [69]Foreign direct investment (FDI) plays a crucial role in financing development and has significant social and environmental impacts. Efforts to define and measure the contributions of Foreign Direct Investment (FDI) are crucial for promoting a green and inclusive economy. [70]The term "green FDI" has gained traction to identify investments that advance environmental goals.

The study specifically focuses on green Foreign Direct Investment (FDI), discussing its definition and how various stakeholders can promote it, particularly in developing countries. It begins with an overview of FDI's nature, magnitude, and relationship with sustainable development objectives. [71]A country's growth and development can be assessed through its Gross Domestic Product (GDP), which represents the total monetary value of goods and services produced within a country in a given year. Essentially, a higher GDP indicates greater economic activity, meaning more production, earnings, consumption, and spending. Countries with higher GDPs are considered developed, while those with lower GDPs are classified as developing or underdeveloped.

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[67] Green Foreign Direct Investment in Developing countries Introduction: The role of Foreign Direct Investment in Financing Sustainable Development. Paragraph 1st.
[68] Green Foreign Direct Investment in Developing countries Introduction: The role of Foreign Direct Investment in Financing Sustainable Development. Paragraph 2nd.
[69] Green Foreign Direct Investment in Developing countries Introduction: The role of Foreign Direct Investment in Financing Sustainable Development. Paragraph 3rd.
[70] Green Foreign Direct Investment in Developing countries Introduction: The role of Foreign Direct Investment in Financing Sustainable Development. Paragraph 4th.
[71] Interplay of Foreign Direct Investment, Remittances, and Economic Growth: Insights from SAARC Countries. Introduction. Paragraph 1st.

[72]According to the World Bank, the GDP of the top six countries—the United States, China, Japan, Germany, the United Kingdom, and India—ranges from $20.89 trillion to $2.66 trillion. [73]In contrast, the GDPs of Bangladesh, Bhutan, Nepal, Pakistan, Sri Lanka, the Maldives, and Afghanistan are significantly lower, illustrating a stark economic divide. In recent decades, remittances from developed to developing countries have surged and become a crucial source of foreign currency, even surpassing exports and foreign direct investment (FDI). Policymakers often view remittances as a vital means of stimulating investment and consumption in these nations (Timsal & Safdar, 2024).

CONCLUSION

Over the past few decades, Foreign Direct Investment (FDI) has become a fundamental component of the economic landscape in developing countries, profoundly shaping growth trajectories and investment patterns. This essay explores the various factors driving the increasing appeal of Foreign Direct Investment (FDI), situates the discussion within the broader framework of globalization and internationalization, and highlights the numerous opportunities and challenges it presents to host nations. Therefore, the essay explores how the evolution of internationalization theories can be traced back to the early 1800s, beginning with the seminal works of Adam Smith, who introduced the concept of 'Absolute Cost Advantage,' and David Ricardo, who expanded on this idea with his theory of 'Comparative Cost Advantage.' These foundational theories provided a crucial framework for understanding the motivations behind countries' engagement in trade and foreign investment, focusing on their unique production efficiencies and resource endowments. For instance, Smith posited that nations should specialize in producing goods where they hold an absolute advantage. At the same time, Ricardo highlighted the benefits of countries specializing in goods for which they hold a comparative advantage, regardless of overall productivity. Building on these principles, John Dunning developed his eclectic paradigm, which connects the motivations for internationalization to the dynamics of foreign direct investment (FDI).

[72] Interplay of Foreign Direct Investment, Remittances, and Economic Growth: Insights from SAARC Countries. Introduction. Paragraph 2nd.
[73] Interplay of Foreign Direct Investment, Remittances, and Economic Growth: Insights from SAARC Countries. Introduction. Paragraph 2nd.

Dunning emphasized three critical advantages—ownership, location, and internalization—that multinational enterprises (MNEs) leverage to compete effectively in the global market. These advantages enable firms to optimize their operations, capitalize on local market conditions, and minimize transaction costs, thereby facilitating successful foreign investment endeavours. Notably, FDI inflows to developing countries have reached remarkable heights, accounting for over 53% of total global flows. This shift underscores growing investor confidence and the growing appeal of emerging markets despite fluctuations in investment patterns persisting.

This essay distinguishes between various types of Foreign Direct Investment (FDI), including mergers and acquisitions (M&A) and greenfield investments. M&A typically focus on the acquisition of existing assets and companies, providing instant access to established markets and resources. In contrast, greenfield investments entail the establishment of new operations and facilities, injecting fresh capital and capabilities into host economies.

While both forms can spur economic growth, their implications for local development vary, necessitating a deeper examination of their effects on employment, technology transfer, and overall economic infrastructure. Transnational corporations (TNCs) and multinational corporations (MNCs) play a crucial role in the foreign direct investment (FDI) landscape. Their operational strategies and approaches can have a significant impact on local economies, resulting in varied outcomes. In some cases, FDI can yield beneficial outcomes, including job creation, technology transfer, and skills development; however, these advantages are not uniformly distributed across all sectors.

The involvement of developmental states, particularly in regions such as East and Southeast Asia, further illustrates how proactive government intervention can facilitate successful foreign direct investment (FDI). These nations have implemented policies that create conducive environments for foreign investments, which in turn foster economic growth and societal advancement. Conversely, countries characterized as non-developed states often witness less advantageous outcomes from foreign investments, leading to questions about the effectiveness of FDI in those contexts. The essay also highlights regional variations in FDI trends, with China standing out as a

leading recipient of foreign investments. This phenomenon underscores not only the phenomenal scale of investment flowing into the country but also the strategic significance of various host countries in the global economy. While the influx of FDI presents potential pathways for growth, critical questions remain regarding the tangible benefits conferred upon local economies. In regions where there are weak linkages between foreign direct investment (FDI) and local development, the anticipated outcomes of foreign investments can be underwhelming.

Thus, the pressing question arises: Do foreign direct investments genuinely contribute to economic growth in developing countries? Research indicates that FDI can indeed play a significant role in bolstering economic growth; however, the degree of this contribution is contingent upon various factors, including the nature of the investment, the regulatory framework in place, and the prevailing economic conditions of the host nation. Developing countries that strategically regulate and nurture constructive relationships with TNCs often experience more substantial economic benefits from FDI. In contrast, those lacking robust frameworks may find that investments do not integrate meaningfully with local economies, ultimately leading to limited positive outcomes. While FDI is a critical mechanism for capital influx, economic advancement, and poverty alleviation in developing countries, the effectiveness of these investments is highly dependent on a collaborative approach between foreign investors and local governments. A nuanced understanding of internationalization theories, combined with strategic governmental intervention, will be essential to ensuring that foreign investments yield meaningful, long-term benefits for host economies and contribute to sustainable growth.

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CHAPTER 4

THE NEXUS BETWEEN ENERGY CONSUMPTION AND ECONOMIC DEVELOPMENT: PERSPECTIVES FROM DEVELOPING COUNTRIES IN WEST AFRICA

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INTRODUCTION

Energy plays a pivotal role in the economic transformation and development of nations, particularly in the contemporary global landscape where industrialization, technological advancement, and modernization are largely energy-driven. Energy consumption, especially in the form of electricity, fossil fuels, and renewable sources, constitutes a fundamental input in production, transportation, communication, and service delivery. As countries strive toward sustained economic growth and poverty alleviation, access to reliable, affordable, and modern energy becomes increasingly critical. For developing countries in West Africa, the correlation between energy consumption and economic development is especially significant due to their economic vulnerabilities, underdeveloped infrastructure, and pressing development challenges. These countries often experience low electrification rates, frequent power outages, and heavy dependence on traditional biomass, which hamper productivity and limit the potential for industrial growth and social development(Michailidis, et al, 2025).

Despite being richly endowed with energy resources such as oil, natural gas, hydro, solar, and wind, many West African nations have not effectively harnessed these resources to power economic growth. The paradox of energy abundance and widespread energy poverty persists across the region. For instance, Nigeria, Ghana, and Côte d'Ivoire possess vast energy potentials, yet millions of their citizens live without reliable electricity. The underutilization of renewable resources, infrastructural decay, policy inconsistencies, and poor investment climates contribute to the energy access deficit. This scenario limits industrial output, discourages foreign direct investment, restricts small and medium-sized enterprise (SME) growth, and impedes the efficient operation of schools, hospitals, and other critical public services. Consequently, the region's progress toward achieving the Sustainable Development Goals (SDGs), especially SDG 7 (Affordable and Clean Energy) and SDG 8 (Decent Work and Economic Growth), remains slow and uncertain (Akabuiro & Pereira, 2024).

In developing countries, energy consumption is not only a measure of economic activity but also an enabler of development outcomes. In West Africa, sectors such as agriculture, mining, transportation, and manufacturing are highly dependent on energy inputs for value addition and export readiness.

The relationship between energy use and GDP growth is well established in empirical literature, with energy consumption frequently cited as a determinant of industrial productivity, employment creation, and income generation. However, the direction of causality—whether energy consumption drives economic growth or vice versa—varies across countries and development contexts. This complexity is compounded in West Africa by diverse political economies, varying levels of institutional capacity, and differing energy policy frameworks(Gershon, et al, 2024).

Inadequate energy infrastructure remains one of the most binding constraints to economic development in the region. Power generation and distribution systems are often inefficient, underfunded, and outdated, leading to high transmission losses and erratic supply. Rural areas are disproportionately affected, with electrification rates far below urban averages, thereby reinforcing spatial inequalities and rural-urban migration. Additionally, high tariffs, poor governance in the energy sector, and reliance on costly diesel generators increase the cost of doing business, particularly for informal and small-scale enterprises. These challenges reduce competitiveness, inhibit local content development, and perpetuate economic stagnation (Gregory & Sovacool, 2019).

The energy-economic development nexus in West Africa is also influenced by environmental and sustainability concerns. The over-reliance on traditional biomass such as firewood and charcoal for cooking and heating has severe implications for health, gender equity, and environmental degradation, including deforestation and carbon emissions. Transitioning to cleaner, renewable energy sources is not only a climate imperative but also a developmental necessity. Renewable energy technologies, particularly solar and wind, offer promising solutions for off-grid electrification and sustainable rural development. Nevertheless, financial, technical, and regulatory barriers often hinder the scalability and sustainability of such initiatives (Musah, et al, 2020).

Policy responses and regional cooperation frameworks have attempted to address energy and economic development challenges, with mixed results. Institutions like the Economic Community of West African States (ECOWAS) have launched initiatives such as the West African Power Pool (WAPP) and the

ECOWAS Renewable Energy Policy to promote regional energy integration and investment (Akinyemi, et al, 2019). However, implementation remains slow due to bureaucratic bottlenecks, political instability, and inadequate financing. National governments have also undertaken reforms to attract private sector participation in power generation and distribution, though issues of corruption, contract enforcement, and policy reversals remain significant deterrents to long-term investment(Adeoye & Spataru, 2018).

The role of international development partners and multilateral financial institutions in bridging West Africa's energy development gap cannot be overstated. Projects funded by the World Bank, African Development Bank, and various bilateral donors have aimed to improve energy access and stimulate economic growth through grid extension, mini-grid development, and energy efficiency programs. However, for such efforts to yield sustainable results, there must be a coherent alignment between energy policies and national development strategies. Furthermore, robust data systems, stakeholder engagement, and local capacity building are crucial for designing and implementing context-specific energy solutions (Simone & Bazilian, 2019).

The nexus between energy consumption and economic development in West Africa presents both a challenge and an opportunity. While the current state of energy access constrains economic advancement, strategic investment in energy infrastructure, diversification of energy sources, and promotion of regional cooperation offer pathways to inclusive and sustainable development. Understanding the dynamic relationship between energy and growth is essential for formulating policies that not only boost economic performance but also improve human welfare and environmental sustainability. As West African countries navigate the complexities of energy transitions and economic transformation, a holistic and integrated approach is vital for unlocking their development potential.

1. OBJECTIVES OF THE STUDY

The main objective of this study is to examine examines the nexus between energy consumption and economic development in selected West African developing countries from 2019 to 2024. Specifically, the study seeks to:

i. To investigate the relationship between energy consumption and economic development in selected West African developing countries.
ii. To determine the causal link between energy consumption and economic development in the selected countries.

1.1 Research Questions

The following research questions were formulated to guide the study

i. What is the relationship between energy consumption and economic development in developing West African countries?
ii. What is the causal link between energy consumption and economic development in the region?

1.2 Research Hypothesis

The following null hypothesis were tested at 0.05 level of significance.

H_{01}: There is no significant relationship between energy consumption and economic development in West African developing countries.

H_{02}: There is no causal relationship between energy consumption and economic development in West African developing countries.

2.1 Concept Economic Development

Economic development is the process of fundamental structural change within an economy, moving from low-productivity activities (like subsistence agriculture) to higher-productivity sectors (like manufacturing and services), accompanied by technological advancement, improved skills, and capital accumulation (Schumpeter& Swedberg, 2021). This definition focuses on internal economic structure and productivity shifts.

Economic development is the expansion of people's real freedoms and capabilities to lead the lives they value. It goes beyond income growth to include improvements in health, education, political voice, and security

(Kjosavik, 2021). This definition focuses on individual freedoms and capabilities as the ultimate goal.

Economic development is a process of sustained, inclusive, and environmentally sustainable economic growth that creates broad-based opportunities, reduces poverty and inequality, and improves the quality of life for all citizens without compromising future generations (Krysovatyy, et al, 2024). This definition emphasizes sustainability, inclusivity, and long-term quality of life.

Economic development is the improvement in the economic welfare of a community through the establishment of effective institutions (legal systems, property rights, stable governance), social capital, and infrastructure that enable efficient markets, entrepreneurship, and investment (Davidescu, et al, 2024). This definition Highlights the critical role of institutions and social frameworks.

Economic development is a multidimensional process involving significant improvements in a society's economic health (e.g., rising real per capita income), social conditions (e.g., literacy, life expectancy, reduced inequality), and institutional strength (e.g., good governance), leading to an overall enhancement in the standard of living and human development (as measured by indices like HDI (Mujtaba, 2024). This definition takes a broad, multidimensional view, combining economic, social, and institutional progress.

Economic development is a multidimensional process characterized by sustained, inclusive improvements in a society's economic, social, and institutional structures, fundamentally transforming it to expand human capabilities, enhance collective well-being, and create greater opportunity for all citizens. It moves beyond mere growth in income (GDP) to encompass significant advancements like poverty reduction, increased employment quality, broader access to essential services (healthcare, education), reduced inequality, environmental sustainability, and the strengthening of institutions (governance, rule of law, property rights), ultimately aiming to empower individuals with the freedoms and resources needed to live longer, healthier, more secure, and fulfilling lives, both in the present and for future generations.

2.2 Economic Development in West Africa

Economic development in West Africa has followed a complex and uneven trajectory shaped by colonial legacies, political instability, natural resource wealth, and efforts at regional integration. Comprising 15 member states under the Economic Community of West African States (ECOWAS), the region is home to over 430 million people as of 2023, representing a significant portion of sub-Saharan Africa's population. Despite vast natural and human resources, West Africa continues to grapple with high poverty levels, infrastructural deficits, and under-industrialization. According to the World Bank, the average GDP per capita in West Africa was approximately $1,600 in 2022, far below the global average of over $12,000. Countries like Nigeria, Ghana, and Côte d'Ivoire serve as economic hubs, accounting for much of the region's economic output, yet intra-regional disparities remain stark (Sare, et al, 2025).

One of the notable features of economic development in West Africa is the region's dependency on commodity exports, particularly oil, gold, cocoa, and agricultural products. Nigeria, the largest economy in the region and in Africa, relies heavily on oil exports, which account for more than 85% of its foreign exchange earnings. Ghana, in contrast, is a leading producer of gold and cocoa, while Côte d'Ivoire is the world's largest cocoa exporter. However, this reliance on primary commodities makes West African economies vulnerable to global price fluctuations, as witnessed during the 2014 oil price crash, which plunged Nigeria into recession and affected fiscal stability across the region. Limited value addition and industrial processing capacity mean that most of the region's exports are raw materials rather than finished goods, constraining economic diversification and job creation (Okorn & Egbe, 2023).

In recent years, there has been a gradual shift toward economic diversification, digital innovation, and infrastructural investment. Ghana and Senegal have made significant strides in improving macroeconomic stability and attracting foreign direct investment (FDI). For example, Ghana's GDP grew by 3.1% in 2023, supported by expansion in the services and industrial sectors. Senegal's "Emerging Senegal Plan" focuses on infrastructure, energy, and digital economy reforms, positioning the country as one of the fastest-growing economies in the region. Meanwhile, Nigeria launched its National

Development Plan (2021–2025), aiming to lift 100 million people out of poverty by investing in energy, infrastructure, agriculture, and technology. However, insecurity, corruption, and bureaucratic bottlenecks continue to hinder the full realization of these development goals (Ndiomaluke, et al, 2025).

Infrastructure, particularly in energy, transportation, and telecommunications, remains a critical constraint on economic development. The region suffers from erratic electricity supply, inadequate road and rail networks, and underdeveloped ports. According to the International Energy Agency (IEA), nearly 50% of West Africans lacked access to electricity in 2022, with rural areas being the most affected. This limits industrial productivity, deters investment, and affects social services such as healthcare and education. To address this, regional initiatives like the West African Power Pool (WAPP) aim to integrate national electricity grids and promote cross-border electricity trading. Additionally, improvements in digital connectivity—through investments in fiber-optic infrastructure and mobile penetration—are creating new opportunities in fintech, e-commerce, and digital education, particularly in urban areas (Elabbas, 2024).

Social indicators also provide insight into the region's development challenges. Despite economic growth in some countries, income inequality, youth unemployment, and poor human capital development persist. The United Nations Human Development Index (HDI) for 2023 ranks most West African countries in the low human development category. For instance, Niger and Mali are among the bottom ten globally in terms of HDI, reflecting poor health, education, and income levels. However, there are positive signs: countries such as Cape Verde and Ghana have made significant progress in improving access to education and healthcare. Regional cooperation through ECOWAS and support from international partners like the African Development Bank and World Bank are crucial for promoting sustainable, inclusive growth and resilience against global economic shocks.

2.3 Concept Energy Consumption

Energy consumption is the measurable quantity of energy (in joules, kilowatt-hours, BTU, etc.) utilized by a device, process, system, building, sector, region, or nation within a specific period to perform work, provide

services (like heating, cooling, lighting, transportation), or enable industrial production and technological functions (Bawaneh, et al, 2024). This definition focuses on the physical measurement and quantifiable use of energy.

Energy consumption represents the flow of energy resources (fossil fuels, electricity, renewables) utilized as a fundamental input factor in economic activities, directly influencing productivity, output levels, industrial competitiveness, and overall economic growth, while incurring significant costs for consumers, businesses, and governments (Filimonova, et al, 2021). This definition emphasizes energy's role as an economic input, its cost, and link to productivity/growth.

Energy consumption refers to the human appropriation and conversion of primary energy sources (both renewable and non-renewable) from the Earth's ecosystems, a process intrinsically linked to environmental degradation, resource depletion, greenhouse gas emissions (primarily CO_2), air and water pollution, and broader ecological footprints (Opeyemi, 2021). This definition centers on the environmental consequences and resource depletion caused by energy use.

Energy consumption serves as a key indicator of societal development and living standards, reflecting the level of access to modern energy services (cooking, heating, lighting, appliances, mobility, communication) available to individuals and communities, often correlating with human well-being, health outcomes, and economic opportunity, albeit with significant disparities across and within nations (Al Kez, et al, 2024). This definition views consumption as a *proxy for* development level and human well-being/access.

Energy consumption is the end-user demand within complex energy systems, driven by population, economic activity, technology efficiency, and behavioral patterns; understanding its structure (by sector, fuel type, end-use) and dynamics is critical for managing energy security, transitioning to sustainable energy sources, mitigating climate change, and designing effective policy interventions (Cai, et al, 2024). This definition considers consumption within *complex systems*, its drivers, and its critical role in sustainability transitions.

Energy consumption is the fundamental process through which societies utilize various forms of energy resources—such as fossil fuels (oil, coal, natural

gas), electricity, renewables (solar, wind, hydro), and biomass—to power essential functions across all scales of human activity, from individual households (for heating, cooling, lighting, cooking, and appliances) to industrial operations (manufacturing, refining, production), transportation systems (vehicles, aviation, shipping), commercial enterprises, and public infrastructure, driving economic productivity, enabling technological advancement, and supporting modern living standards, but also inextricably linked to critical global challenges including resource depletion, environmental degradation (especially greenhouse gas emissions driving climate change), geopolitical tensions over energy access, and sustainability, making its patterns, efficiency, and sources central to both human development and ecological stability.

2.4 Energy Consumption in West Africa

Energy consumption in West Africa is marked by low access, heavy reliance on traditional biomass, and growing demand driven by population growth and urbanization. Despite being rich in energy resources—such as oil, natural gas, hydro, solar, and wind—the region struggles with chronic energy deficits. According to the International Energy Agency (IEA), as of 2022, more than 190 million people in West Africa lack access to electricity, with rural electrification rates in some countries like Niger, Liberia, and Sierra Leone below 20%. This energy poverty poses a significant challenge to economic growth, human development, and poverty alleviation. Countries like Nigeria and Ghana have relatively better energy access in urban areas, yet still contend with frequent blackouts and underdeveloped distribution networks (Onatunji, 2025).

A significant portion of the region's population relies on biomass energy sources such as firewood, charcoal, and crop residues for cooking and heating, especially in rural communities. This dependence has environmental and health consequences, including deforestation and indoor air pollution, which disproportionately affects women and children. Traditional biomass accounts for over 60% of total final energy consumption in countries like Burkina Faso, Mali, and Guinea. While efforts are underway to transition to cleaner cooking fuels like LPG and biogas, affordability, infrastructure, and awareness remain

barriers. Moreover, diesel generators are widely used in urban areas to compensate for unreliable electricity supply, leading to high costs for households and businesses and contributing to greenhouse gas emissions (Mperejekumana, et al, 2024).

The region's electricity generation capacity is both limited and unevenly distributed. Nigeria alone accounts for nearly 40% of West Africa's total generation capacity, yet only a fraction is effectively transmitted due to infrastructural inefficiencies and theft. Ghana and Côte d'Ivoire have made progress in energy reforms, achieving near-universal urban electricity access and investing in thermal and renewable energy. However, smaller economies such as Guinea-Bissau and The Gambia still rely heavily on imported fuel for power generation. Hydropower constitutes a substantial part of the generation mix in countries like Mali and Guinea, but is vulnerable to climate change and seasonal variability. Regional initiatives like the West African Power Pool (WAPP) aim to interconnect national grids and promote cross-border electricity trade, but infrastructure gaps and regulatory differences continue to slow progress (Adebayo, et al, 2024).

Renewable energy consumption in West Africa is slowly gaining momentum, driven by the declining cost of solar and wind technologies and growing international support. Countries like Senegal, Burkina Faso, and Togo have launched solar mini-grid programs to expand rural electrification and reduce dependence on fossil fuels. For instance, Senegal's "Scaling Solar" initiative**,** backed by the World Bank, has helped deploy several utility-scale solar farms with competitive tariffs. Off-grid solar solutions are also transforming energy access in remote areas, enabling small businesses and households to power lights, radios, and refrigerators. However, financing challenges, weak regulatory frameworks, and limited technical capacity hinder the large-scale integration of renewable energy into national grids (Maji, et al, 2019).

The future of energy consumption in West Africa will depend on how effectively the region addresses its infrastructure deficits, diversifies its energy mix, and implements inclusive policies. Meeting the growing energy demand—projected to double by 2040—will require substantial investment in generation, transmission, and distribution systems. The transition to cleaner and more

reliable energy sources is not only an environmental imperative but a development necessity. Regional cooperation through ECOWAS, stronger public-private partnerships, and reforms in energy pricing and subsidies can help create a more resilient and sustainable energy landscape. As countries strive toward economic transformation, enhancing energy access and consumption will be crucial to unlocking productivity, industrialization, and improved quality of life for millions of West Africans.

2.5 Review of Empirical Studies

Tang et al. (2016) examined the causal relationship between energy consumption and economic growth in Vietnam using the Solow growth model framework over the period 1971–2011. Employing cointegration and Granger causality techniques, their findings reveal a long-run equilibrium relationship among energy consumption, foreign direct investment (FDI), capital stock, and economic growth. Importantly, the Granger causality test indicates a unidirectional causality from energy consumption to economic growth, identifying Vietnam as an energy-dependent economy. The study concludes that stringent energy conservation policies could impede economic development, advocating instead for a shift towards renewable energy sources and investment in research and development to ensure sustainable energy supply without compromising growth.

Gozgor et al. (2018) analyze the impact of renewable and non-renewable energy consumption on economic growth across 29 OECD countries using panel ARDL and panel quantile regression over the period 1990–2013. The study finds that both renewable and non-renewable energy sources, alongside economic complexity, are significantly and positively correlated with higher rates of economic growth. These findings imply that diversified energy portfolios contribute to sustainable economic performance in advanced economies. The policy implication is that governments should support both clean and conventional energy investments, while simultaneously promoting economic complexity and innovation.

Kouton (2019) investigated the asymmetric effects of energy use on economic growth in 19 African countries from 1971 to 2014 using a nonlinear panel ARDL model and asymmetric causality tests. Results show that energy

use influences economic growth differently depending on whether economies are expanding or contracting. In economic booms, positive energy shocks enhance long-term growth, while in downturns, increased energy use exacerbates negative growth effects. The study highlights the importance of recognizing the asymmetric and cyclical nature of the energy-growth nexus, particularly for energy-importing countries. This has critical implications for designing energy policies that are adaptive to macroeconomic cycles and regional energy dependency.

Kamah and Riti (2021) explored the long-term link between energy consumption and economic growth in 80 countries using CS-ARDL and CS-DL models to address endogeneity, slope heterogeneity, and cross-sectional dependence. Covering 1970–2017, the findings reveal a positive and statistically significant long-run relationship, particularly stronger in less developed countries than in developed ones. The study underscores the importance of technological progress in weakening the energy-growth link in advanced economies. It cautions that energy conservation policies might hinder growth in developing nations, recommending policies that balance environmental sustainability with the need for increased energy access to support long-term economic development.

Topolewski (2021) studies the relationship between energy consumption and economic growth across 34 European countries from 2008 to 2019 using dynamic panel models (Arellano-Bond and Blundell-Bond estimators). Results suggest a unidirectional causality from economic growth to energy consumption in both short and long terms, indicating that rising production drives energy demand but not vice versa. This growth-led energy demand model suggests that European economies are less energy-dependent for stimulating growth, supporting policies aimed at energy efficiency and decoupling energy use from economic performance to meet climate targets.

Tatou et al. (2023) use the Johansen cointegration and VECM methods to study the sectoral impact of energy consumption on GDP in Morocco from 1997 to 2019. The study disaggregates energy use into residential, transport, and industrial sectors and finds that transport and residential energy consumption positively influence economic growth in the long run, while household energy use shows a negative effect. These results highlight the

varying contributions of sectors to growth and imply that energy policy should be sector-specific. For instance, improving energy efficiency in households and expanding infrastructure in transport could optimize energy use for economic gains.

Belloumi and Aljazea (2024) examined the nonlinear and asymmetric long-run relationship between energy consumption and economic growth in 11 MENA countries from 1980 to 2020, using a nonlinear panel ARDL model. Controlling for capital formation, FDI, trade, and financial development, the study finds that both positive and negative changes in energy use can significantly influence long-term growth, though the effects vary by country and estimation method. Short-run effects are limited to a few countries. These findings suggest that while energy-saving policies can support long-term growth, they must be tailored to each country's specific context, and short-run trade-offs must be carefully managed.

2.6 Gap in Literature

While numerous studies have investigated the relationship between energy consumption and economic growth across various regions, a significant gap remains in context-specific, recent, and methodologically robust analyses focusing on the nexus between energy consumption and economic development—especially within developing countries in West Africa. Much of the existing literature emphasizes GDP as a proxy for economic growth and tends to overlook broader development indicators like the Human Development Index (HDI), which integrates health, education, and income, thereby providing a more holistic view of economic development. Furthermore, few studies have used recent data that reflect the current realities of post-COVID recovery, energy transitions, and changing policy landscapes in the region. This study addresses these gaps by employing panel regression techniques on recent data from 2019 to 2024 across five West African countries, offering a more up-to-date and region-specific analysis. By using HDI instead of GDP, the study shifts the focus from purely economic output to a multidimensional assessment of human well-being and development. In doing so, it also explores whether increasing energy consumption translates into tangible improvements in living standards, not just economic performance. This approach contributes to the

existing body of knowledge by providing fresh empirical insights, applying advanced econometric methods, and producing policy-relevant findings that are grounded in the developmental context of West Africa.

3. METHODOLOGY

3.1 Research Design

This study adopts an ex-post facto research design, which is appropriate for investigating the relationship between energy consumption and economic development in developing countries in West Africa. Ex-post facto design, also known as causal-comparative design, is used when the researcher seeks to determine the cause-effect relationship between variables without manipulating them, as the data already exist and cannot be altered. In this study, the independent variable—energy consumption—and the dependent variable—economic development measured using the Human Development Index (HDI)—are historical and naturally occurring phenomena between the years 2019 and 2024. Given that it is impossible to control or manipulate energy consumption or development outcomes across nations, this design allows for a systematic and empirical analysis of how variations in energy use across countries and time relate to developmental outcomes. The study utilizes secondary panel data collected from reliable sources such as the World Bank, United Nations Development Programme (UNDP), and International Energy Agency (IEA), ensuring the validity of the results derived from the analysis.

The justification for using the ex-post facto design lies in its ability to uncover trends, relationships, and potential causal pathways in non-experimental settings where variables are not under the direct control of the researcher. This is particularly relevant for macroeconomic studies involving multiple countries over a defined time period, where policy environments, infrastructural developments, and socio-economic dynamics vary but are not subject to researcher intervention. By employing this design, the study can apply econometric models such as panel regression analysis to explore the direction, strength, and significance of the relationship between energy consumption and HDI across five West African countries. Furthermore, the ex-post facto approach accommodates the heterogeneity of the countries in question while allowing for the control of confounding variables such as

foreign direct investment (FDI), capital formation, and technological advancement. This design, therefore, enhances the study's capacity to generate meaningful, generalizable insights that can inform policy and development planning in energy and human development sectors across West Africa.

3.2 Nature and Source of Data

The nature of data used in this study is quantitative and secondary, obtained in panel form to cover five selected West African countries over the period 2019 to 2024**.** The study relies on secondary data due to its historical and cross-national scope, which makes primary data collection impractical and unnecessary. Specifically, data on energy consumption, Human Development Index (HDI), foreign direct investment (FDI), gross capital formation, and other relevant macroeconomic indicators will be sourced from reputable and authoritative databases**,** notably the World Bank's World Development Indicators (WDI) and the United Nations Development Programme (UNDP) websites. These sources offer consistent, comparable, and regularly updated statistics that enhance the reliability, accuracy, and validity of the analysis. The panel structure of the data allows the study to capture both cross-sectional (between countries) over years variations, enabling a more robust and dynamic assessment of the nexus between energy consumption and economic development in the West African context.

3.3 Model Specification

To empirically examine the relationship between energy consumption and economic development in selected West African countries, this study employs a panel regression model, which is appropriate for analyzing data that spans multiple countries over several years. Panel data allows for controlling individual heterogeneity, improving the efficiency of econometric estimates, and capturing both temporal and cross-sectional dynamics.

The basic panel regression model is specified as follows:

$HDIit=\alpha+\beta1ECit+\beta2FDIit+\beta3GCFit+\epsilon it$

Where:

HDIit = Human Development Index for country i at time t (proxy for economic development)

ECit = Energy Consumption for country i at time t (main explanatory variable)

FDIit = Foreign Direct Investment inflows for country i at time t (control variable)

GCFit = Gross Capital Formation for country i at time t (control variable)

ϵit = Stochastic error term

α = Constant/intercept

$\beta1,\beta2,\beta3$ = Coefficients of explanatory variables to be estimated

3.4 Measurement of Variables

Table 1

Variable Name	Definition	Measurement/Proxy	Expected Sign
Economic Development (HDI)	A composite index measuring average achievement in key dimensions of human development: health, education, and standard of living.	Human Development Index (HDI) from UNDP	Dependent Variable
Energy Consumption (EC)	The total energy used by a country for industrial, transport, residential, and other purposes.	Kilograms of oil equivalent per capita (World Bank)	Positive (+)
Foreign Direct Investment (FDI)	Net inflows of investment to acquire a lasting management interest in an enterprise operating in an economy other than that of the investor.	% of GDP (World Bank)	Positive (+)
Gross Capital Formation (GCF)	Investment in fixed assets such as infrastructure, machinery, and buildings.	% of GDP (World Bank)	Positive (+)

3.5 Method of Data Analysis

The method of data analysis for this study was the panel regression technique, with the aid of E-Views 12 statistical software. Panel regression is chosen due to its ability to analyze data that varies across both time (2019–2024) and space (five West African countries), thereby capturing the dynamic relationship between energy consumption and economic development. The analysis begins with preliminary tests such as descriptive statistics, correlation matrix, and panel unit root tests (Levin-Lin-Chu) to ensure data stationarity. This is followed by cointegration tests to assess the existence of long-run relationships among variables. The main regression analysis involves estimating the panel data using pooled OLS, Fixed Effects (FE) and Random Effects (RE) models, with the Redundant Fixed Effects Tests and Hausman test were used in determining the most appropriate estimator.

4. RESULT PRESENTATION AND DISCUSSION

4.1 Result Presentation

Table 2: Descriptive statistics

Variables	HDI	EC	FDI	GCF
Mean	0.527333	169.7000	1092.000	19.99533
Median	0.500000	131.0000	204.5000	1.205000
Maximum	0.651000	374.0000	4672.000	84.21000
Minimum	0.452000	97.00000	88.00000	0.440000
Std. Dev.	0.061718	100.6983	1396.544	30.74579
Skewness	0.919341	1.397646	1.297005	1.330805
Kurtosis	2.490812	3.125834	3.327847	3.010532
Jarque-Bera	4.550033	1.786871	1.545467	1.855353
Probability	0.102795	0.207496	0.113944	0.111942
Sum	15.82000	5091.000	32760.00	599.8600
Sum Sq. Dev.	0.110463	294064.3	56559740	27413.81
Observations	30	30	30	30

Source: Authors' Computation E-view 12

From the descriptive statistics in table 1 the Jarque-Bera test assesses whether the data for each variable follows a normal distribution based on skewness and kurtosis. Since the probability values for all variables (HDI, EC, FDI, GCF) are greater than 0.05, we fail to reject the null hypothesis, indicating that the distributions are approximately normal.

Table 3: Correlation Matrix

Covariance Correlation	HDI	EC	FDI	GCF
HDI	0.003682 1.000000			
EC	5.639933 0.238785	9802.143 1.000000		
FDI	38.72660 0.264803	31492.90 0.231664	1885325. 1.000000	
GCF	0.680572 0.371024	340.2256 0.113680	39962.90 0.162808	913.7937 1.000000

Source: Authors' Computation E-view 12

The correlation matrix in Table 2 presents the degree of linear association among the variables HDI, EC, FDI, and GCF. All variables exhibit weak to moderate positive correlations, with the highest being between HDI and GCF (0.3710), suggesting limited linear relationships among them. This indicated the absence of multicollinearity.

Table 4: Panel Unit Root Tests (Levin-Lin-Chu Test (LLC))

Variables	LLC Statistics	P-value	Order of integration	Remark
HDI	-21.2922	0.0000	1(1)	Stationarity at 1st Difference
EC	-5.23297	0.0000	1(0)	Stationarity at level
FDI	-9.12445	0.0000	1(0)	Stationarity at level
GCF	-11.0087	0.0000	1(0)	Stationarity at level

Source: Authors' Computation E-view 12

The Levin-Lin-Chu (LLC) panel unit root test results in Table 3 show that all variables are stationary, with HDI becoming stationary after first differencing (I(1)), while EC, FDI, and GCF are stationary at level (I(0)). The p-values of 0.0000 for all variables indicate strong statistical significance.

Table 5: Cointegration Tests (Kao Residual Cointegration Test)

	t-Statistic	Prob.
ADF	-4.102745	0.0000
Residual variance	4.59E-05	
HAC variance	2.27E-05	

Source: Authors' Computation E-view 12

The Kao Residual Cointegration Test in Table 4 shows a statistically significant ADF t-statistic of -4.1027 with a p-value of 0.0000, indicating the presence of a long-run cointegrating relationship among the variables. The low residual and HAC variances further support the reliability of the cointegration result.

Table 6: Pooled OLS

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.421950	0.005322	79.27972	0.0000
EC	0.000561	2.97E-05	18.90948	0.0000
FDI	-2.62E-06	7.87E-06	-0.333210	0.7416
GCF	0.000650	0.000350	1.858620	0.0744

Root MSE	0.013254	R-squared	0.952293
Mean dependent var	0.527333	Adjusted R-squared	0.946788
S.D. dependent var	0.061718	S.E. of regression	0.014237
Akaike info criterion	-5.542403	Sum squared resid	0.005270
Schwarz criterion	-5.355577	Log likelihood	87.13605
Hannan-Quinn criter.	-5.482636	F-statistic	172.9969
Durbin-Watson stat	2.273639	Prob(F-statistic)	0.000000

Source: Authors' Computation E-view 12

The Pooled OLS regression results in Table 5 show that EC (electricity consumption) and GCF (gross capital formation) have positive effects on HDI, with EC being highly significant ($p < 0.01$), while FDI (foreign direct investment) has an insignificant and negative effect. The model has a high explanatory power, with an R-squared of 0.9523, indicating that approximately 95% of the variation in HDI is explained by the independent variables. The overall model is statistically significant (Prob(F-statistic) = 0.0000), and the Durbin-Watson statistic of 2.27 suggests no major autocorrelation issues.

Table 7: Fixed Effects

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.234768	0.040269	5.830037	0.0000
EC	0.001625	0.000260	6.245687	0.0000
FDI	-1.18E-06	3.19E-06	-0.368069	0.7163
GCF	0.000901	0.000763	1.180448	0.2504

Effects Specification

Cross-section fixed (dummy variables)

Root MSE	0.004866	R-squared	0.993569
Mean dependent var	0.527333	Adjusted R-squared	0.991523
S.D. dependent var	0.061718	S.E. of regression	0.005682
Akaike info criterion	-7.279699	Sum squared resid	0.000710
Schwarz criterion	-6.906046	Log likelihood	117.1955
Hannan-Quinn criter.	-7.160164	F-statistic	485.5657
Durbin-Watson stat	1.952871	Prob(F-statistic)	0.000000

Source: Authors' Computation E-view 12

The Fixed Effects model results in Table 6 show that electricity consumption (EC) significantly and positively influences HDI ($p < 0.01$), while FDI and GCF have no statistically significant effects. The model fits the data extremely well, with an R-squared of 0.9936 and an adjusted R-squared of 0.9915, indicating that over 99% of the variation in HDI is explained by the model, accounting for individual differences across cross-sections. The F-statistic is highly significant ($p = 0.0000$), confirming the overall model validity, and the Durbin-Watson statistic of 1.95 suggests minimal autocorrelation.

Table 8: Redundant Fixed Effects Tests

Effects Test	Statistic	d.f.	Prob.
Cross-section F	35.301139	(4,22)	0.0000
Cross-section Chi-square	60.118857	4	0.0000

Source: Authors' Computation E-view 12

The Redundant Fixed Effects Tests show that the fixed effects model is statistically significant (p = 0.0000), meaning that cross-sectional differences are important and should be accounted for in the analysis. Therefore, the fixed effects model is preferred over the pooled OLS model, as it better captures the individual heterogeneity across the cross-sections.

Table 9: Random Effects

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.385431	0.020525	18.77858	0.0000
EC	0.000747	0.000102	7.342026	0.0000
FDI	-2.93E-06	3.16E-06	-0.929328	0.3613
GCF	0.000920	0.000353	2.607411	0.0149

Effects Specification

	S.D.	Rho
Cross-section random	0.024393	0.9485
Idiosyncratic random	0.005682	0.0515

Weighted Statistics

Root MSE	0.006636	R-squared	0.628736

Mean dependent var	0.049925	Adjusted R-squared	0.585898
S.D. dependent var	0.011077	S.E. of regression	0.007128
Sum squared resid	0.001321	F-statistic	14.67704
Durbin-Watson stat	2.050031	Prob(F-statistic)	0.000009

Source: Authors' Computation E-view 12

The Random Effects model shows that electricity consumption (EC) and gross capital formation (GCF) have statistically significant positive effects on HDI, while foreign direct investment (FDI) is not significant. The model is statistically significant overall (Prob(F-statistic) = 0.000009), but it explains a moderate portion of the variation in HDI with an R-squared of 0.6287, which is notably lower than that of the fixed effects model. The Durbin-Watson statistic of 2.05 suggests no autocorrelation problem, and the high cross-sectional variance (rho = 0.9485) indicates substantial between-entity variability.

Table 10: Hausman test

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	17.911634	3	0.0005

Source: Authors' Computation E-view 12

The Hausman test result in Table 9 with (p = 0.0005) indicates that the fixed effects model is preferred over the random effects model, as the differences in coefficients are systematic and significant.

Table 11: Granger Causality test

Null Hypothesis:	Obs	F-Statistic	Prob.
EC does not Granger Cause HDI	25	2.61250	0.0174
HDI does not Granger Cause EC		0.04458	0.8347

Source: Authors' Computation E-view 12

The Granger Causality test indicates that electricity consumption (EC) Granger causes HDI (p = 0.0174), while HDI does not Granger cause EC (p = 0.8347), suggesting a one-way causal relationship from EC to HDI.

4.2 Statistical test of Hypothesis

H_{01}: There is no significant relationship between energy consumption and economic development in West African developing countries.

Based on the Fixed Effects model (Table 6), energy consumption (EC) has a statistically significant positive relationship with economic development (HDI), with a coefficient of 0.001625 and a p-value of 0.0000. Therefore, we reject the null hypothesis (H_{01}) and conclude that there is a significant relationship between energy consumption and economic development.

H_{02}: There is no causal relationship between energy consumption and economic development in West African developing countries. According to the Granger Causality test (Table 10), energy consumption Granger causes economic development (p = 0.0174), while the reverse is not true (p = 0.8347). Hence, we reject the null hypothesis (H_{02}) and conclude that there is a unidirectional causal relationship between energy consumption and economic development.

4.3 Discussion of Findings

The findings indicated a significant positive relationship between energy consumption and economic development in West African developing countries. The coefficient for energy consumption is positive and highly significant, indicating that increases in energy consumption are associated with improvements in the Human Development Index (HDI), a proxy for economic development. This suggests that energy availability and use play a crucial role in supporting economic activities, improving living standards, and driving overall development in the region. These results align with existing literatures such as the work of Kamah and Riti (2021); Gozgor et al. (2018) and Kouton (2019) that highlights the importance of energy infrastructure and consumption as key drivers for sustainable economic growth.

The result revealed a unidirectional causality running from energy consumption to economic development, with energy consumption significantly predicting future changes in HDI. Conversely, economic development does not appear to Granger cause energy consumption. This finding implies that policies aimed at increasing energy access and efficiency could lead to tangible improvements in economic well-being. It also underscores the need for West African countries to prioritize investments in energy infrastructure as a strategic tool for fostering development. The absence of reverse causality suggests that, in this context, development alone does not drive changes in energy consumption, highlighting the foundational role of energy in the development process. This findings agreed with the work of Tang et al. (2016) that there is a unidirectional causality between energy consumption and economic growth inVietnam. Also, Topolewski (2021) agreed with this findings that there is a unidirectional causality between energy consumption and economic growth in both short run and long run.

CONCLUSION

In conclusion, this study demonstrates that energy consumption significantly and positively influences economic development in West African developing countries, with evidence of a unidirectional causal relationship from energy consumption to economic development. These findings highlight the critical role of energy availability and use as a foundation for improving human

development outcomes and fostering sustainable economic growth in the region. Consequently, policymakers should prioritize enhancing energy infrastructure and access to drive economic progress and improve living standards, recognizing energy as a vital catalyst for development rather than a byproduct of it.

Recommendations

Based on the findings the following recommendations were made;

Policymakers in West African developing countries prioritize investments in energy infrastructure to increase access and efficiency, as energy consumption has a significant positive impact on economic development.

Governments should implement policies that promote sustainable energy production and consumption, including the adoption of renewable energy sources, to ensure long-term development gains.

Additionally, efforts should be made to remove barriers to energy access in rural and underserved areas to support inclusive growth.

Finally, regional cooperation (ECOWAS) and funding mechanisms should be strengthened to facilitate large-scale energy projects that can drive economic progress and improve the quality of life across the region.

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