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Driving Employment through Renewable Energy in Developing Economies: Insights from Panel Data

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Abstract

Employment generation remains a central challenge for developing countries, where energy transitions, institutional quality, and fiscal policies play critical roles in shaping labour market outcomes. This study investigates the impact of renewable energy consumption on employment in 85 developing countries over the period 2000 to 2022. Using panel data and robust econometric techniques, including fixed-effects, generalised least squares, Driscoll-Kraay, and further two-stage least squares estimations to address endogeneity, the analysis demonstrates that renewable energy consistently fosters job creation. Economic growth and government effectiveness also positively influence employment, highlighting the importance of output expansion and institutional quality. Public expenditure, foreign direct investment, education, and renewable energy investments further support employment generation. The findings underscore the critical role of sustainable energy policies, sound governance, and strategic fiscal and investment interventions. Policymakers are therefore strongly encouraged to prioritise renewable energy deployment, strengthen institutional frameworks, and enhance targeted public investments to foster inclusive labour markets and sustainable economic development.

Section I. Introduction

Macroeconomic stability is a fundamental determinant of sustainable development, as it creates an environment conducive to investment, growth, and structural transformation (Bleaney, 1996). The objectives of full employment, low inflation, sustained growth, and external balance, often summarised by Kaldor's (1971) "magic square", are systematically embedded in national development strategies and competitiveness frameworks. In this regard, Schwab et al. (2016) identify macroeconomic stability as one of the core pillars of economic performance because it fosters a predictable environment essential for investment and structural transformation. Stable prices, low unemployment, and balanced external accounts reduce uncertainty for both domestic and foreign investors, enabling long-term development planning. Moreover, macroeconomic stability enhances the effectiveness of fiscal and monetary policies and supports structural shifts in the economy (Ullah et al., 2024). Ensuring resilience against shocks reinforces sustainable growth and competitiveness in both developed and developing countries. However, in recent decades, geopolitical tensions, health crises, and recurrent energy shocks have weakened this stability, particularly in developing countries (Balbaa, 2024). These economies record unemployment rates well above the IMF's benchmark thresholds, persistent trade deficits, and weak growth, all of which constrain their capacity to achieve macroeconomic adjustment (Abaidoo & Agyapong, 2024).

Conceptually, macroeconomic stability refers to the low volatility of key economic variables such as prices, growth, employment, and the trade balance. Some approaches equate it with monetary stability (Friedman, 1968; Mishkin, 2007), while others emphasise the stability of real variables, including sustainable growth, low unemployment, and viable external accounts (Rodrik, 2000; Stiglitz, 2018). The Phillips (1958) inflation–unemployment trade-off illustrates the difficulty of achieving low inflation and low unemployment simultaneously: policies designed to reduce unemployment may fuel inflation,

whereas inflation-control measures often increase unemployment. While the literature highlights the importance of monetary and fiscal policies (Diop & Diaw, 2015; Taylor, 1993) as well as trade openness (Combes et al., 2000), structural determinants, particularly energy dynamics, remain insufficiently explored. De Ménil and Westphal (1980) show that fluctuations in energy prices affect both inflation and the trade balance, revealing a dual macroeconomic transmission channel.

In this context, the global energy transition has emerged as an imperative requiring substantial investment. Its impact extends far beyond environmental considerations. Investments in renewable energy generate a wide range of jobs due to the multiplicity of activities involved in design, installation, maintenance, and system management (Petreski et al., 2023). As early as the 2000s, several countries recognised that renewable energy was not only a climate solution but also an engine of economic development. Denmark's experience is illustrative: the expansion of wind energy created nearly 20,000 jobs (Lund, 2009). More broadly, recent studies show that trajectories aiming for a 100% renewable energy mix are labour-intensive and require large-scale investments (Raffin & Quirion, 2025).

This dynamic is particularly relevant for developing countries, which are characterised by rapid population growth and an expanding labour force. Yet structural challenges in generating stable employment remain acute. In Africa, the African Development Bank (AfDB, 2016) estimates that more than ten million young people enter the labour market each year, while only three million find formal employment. As a result, most young workers are unemployed, in precarious jobs, or absorbed into the informal sector.

Against this backdrop, the promotion of renewable energy represents a strategic lever for strengthening macroeconomic stability while addressing the growing demand for jobs in developing countries. Ambitious energy policies reduce vulnerabilities associated with dependence on fossil fuels and promote the creation of direct and indirect jobs across key sectors such as construction, maintenance, manufacturing, and energy services (IRENA & ILO, 2024). Renewable energy reduces unemployment through multiple mechanisms by expanding labour demand across sectors. It is more labour-intensive than fossil-fuel systems during manufacturing, installation, and deployment, creating substantial short- and medium-term employment in engineering, civil works, logistics, and project development (Ram et al., 2022). Continuous operation and maintenance generate stable, long-term jobs, especially in solar PV, wind, and mini-grid systems (ILO, 2024). Renewable investments also foster new value chains, component manufacturing, digital energy services, transport, and construction, enhancing structural transformation and labour absorption (Gielen et al., 2019). By lowering dependence on imported fossil fuels, countries can redirect savings to productive sectors, supporting SMEs and employment.

Despite concerns over fossil-fuel job losses, evidence shows net employment effects of renewables are overwhelmingly positive, particularly in developing economies (De Santis et al., 2021). Fossil-fuel industries are increasingly capital-intensive, employing fewer workers, while rural renewable electrification creates local enterprises and income opportunities, reducing underemployment (IRENA &

ILO, 2024). Overall, renewable energy acts as a net job creator, strengthening labour markets, driving structural change, and reducing unemployment in developing countries.

Despite its potential, the relationship between renewable energy and employment remains insufficiently explored in developing countries, even though it is essential for guiding effective public policy. Understanding this relationship is particularly important because the impact of renewable energy investments varies across economic, technological, and policy contexts, while developing countries face specific labour market characteristics such as high demographic pressure, dual labour markets, and limited productive diversification. This study addresses these gaps by examining the effect of renewable energy consumption on employment across 85 developing countries over the period 2000–2022, while accounting for key macroeconomic and policy variables, including economic growth, public expenditure, foreign direct investment, and the money supply.

Using robust econometric techniques, including fixed-effects, Driscoll-Kraay, and two-stage least squares estimations to address endogeneity, the analysis demonstrates that renewable energy consistently promotes job creation.

The study contributes to the literature by offering a broad, cross-country perspective on renewable energy and employment in developing economies, combining rigorous econometric methods with contextualised macroeconomic analysis. By highlighting the conditions under which renewable energy can generate net job creation, the findings provide actionable guidance for policymakers seeking to integrate sustainable energy adoption with employment generation strategies. Ultimately, this research demonstrates that the energy transition is not only an ecological imperative but also a mechanism for structural transformation, capable of enhancing employment outcomes, economic resilience, and long-term macroeconomic stability in developing countries.

The article is organised to provide a coherent and systematic analysis. The first section introduces the study, followed by a literature review on renewable energy and employment in the second section. The third section outlines the methodology employed, while the fourth section presents and discusses the empirical results. Finally, the fifth section offers conclusions and policy recommendations.

Section II. Literature Review

2.1. Theoretical Debates on Renewable Energy and Employment

Theoretical debates regarding the employment effects of renewable energy are extensive and sometimes conflicting, reflecting the complexity of the relationship. This section highlights key theoretical perspectives on how renewable energy influences job creation.

2.1.1. Knowledge Accumulation and Employment Dynamics in Renewable Energy Production

Romer's (1986) endogenous growth theory represents a significant departure from neoclassical exogenous growth models (Solow, 1956), emphasising technological progress as an internally generated factor. Investments in human capital, research, and development generate the knowledge necessary for innovation and productivity growth (Lucas Jr, 1988). Applied to renewable energy, technological innovations not only stimulate economic growth but also create new employment opportunities across design, installation, maintenance, and system management (Apergis & Danuletiu, 2014). Moreover, positive externalities from renewable energy investments extend to R&D and innovation-driven job creation, generating broader structural benefits for the economy (Romer, 1986; Raffin & Quirion, 2025).

However, critics argue that Romer's model overemphasises increasing returns to scale and the potential of knowledge accumulation, which may not persist long-term, particularly in developing countries with weak innovation systems and limited infrastructure (Rodrik, 2000; Stiglitz, 2018). Therefore, renewable energy investments alone cannot ensure macroeconomic stability or sufficient employment creation without complementary institutional support and inclusive policies (Acemoglu & Robinson, 2005).

2.1.2 Technological Innovation as a Driver of Employment

(Schumpeter, 1976) theory of creative destruction illustrates how technological innovation drives structural transformation and employment. By replacing outdated technologies with more productive ones, innovative firms gain market competitiveness while less innovative firms exit the market. Renewable energy exemplifies such innovation, displacing fossil fuels and creating new employment opportunities, thereby contributing to macroeconomic stability and long-term growth (Acemoglu, 2002; Aghion et al., 2013).

Renewable energy development follows Schumpeterian innovation cycles, both radical and incremental, stimulating structural transformation and generating employment across multiple sectors (Malerba & Orsenigo, 1996). Nonetheless, the creative destruction framework has limitations. Innovation alone does not guarantee sustainable employment (Nathan & Ahmed, 2018). Job losses in fossil-fuel sectors, particularly in agriculture, may be permanent. Effective renewable energy deployment requires institutional regulation to ensure that displaced workers are reintegrated and to mitigate potential social costs (Liao et al., 2021). Short-term employment reductions can occur if skill gaps or insufficient local capacities are not addressed, highlighting the need for complementary policies, training programs, and inclusive innovation strategies.

2.1.3. Mechanisms through which renewable energy creates Jobs

The following paragraphs highlight the mechanisms through which renewable energy generates jobs in developing countries, both directly and indirectly.

Direct jobs constitute the primary channel of employment creation. Manufacturing solar panels, wind turbines, and batteries requires a wide range of skills, providing positions for engineers, technicians, and assembly workers (Heinbach et al., 2014). Recent expansions in renewable energy capacity, involving larger and more complex equipment, have further increased the demand for skilled labour (Malik et al., 2021). Installation of renewable energy infrastructure, solar plants, wind farms, and hydroelectric facilities also generates significant employment opportunities for both highly skilled engineers and lower-skilled workers. These jobs, often temporary, yield a net average of 2.3 jobs per MW installed in wind energy projects (Aldieri et al., 2019; Dvořák et al., 2017). Maintenance activities provide another direct employment channel, offering stable, ongoing work in repair, monitoring, lubrication, cleaning, and daily management of renewable energy facilities (Elkouiri et al., 2020; Lehr et al., 2012; Lehr & Banning, 2018).

Indirect employment represents a second mechanism. The production of inputs required for renewable energy, such as metals, cables, transformers, cement, and batteries, creates substantial employment in the metallurgical, electromechanical, and plastics industries, often exceeding that of the energy sector itself (Gielen et al., 2019). Transportation, logistics, and storage of components also generate specialised jobs, particularly in remote areas, requiring personnel for handling and security of materials (IRENA, 2020). Additionally, regulatory and financial services associated with renewable energy require legal and financial experts to ensure sector compliance and effective policy implementation (Bowen, 2012). Finally, induced employment constitutes a third channel. Wages in the renewable energy sector increase household consumption and investment, generating additional jobs across other sectors in line with the Keynesian multiplier effect. In developing countries, access to clean energy also promotes micro-entrepreneurship and related activities, such as workshops, small-scale mills, food preservation, and local services (IRENA, 2020).

Overall, renewable energy promotes direct, indirect, and induced employment, supporting structural transformation, local development, and macroeconomic stability in developing countries.

2.2. Empirical Evidence of Job Creation by Renewable Energy

Empirical evidence overwhelmingly indicates that renewable energy (RE) contributes significantly to employment generation across various regions, sectors, and technological contexts. Indeed, renewable energy deployment creates opportunities not only through direct employment in the production, installation, and maintenance of renewable energy technologies but also via indirect and induced effects across supply chains and related service sectors. For example, Blanco and Rodrigues (2009) investigated the impact of wind energy on direct employment in European Union countries and found that renewable energy firms, particularly within the wind sector, employed approximately 104,350 individuals in 2008, representing a 226% increase compared to 2003. Similarly, Przychodzen and Przychodzen (2020) analysed data from 27 post-socialist countries in Central and Eastern Europe, the Caucasus, and Central Asia over the period 1990–2014, demonstrating that renewable energy

development fosters job creation in transitioning economies, particularly when investments are complemented by supportive institutional frameworks and financial incentives. These findings suggest that, under conducive conditions, renewable energy can simultaneously contribute to environmental sustainability and socioeconomic development by enhancing local employment opportunities.

Moreover, in the United States, Yi (2013) examined 361 metropolitan areas to assess the employment implications of regional adoption of sustainability standards promulgated by the International Council for Local Environmental Initiatives (ICLEI). Using ordinary least squares (OLS) for preliminary analysis and two-stage probit least squares (2SPLS) for final estimation, Yi (2013) found that regions adhering to ICLEI standards maintained, on average, 9.3% more jobs than non-adherent regions. In addition, each additional state-level clean energy policy was associated with a 1% increase in green jobs, indicating that the policy environment plays a critical role in determining the employment impact of renewable energy initiatives.

Similarly, evidence from the Middle East further reinforces these conclusions. Van der Zwaan et al. (2013) employed the TIAM-ECN integrated assessment model to estimate employment impacts from wind and solar energy expansion and projected approximately 155,000 direct jobs and 115,000 indirect jobs. Likewise, in Portugal, Oliveira et al. (2013) demonstrated that the local production of renewable energy equipment generates substantial employment through both direct manufacturing and ancillary supply chains. Furthermore, Markaki et al. (2013) estimated that investments in renewable energy totalling €47.9 billion over the 2010–2020 period would generate approximately 108,000 full-time jobs annually and yield an average annual GDP increase of €9.4 billion, illustrating the dual contribution of renewable energy to economic growth and employment creation. In addition, biomass energy has been found to exert a notable positive effect on employment. Tourkolias and Mirasgedis (2011) in Greece quantified the direct physical effects of renewable energy deployment on employment and monetised the associated benefits using a two-step methodological approach, demonstrating significant economic and labour market gains.

In the United Kingdom, Arvanitopoulos and Agnolucci (2020) applied a two-step approach encompassing theoretical reduced-form modelling and econometric estimation, including unit root tests and a vector error correction model (VECM), to analyse renewable energy employment from 1990 to 2016. Their results indicated that renewable energy generates approximately six times more jobs than fossil fuel industries, highlighting the labour-intensive nature of renewable energy relative to conventional energy sources. Within the European Union, Bali Swain et al. (2022) employed a panel vector autoregressive regression using data from 28 EU countries and Norway, revealing that renewable energy exerts a positive and statistically significant effect on employment, albeit modest in magnitude. Similarly, in China, Mu et al. (2018) estimated that a one-terawatt-hour expansion in solar photovoltaic capacity creates between 15,800 and 45,100 direct and indirect jobs. In addition, Llera Sastresa et al. (2010) confirmed that renewable energy enhances both the quantity and quality of employment, using metrics such as jobs per megawatt installed and quality-adjusted employment factors.

Expanding on these insights, Wysocka (2023) examined renewable energy deployment in Poland between 2005 and 2020, employing panel data econometric models, including fixed-effects regression and input-output analysis, to estimate direct, indirect, and induced employment effects. The study found that investments in renewable energy significantly generate jobs, particularly in manufacturing, installation, and maintenance, with stronger effects observed in regions with higher deployment levels. Complementing this, Malamatenios (2016) qualitatively explored the employment effects of renewable energy, focusing on the skills required and existing education and training gaps across multiple sectors. The study highlighted substantial employment creation within renewable energy industries while simultaneously emphasising the need for targeted workforce development programs to support sustainable and inclusive labour market growth. Taken together, these studies provide robust empirical evidence that renewable energy can act as a catalyst for employment creation, driving both economic growth and social development.

Nevertheless, despite the broadly positive evidence, not all studies indicate that increasing renewable energy deployment automatically reduces unemployment or generates net employment gains. For instance, Hanna, Heptonstall, and Gross (2024) conducted a systematic review of international evidence on job creation in the transition to renewable energy and energy efficiency. Their analysis revealed that the effects of renewable energy on employment are highly context-dependent. In particular, in some instances, expansion in renewable energy and energy efficiency sectors did not reduce unemployment, largely due to job displacement in conventional energy sectors or insufficient labour absorption capacity. Similarly, Saboori et al. (2022) examined the relationship between renewable energy production and unemployment rates across U.S. states using panel data econometric models covering several decades. Their findings were mixed: while some states experienced reductions in unemployment with increased renewable energy production, in others, there was no significant effect, or in certain cases, unemployment increased slightly. The study highlighted the influence of regional economic structures, labour market conditions, and technological development levels in determining labour market outcomes.

In a similar vein, Nteegah and Dinyelu (2025) investigated the impact of energy utilisation, including renewable energy, on unemployment in Nigeria. Using national-level econometric analysis, they found that increases in energy access and renewable energy deployment did not consistently reduce unemployment. Moreover, in some cases, energy expansion had negligible or even slightly adverse effects on labour market outcomes, reflecting structural constraints, skill mismatches, and limited labour absorption capacity. Collectively, these studies highlight that renewable energy expansion alone is insufficient to ensure sustainable employment creation. Instead, complementary policies, including workforce training, labour market interventions, and supportive institutional frameworks, are essential to translate energy investments into inclusive and lasting job opportunities.

In conclusion, the existing literature demonstrates a nuanced and context-sensitive relationship between renewable energy and employment. While numerous empirical studies consistently show that renewable energy projects contribute positively to job creation across regions, sectors, and technologies, others highlight scenarios in which renewable energy expansion does not automatically reduce unemployment.

This divergence accentuates the importance of considering local economic structures, labour market characteristics, technological requirements, and policy frameworks when designing renewable energy initiatives. Hence, to maximise the employment benefits of renewable energy, policymakers must adopt an integrated approach that combines technological investments with targeted labour-market policies, workforce training programs, and institutional support mechanisms. By doing so, countries can simultaneously pursue environmental sustainability, economic growth, and inclusive labour market outcomes.

Section III. Methodology

3.1. Econometric Equation

To empirically examine the relationship between renewable energy and employment in developing countries (list of countries, Appendix 1) over the period 2000–2022, the analysis builds upon the theoretical and empirical foundations established by Przychodzen & Przychodzen (2020) and Wysocka (2023), who accentuate the necessity of accounting for the direct, indirect, and induced effects of renewable energy deployment on labour markets. Accordingly, the econometric model to be estimated can be expressed as follows:

$$\begin{aligned}\mathrm{lnEMPi,t} = \alpha 0 + \alpha 1 \mathrm{lnREi,t} + \beta 1 \mathrm{lnGDPGROWTHi,t} + \beta 2 \mathrm{lnGOVEFFECTi,t} + \beta 3 \mathrm{lnFDIi,t} \\ + \beta 4 \mathrm{lnBROADMONi,t} + \beta 5 \mathrm{lnGGFCi,t} + \pi t + \mu i + \varepsilon i,t\end{aligned}$$

The dependent variable, $\ln EMP_{i,t}$, denotes the natural logarithm of employment or the employment rate in country $i$at time t, sourced from the International Labour Organisation (ILO) database. The primary explanatory variable, $\ln RE_{i,t}$, represents the natural logarithm of renewable energy production or investment, obtained from the International Energy Agency (IEA) Statistics.

To control for key macroeconomic and structural determinants, the model includes: $\ln GDPGROWTH_{i,t}$, the logarithm of real GDP growth (World Bank WDI); $\ln GOVEFFECT_{i,t}$, governance effectiveness (Worldwide Governance Indicators); $\ln FDI_{i,t}$, foreign direct investment inflows (WDI); $\ln BROADMON_{i,t}$, broad money supply as a proxy for financial development (IMF IFS); and $\ln GGFC_{i,t}$, gross government final consumption expenditure (WDI). Time-specific effects, π_t, account for common shocks across countries, while country-specific fixed effects, μ_i, capture unobserved heterogeneity. The stochastic error term, $\epsilon_{i,t}$, represents idiosyncratic variation.

3.2. Estimation Technique

Initially, the study used the generalised least squares (GLS)(Bai et al., 2020), the Driscoll & Kraay (1995) and the fixed-effects estimator was applied to address heteroskedasticity (Appendix 2), cross-sectional correlation, and autocorrelation. However, as this estimator does not fully resolve endogeneity, common in panel data when explanatory variables correlate with the error term, a complementary approach is necessary (Table 2).

To address endogeneity, a Two-Stage Least Squares (2SLS) approach based on (Theil, 1953) Theil's (1953) combined moments is used, employing instrumental variables that are exogenous to the model. In this study, renewable electricity production and natural resource rents serve as instruments. Renewable electricity production and natural resource rents are used as instruments because prior studies show they strongly correlate with energy dynamics, ensuring instrument relevance (Apergis & Payne, 2014; Sadorsky, 2009). They are also considered plausibly exogenous in the literature (Bhattacharyya, 2019), as their effects on economic outcomes operate only indirectly through energy structures. The selection of the appropriate model, fixed or random effects, is guided by the Hausman (1978) test; a p-value above 10% indicates the suitability of random effects, whereas a lower p-value favours fixed effects (Appendix 3).

Instrument validity is assessed using the Sargan (1958) and Hansen (1982) tests, with p-values above 10% confirming instrument exogeneity. Additionally, model fit is evaluated via the Within R-squared, capturing intra-individual variation explained by the covariates, and the Between R-squared, reflecting the contribution of fixed effects to overall variation. This methodology ensures robust and consistent estimation of the employment effects of renewable energy in developing countries.

Section IV. Results and Discussions

4.1. Descriptive Statistics

Table 4.1 reports the descriptive statistics. Employment averages 57.89%, ranging from 19.89% to 85.84%, indicating substantial variation across countries. Renewable energy consumption shows considerable heterogeneity as well, with a mean of 45.79%, a minimum of 0.1%, and a maximum of 98.3%. GDP growth is highly volatile, averaging 4.07% but spanning from − 50.34% to 86.83%, reflecting extreme economic fluctuations in the sample. Gross fixed capital formation averages 14.69%, while foreign direct investment, with a mean of 4.09%, varies widely across observations. Broad money supply exhibits significant dispersion, reaching a maximum of 131,119. Government effectiveness averages − 0.53, suggesting generally low governance performance. Energy investment also shows substantial variation, with a mean of 8.67×10^8, highlighting differences in energy sector development and financing across countries.

Table 1
– Summary Statistics

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
Employment	1,978	57.89	12.74	19.89	85.84
Renewable Energy Consumption	1,978	45.79	30.62	0.10	98.30
GDP Growth	1,978	4.07	5.77	-50.34	86.83
Gross Fixed Capital Formation	1,978	14.69	6.30	2.06	50.84
Foreign Direct Investment	1,978	4.09	6.66	-37.17	103.34
Broad Money Supply	1,978	82.13	2,947.86	-99.89	131,119
Government Effectiveness	1,978	-0.53	0.62	-2.23	1.26
Investment in Energy	1,978	8.67e + 08	1.25e + 09	272,262	9.58e + 09
Source: Author calculation					

Figure 1 illustrates a positive relationship between renewable energy consumption (lnrenerg) and employment (lnemp). Most countries cluster between 2–5 on the x-axis and 4–5 on the y-axis, indicating that moderate renewable energy use is generally associated with higher employment. The analysis suggests that renewable energy consumption contributes to job creation in developing countries. However, there is noticeable dispersion, with outliers such as Algeria, Iran, and São Tomé and Principe deviating from the trend, likely reflecting country-specific factors affecting employment or energy consumption. Overall, the plot supports a general positive association, despite some variability.

4.2. Renewable Energy and employment in developing countries: Baseline estimations (Table 2).

The findings in Table 2 reveal that renewable energy consumption has a positive and statistically significant impact on employment in developing countries. Specifically, a 1% increase in renewable energy consumption leads to a 0.0728% rise in employment, ceteris paribus. This result is consistent with theoretical expectations and suggests that scaling up renewable energy can support labour market expansion. The mechanism underlying this relationship operates through direct job creation in the construction, installation, and maintenance of renewable energy systems, as well as through indirect effects linked to improved energy security, reduced production costs, and increased private investment and firm productivity. Over time, the development of renewable energy industries may also facilitate structural transformation and generate more durable employment opportunities. This result suggests

that energy transition policies can simultaneously promote environmental sustainability and foster employment growth. Similar evidence has been reported in the empirical literature, particularly in emerging economies, where renewable energy sectors remain labour-intensive and have demonstrated strong potential for creating green jobs (Hanna et al., 2024; Ma & Wang, 2025). However, the relatively moderate elasticity observed suggests that complementary measures, such as human-capital development and institutional support, are necessary to maximise the employment benefits of renewable energy deployment.

Regarding the control variables, economic growth is found to have a positive and statistically significant effect on employment at the 5% level. A 1% increase in GDP is associated with a 0.0132% rise in employment. This result aligns with conventional growth and labour demand theories, which posit that higher output expansion stimulates labour requirements through several mechanisms. First, economic growth boosts production and investment, encouraging firms to expand their workforce to meet rising demand. Second, growth fosters increased consumption and business confidence, which further drives job creation in both industrial and service sectors. Third, growth may facilitate structural transformation, shifting labour from low-productivity activities into more employment-intensive sectors, particularly in developing economies. This result implies that sustained economic expansion remains a key driver of job creation, and policies that reinforce productive investment, innovation, and private sector development can generate significant employment gains. Similar findings are reported in studies such as Hlongwane & Khobai (2025), particularly in the context of countries where labour markets are more sensitive to growth dynamics.

Government effectiveness, a key measure of institutional quality, has a positive and statistically significant effect on employment at the 1% level. A 1% improvement in government effectiveness is associated with a 0.0206% increase in employment, ceteris paribus. Effective governance enhances regulatory frameworks, reduces bureaucratic inefficiencies, enforces property and contract rights, and improves the business environment, thereby encouraging firm investment and job creation. This finding implies that institutional quality is a critical determinant of labour market performance. Consistent with North (1990), strong institutions shape economic outcomes by creating a stable environment for productive activity. Recent empirical evidence also supports this link; for example, Jomi & Baye (2025) find that improvements in institutional quality significantly increase employment and productivity in Sub-Saharan African countries.

Conversely, the money supply variable, while statistically significant at the 5% level, has a negative effect on employment. A 1% increase in money supply is associated with a 0.00596% decline in employment, ceteris paribus. This likely reflects inflationary pressures arising from excessive monetary expansion, which can increase production costs, reduce real output, and prompt firms to adjust labour demand downward. The result implies that unrestrained monetary growth may have contractionary effects on employment, highlighting the importance of maintaining price stability to support labour market performance. Empirical studies in developing economies similarly find that high inflation, often linked to

rapid increases in money supply, can dampen job creation by raising business uncertainty and lowering investment incentives (Kassouri, 2024; Gu et al., 2025)

Table 2
The Effect of Renewable Energy on Employment in Developing Countries

Variables	GLS	Fixed Effects	Driscoll-Kraay
Renewable Energy	0.0723*** (0.00212)	0.0181*** (0.00482)	0.0728*** (0.00186)
GDP	0.00812*** (0.00125)	0.00415*** (0.000776)	0.0132*** (0.00328)
Money Supply	-0.00225* (0.00122)	-0.00156** (0.000757)	-0.00596** (0.00278)
Public Expenditure	0.00979** (0.00461)	0.0226*** (0.00551)	0.00432 (0.00406)
Governance Effectiveness	0.0168*** (0.00345)	0.0119*** (0.00421)	0.0206*** (0.00694)
FDI	0.00546*** (0.00162)	0.00290** (0.00123)	0.00354 (0.00550)
Constant	4.513*** (0.0170)	4.737*** (0.0256)	4.495*** (0.0219)
Observations	1976	1976	1976
Number of Countries	86	86	86
Fisher (p-value)	0.0000	0.0000	0.0000
R^2 within	–	0.4435	0.5616
Source: Author calculation			

Foreign direct investment (FDI) positively influence employment, with effects significant at the 5% level. A 1% increase in FDI increases job creation by 0.0056%, ceteris paribus, according to generalised least squares (GLS) estimations. Government spending stimulates employment by financing infrastructure, public services, and social programs, generating direct and indirect jobs. FDI promotes employment by introducing capital, technology, and managerial expertise, which enhance productivity and foster business expansion. These findings align with empirical evidence showing that foreign investment contributes significantly to labour market growth in developing countries (Lakemann et al., 2025).

4.3. Renewable Energy and employment in developing countries: Addressing Endogeneity

Endogeneity is a frequent concern in panel data analyses and can lead to biased and inconsistent estimates if not properly addressed. It may arise from omitted variable bias, where relevant explanatory factors are excluded (Wooldridge, 2002), from reverse causality, in which the explanatory variable is influenced by the dependent variable, or from unobserved heterogeneity across units (Mundlak, 1978).

To ensure robust and reliable results, it is therefore essential to account for endogeneity. This section outlines the methods employed to address potential endogeneity in the relationship between renewable energy consumption and employment creation.

Table 3
Renewable Energy and employment in developing countries (2SLS Results)

Variables	**Coefficient**	**Std. Error**	**Significance**
Renewable Energy consumption	0.0779	0.00673	***
GDP	0.0142	0.00346	***
Effectiveness	0.0407	0.0104	***
Money Supply	-0.00364	0.00325	
Public Expenditure	0.00260	0.000864	***
FDI	0.00127	0.000736	*
Renewable Energy Investment	0.0314	0.00356	***
Education Expenditure	0.0120	0.00315	***
Constant	3.834	0.0855	***
Observations	1,962		
Number of countries	86		
Fisher test (p-value)	0.0000		
R-squared	0.4369		
Sargan/Hansen (p-value)	0.4052		
Source: Author calculation			

Estimates obtained using generalised least squares (GLS), fixed-effects, and Driscoll-Kraay models indicate that renewable energy consumption exerts a positive influence on employment in developing countries. To enhance the robustness of these results and address potential endogeneity, a two-stage least squares (2SLS) approach was employed. The analysis confirms that renewable energy continues to have a positive effect on employment, with statistical significance rising to the 1% level. Specifically, a 1% increase in renewable energy consumption is associated with a 0.0779% increase in employment. This coefficient in Table 3 exceeds that of the previous models, highlighting the robustness of the 2SLS estimates. These findings are consistent with prior empirical evidence demonstrating that renewable energy expansion fosters job creation (Aldieri et al., 2019; Fragkos & Paroussos, 2018).

Economic growth (GDP) exerts a robust and positive influence on employment, attaining statistical significance at the 1% level, with a coefficient of 0.0142%, thereby confirming its pivotal role in labour

demand through mechanisms such as increased production, investment, consumption, and structural shifts toward labour-intensive sectors (Hlongwane & Khobai, 2025). Government effectiveness likewise remains significant at the 1% level, highlighting the critical role of institutional quality in fostering a conducive business environment and facilitating job creation (North, 1990). Conversely, the money supply exhibits a negative but statistically insignificant effect, indicating that excessive monetary expansion may generate inflationary pressures that constrain employment growth (Gu et al., 2025). Public expenditure is positively associated with employment at the 1% significance level, with a 1% increase in government spending corresponding to a 0.0026% rise in employment, reflecting the stimulatory effects of infrastructure, public services, and social programs. Moreover, investments in renewable energy and education significantly enhance employment, reinforcing their role as sustainable and strategic drivers of labor market expansion in developing economies (Aldieri et al., 2019; Fragkos & Paroussos, 2018).

Section V. Conclusion

The transition to renewable energy represents not only an environmental imperative but also a significant opportunity for socioeconomic development, particularly in developing countries. Against the backdrop of rising energy demand, climate change challenges, and persistent unemployment, understanding the employment implications of renewable energy expansion is critical. This study examines the relationship between renewable energy consumption and employment across 85 developing countries from 2000 to 2022, controlling for key macroeconomic, institutional, and financial determinants. The results consistently demonstrate that renewable energy deployment contributes positively to job creation. Baseline estimations using GLS, fixed-effects, and Driscoll-Kraay models indicate that an increase in renewable energy consumption is associated with an improvement in employment. Addressing potential endogeneity through a Two-Stage Least Squares approach reinforces these findings, which underscores the robustness of the relationship. In addition to renewable energy investment, economic growth, government effectiveness, public expenditure, and investment in education significantly enhance employment outcomes, while excessive monetary expansion may constrain labour demand.

The findings suggest that renewable energy expansion alone is insufficient to guarantee sustained employment growth, as labour market absorption, skill mismatches, and structural economic constraints may limit the translation of energy investments into durable jobs. To maximise the employment benefits of renewable energy, it is essential to implement integrated policies that combine energy transition initiatives with labour-market strategies, education and vocational training tailored to green sectors, and institutional strengthening that enhances governance and the business environment. Coordinated public investments in infrastructure and renewable energy projects, along with measures to support workforce mobility and skill retraining, can further ensure inclusive and sustainable job creation. Overall, renewable energy represents a dual opportunity to advance environmental sustainability and foster employment generation. When complemented by supportive policies, strong institutions, and human-capital development, it can drive inclusive growth, structural transformation, and long-term macroeconomic stability in developing countries.

Declarations

Conflict of interest statement

I certify that I have no affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

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Author Contribution

Michael Kouadio conceived the study, designed the methodology, conducted the data analysis, and wrote the original draft of the manuscript. The author also reviewed and approved the final version of the manuscript.

Data availability statement

We collected Data from the World Development Indicators (WDI) and World Governance Indicators (WGI), and BCEAO for the eight West African Economic and Monetary Union (WAEMU) countries. Additionally, data will be available upon request.

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Figures

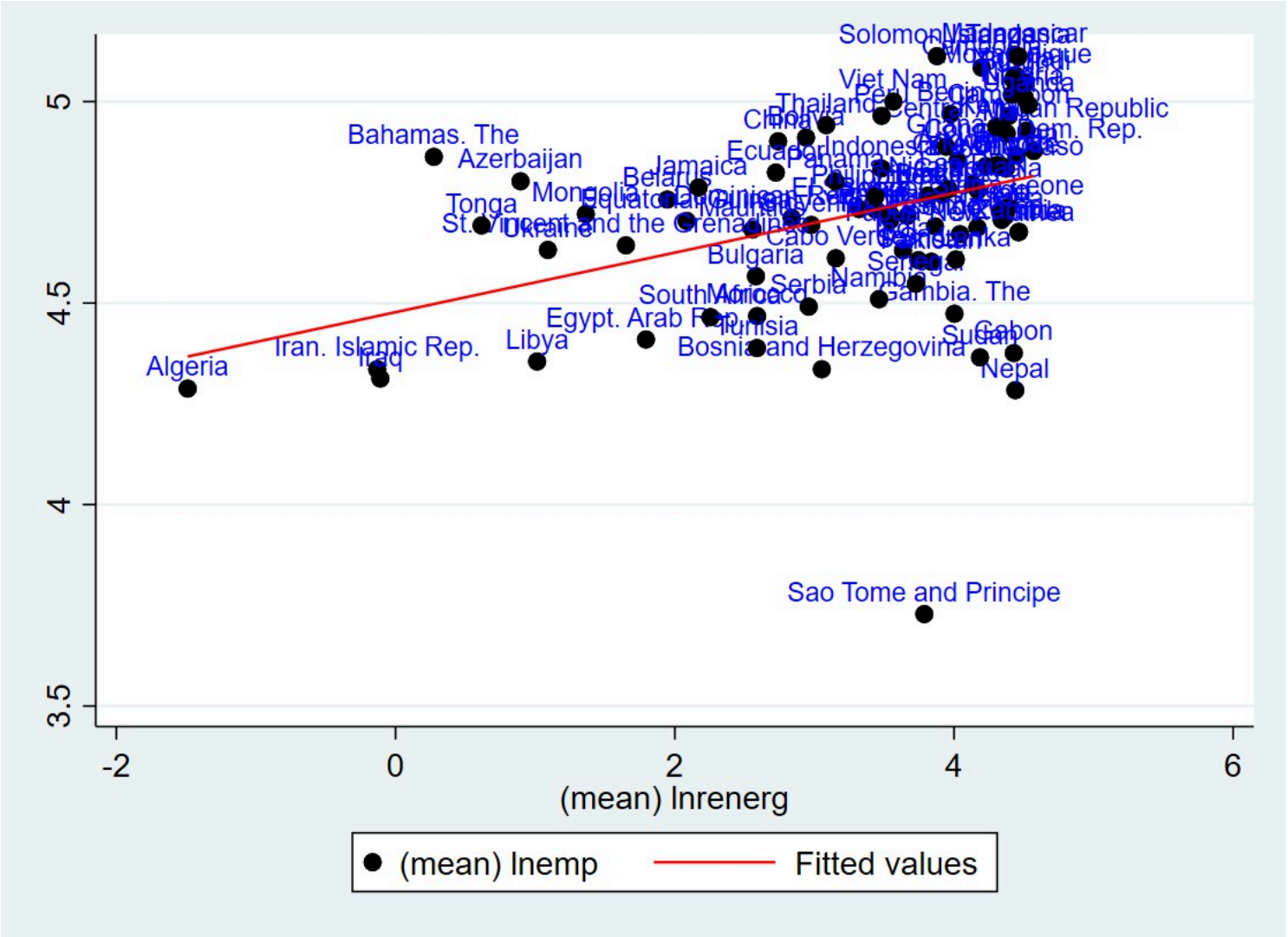

Figure 1

Employment and Renewable Energy Dynamics in developing countries

Source: Author calculation

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