
Renewable Energy Consumption and Energy Accessibility in Kenya

Lydia Jeptoo Kitum¹, Hillary Ndambiri², Yabesh Ombwori Kongo³

^{1,2,3} Department of Economics, Moi University, Kenya

ABSTRACT: Renewable energy is important for enhancing energy accessibility, supporting broader development goals, and ensuring environmental sustainability. This study investigates the influence of four types of renewable energy, namely solar, wind, hydroelectric, and geothermal energy, on energy accessibility in Kenya, guided by the Energy Justice Theory and Energy Stacking Theory. An explanatory research design was adopted using annual secondary data from 1990 to 2023 sourced from the World Bank, IEA, KNBS, and EPRA. Hypotheses were tested through an Autoregressive Distributed Lag (ARDL) model with lag order selected using information criteria. The estimated ARDL (4,4,4,1,4) model reveals that renewable energy sources significantly influence energy accessibility in both the short and long run. Long-run results show that solar energy exerts a positive and statistically significant effect on energy accessibility ($\beta = 73.8975$, $p = 0.002$), hydroelectric energy shows a positive and significant effect ($\beta = 0.8807$, $p < 0.001$), and geothermal energy similarly contributes positively ($\beta = 0.1360$, $p < 0.001$). In contrast, wind energy exhibits a negative and statistically significant long-run relationship ($\beta = -0.2623$, $p = 0.023$), attributed to grid integration challenges and intermittency. The error correction term is negative and significant ($\beta = -5.472$, $p < 0.001$), confirming rapid adjustment to long-run equilibrium. Diagnostic tests confirm that the model is well specified, showing normality, no multicollinearity, homoscedasticity, and no serial correlation. The model explains 97.57% of variation in energy accessibility ($R^2 = 0.9757$). The study recommends strengthening pay-as-you-go solar models, upgrading transmission infrastructure in wind-rich regions such as Turkana, modernising hydroelectric infrastructure with climate-smart planning, and accelerating geothermal exploration through concessional financing and private partnerships.

KEYWORDS: Renewable Energy, Energy Accessibility, ARDL Model, Solar Energy, Wind Energy, Hydroelectricity, Geothermal Energy, Kenya

1. INTRODUCTION

Access to affordable, reliable, and sustainable energy is a foundational pillar for socioeconomic development and a key enabler of human welfare, economic growth, and environmental sustainability. This aspiration aligns with Sustainable Development Goal 7 (SDG 7), which envisions universal energy access powered increasingly by renewable sources such as solar, wind, geothermal, and hydroelectricity. Kenya has made notable strides toward this vision, with electricity coverage reaching approximately 75% in 2023 and installed generation capacity growing from 1,800 MW in 2014 to 2,990 MW in 2021 (Ministry of Energy, 2023). However, significant disparities persist, particularly in rural and marginalised communities where infrastructure remains weak, and supply is intermittent.

Kenya possesses abundant renewable energy potential. The country records solar insolation averaging 4–6 kWh/m²/day, wind potential exceeding 3,000 MW concentrated in the Rift Valley and northern regions, hydroelectric potential estimated at over 3,000 MW in small-scale systems alone, and geothermal resources of over 10,000 MW along the East African Rift System (EPRA, 2022). Yet only a fraction of this potential has been harnessed. The removal of government energy subsidies in 2023, which caused electricity tariffs to rise by up to 77%, compounded energy affordability challenges for low-income households (KIPPRA, 2023).

Despite growing interest in the nexus between renewable energy and development outcomes, limited empirical evidence specifically links disaggregated renewable energy types to energy accessibility in Kenya. Most existing studies focus on global or regional dynamics and few incorporate frameworks such as Energy Justice Theory or Energy Stacking Theory to explain household energy behaviour. This study addresses that gap by empirically examining how solar, wind, hydroelectric, and geothermal energy consumption individually influence electricity accessibility in Kenya over the period 1990 to 2023 using an ARDL bounds testing approach.

Renewable Energy Consumption and Energy Accessibility in Kenya

2. EMPIRICAL LITERATURE

Muh and Tabet (2019) found that approximately 587 million Sub-Saharan Africans lacked electricity access in 2008, and that renewable energy systems have been central to reducing that deficit. Zhao et al. (2022) confirm that increased renewable energy consumption improves global electricity access. Bogdanov et al. (2021) project that electricity will constitute approximately 89% of total primary energy demand by 2050 as renewables dominate. In Africa, barriers to renewable adoption include limited financing, weak regulatory frameworks, insufficient technical expertise, and governance deficiencies (Mas'ud et al., 2015; Fashina et al., 2018).

For solar energy, Ondraczek (2014) and Rolffs et al. (2015) highlight that pay-as-you-go financing models, enabled by mobile money platforms such as M-Pesa, have substantially accelerated rural solar adoption in Kenya. Karekezi and Kithyoma (2003) confirm hydropower's dominance as a cost-effective baseload source, noting vulnerability to climatic variability. KenGen (2022) identifies the Olkaria geothermal fields as the single largest electricity source in Kenya. Wind energy, led by the 310 MW Lake Turkana Wind Power project, has encountered grid integration and transmission challenges that limit its contribution to end-user accessibility (LTWP, 2022).

Energy Justice Theory frames energy access as a matter of equitable distribution, procedural fairness, and recognition of marginalised groups (Sovacool & Dworkin, 2014; Jenkins et al., 2016). Energy Stacking Theory challenges the linear energy ladder model, recognising that households simultaneously use multiple energy sources based on availability, cost, reliability, and cultural preferences (Masera et al., 2000). In Kenya, households often stack solar home systems for lighting while relying on charcoal for cooking, a behaviour that has direct implications for policy design.

Research Gap

Most reviewed studies focus on global or cross-country contexts, providing generalised findings that may not reflect Kenya's specific socio-economic and infrastructural realities. Few studies employ time-series econometric approaches that disaggregate renewable energy by type and control for structural breaks. Theoretical frameworks such as Energy Justice Theory and Energy Stacking Theory also remain underutilised in empirical analyses of energy access in Kenya. This study addresses these gaps.

3.0 METHODOLOGY

3.1 Target Population, Data Types and Sources

The study used annual secondary time-series data covering 1990 to 2023 (34 observations), sourced from the World Bank, the Kenya National Bureau of Statistics (KNBS), the International Energy Agency (IEA), and the Energy and Petroleum Regulatory Authority (EPRA). Energy accessibility was measured as the percentage of Kenya's population with access to electricity, consistent with global energy reporting practices and its status as a measurable, policy-relevant development indicator. An explanatory research design was adopted to examine causal relationships between renewable energy types and energy accessibility (Cooper & Schindler, 2008).

3.2 Measurement of Variables

Table 3.1 presents the operational definitions and measurements of the study variables.

Table 3.1: Description and Measurement of Variables

Abbreviation	Name of Variable	Description and Measurement
EA	Energy Accessibility	Percentage of the population with access to electricity (Murshed, 2020).
SEP	Solar Energy Production	Solar energy share of total grid supply (EPRA, 2022).
WEP	Wind Energy Production	Wind energy share of total grid supply (LTWP, 2022).
HEP	Hydroelectric Production	Hydropower percentage share of total grid supply (KenGen, 2022).
GEP	Geothermal Production	Geothermal energy production in MW (KenGen, 2022).

Source: Research, 2026

Renewable Energy Consumption and Energy Accessibility in Kenya

3.3 Pre-Estimation and Post-Estimation Tests

Descriptive statistics were computed, including means, standard deviations, minimum and maximum values, and correlation coefficients. Stationarity was assessed using the Augmented Dickey-Fuller (ADF) test. To account for structural breaks that can bias standard unit root tests, the Clemente-Montañés-Reyes (CMR) unit root test with double mean shifts using the Additive Outlier (AO) model was applied. Optimal lag length was selected using the Akaike Information Criterion (AIC), Hannan-Quinn Information Criterion (HQIC), and the Likelihood Ratio test, all of which converged on lag 4 as optimal. Post-estimation diagnostics included the Shapiro-Wilk test for normality, Variance Inflation Factors (VIF) for multicollinearity, the White test for heteroscedasticity, and the Breusch-Godfrey LM test for serial correlation. Data was analysed using R statistical software.

Energy accessibility was modelled as a function of the four renewable energy types:

$$EA = f(SEPt, WEPt, HEPt, GEPt)$$

The specific long-run equation was expressed as:

$$EAt = \theta_0 + \theta_1 SEPt + \theta_2 WEPt + \theta_3 HEPt + \theta_4 GEPt + \mu t$$

The ARDL model was selected because it can simultaneously estimate short-run and long-run dynamics among variables integrated at mixed orders $I(0)$ and $I(1)$, making it well-suited for this dataset (Wooldridge, 2013).

4.0 RESULTS AND DISCUSSIONS

4.1 Descriptive Statistics

Table 4.1 presents the descriptive statistics for all study variables.

Table 4.1: Descriptive Statistics

Variable	Mean	Std. Dev.	Min	Max
Energy Accessibility (%)	33.524	22.016	3.5	76.5
Solar Energy (%)	0.115	0.023	0.079	0.158
Wind Energy (%)	16.919	1.360	12.999	19.412
Hydroelectric (%)	76.948	3.587	71.03	82.87
Geothermal (MW)	42.858	36.479	5.752	113.42

Source: Research, 2026

Energy accessibility has a mean of 33.5% with a wide range (3.5% to 76.5%), confirming substantial disparities across the study period, consistent with Saghir and Banerjee's (2013) documentation of persistent inequalities in developing regions. Hydroelectric energy dominates the energy mix with a mean of 76.9% and low variability, reflecting its historical role as Kenya's baseload source. Solar energy's mean of 0.115% reflects limited but growing contribution. Geothermal energy exhibits high variability (standard deviation = 36.48 MW), reflecting phased large-scale investment cycles in the Olkaria geothermal field.

4.2 Pearson Correlation Coefficients

Table 4.2: Pearson Correlation Coefficients

	Energy Access	Solar	Wind	Hydro	Geothermal
Energy Access (1)	1.000				
Solar (2)	0.9772*	1.000			
Wind (3)	0.4230*	0.4869*	1.000		
Hydro (4)	-0.6884*	-0.7799*	-0.6282*	1.000	
Geothermal (5)	0.8954*	0.9351*	0.5081*	-0.9004*	1.000

Key: indicates significance at 5% **Source:** Research, 2026

Solar energy has the strongest positive correlation with energy accessibility ($r = 0.9772$), followed by geothermal energy ($r = 0.8954$). Wind energy shows a moderate positive correlation ($r = 0.4230$). Hydroelectric energy is negatively correlated with energy accessibility ($r = -0.6884$), suggesting a structural shift in Kenya's energy mix as newer renewables expand. The strong negative correlation between hydro and both solar ($r = -0.7799$) and geothermal ($r = -0.9004$) supports this energy diversification narrative.

Renewable Energy Consumption and Energy Accessibility in Kenya

4.3 Stationarity Tests

Table 4.3 presents the results of the Augmented Dickey-Fuller unit root test at levels and after first differencing.

Table 4.3: Augmented Dickey-Fuller Unit Root Test Results

Variable	Z(t)	1% CV	5% CV	10% CV	p-value	Conclusion
Energy Accessibility	-4.409	-3.696	-2.978	-2.620	0.0003	Stationary I(0)
Solar Energy	-1.416	-3.696	-2.978	-2.620	0.5745	Non-stationary
Wind Energy	-2.291	-3.696	-2.978	-2.620	0.1748	Non-stationary
Hydroelectric	-0.377	-3.696	-2.978	-2.620	0.9139	Non-stationary
Geothermal	2.611	-3.696	-2.978	-2.620	0.9991	Non-stationary
After First Differencing						
D_Solar Energy	-5.997	-3.702	-2.980	-2.622	0.0000	Stationary I(1)
D_Wind Energy	-5.550	-3.702	-2.980	-2.622	0.0000	Stationary I(1)
D_Hydroelectric	-4.481	-3.702	-2.980	-2.622	0.0002	Stationary I(1)
D_Geothermal	-3.385	-3.702	-2.980	-2.622	0.0115	Stationary I(1)

Source: Research, 2026

Energy accessibility is stationary at level I(0), while all renewable energy variables are non-stationary at level and become stationary after first differencing I(1). This mixed integration order justifies the use of the ARDL bounds testing approach. Structural break tests identified significant breaks for energy accessibility in 2003 and 2005; solar energy in 1998 and 2010; wind energy in 1998 and 2007; hydroelectric energy in 2011 and 2016; and geothermal energy in 2008 and 2015, all aligned with major policy reforms, investment cycles, and climatic events in Kenya's energy sector.

4.4 Optimum Lag Length Selection

Table 4.4: Optimum Lag Length Selection

Lag	Log LL	LR Stat	p-value	AIC	HQIC	SBIC
0	-197.229	n/a	n/a	13.4819	13.5566	13.7154
1	-70.976	252.51	0.000	6.7317	7.1800	8.1329*
2	-37.203	67.545	0.000	6.1469	6.9687	8.7158
3	3.699	81.804	0.000	5.0868	6.2821	8.8233
4	43.511	79.624*	0.000	4.0993*	5.6682*	9.0035

Note: indicates selected lag order **Source:** Research, 2026

AIC, HQIC, and the Likelihood Ratio test all converge on lag 4 as optimal. Lag 4 was therefore selected to ensure sufficient dynamic structure is captured without excessively sacrificing degrees of freedom. The SBIC selected lag 1, but AIC and HQIC are generally more suitable in small samples.

4.5 Diagnostic Test Results

Table 4.5: Summary of Post-Estimation Diagnostic Tests

Test	Null Hypothesis	Test Statistic	p-value	Conclusion
Shapiro-Wilk	Residuals normally distributed	W = 0.9709	0.504	H ₀ not rejected: Normality holds
VIF (Mean)	No multicollinearity	VIF = 2.89	n/a	H ₀ not rejected: No multicollinearity

Renewable Energy Consumption and Energy Accessibility in Kenya

Test	Null Hypothesis	Test Statistic	p-value	Conclusion
White Test	Residuals are homoscedastic	$\chi^2(14) = 7.52$	0.913	H ₀ not rejected: Homoscedasticity holds
Breusch-Godfrey LM	No serial correlation	$\chi^2(4) = 2.043$	0.728	H ₀ not rejected: No autocorrelation

Source: Research, 2026

All diagnostic tests confirm model adequacy. Residuals are normally distributed ($W = 0.9709$, $p = 0.504$), free from multicollinearity (mean VIF = 2.89), homoscedastic ($p = 0.913$), and serially uncorrelated ($p = 0.728$). The estimated coefficients and standard errors are therefore reliable for statistical inference.

4.6 ARDL Estimation Results

Table 4.6 presents the long-run and short-run ARDL estimation results.

Table 4.6: ARDL Long-Run and Short-Run Estimation Results

Variable	Coefficient	Std. Error	t-Statistic	p-value	Sig.
Long-Run Coefficients (LR)					
Solar Energy	73.8975	15.7839	4.68	0.002	***
Wind Energy	-0.2623	0.0933	-2.81	0.023	**
Hydroelectric	0.8807	0.0834	10.55	<0.001	***
Geothermal	0.1360	0.0159	8.56	<0.001	***
Error Correction Term (ADJ)					
ECT (L1)	-5.4723	0.8872	-6.17	<0.001	***
Short-Run Coefficients (SR)					
Energy Accessibility LD.	3.2301	0.7005	4.61	0.002	***
Energy Accessibility L2D.	1.7425	0.4598	3.79	0.005	***
Energy Accessibility L3D.	0.3168	0.2127	1.49	0.175	
Solar Energy D1.	-662.7237	126.9759	-5.22	0.001	***
Solar Energy LD.	-582.6251	151.5246	-3.85	0.005	***
Solar Energy L2D.	-433.2236	138.0431	-3.14	0.014	**
Solar Energy L3D.	-221.1622	95.4573	-2.32	0.049	**
Wind Energy D1.	2.9399	0.7684	3.83	0.005	***
Wind Energy LD.	4.5317	0.9358	4.84	0.001	***
Wind Energy L2D.	1.8995	0.7753	2.45	0.040	**
Wind Energy L3D.	0.5362	0.4687	1.14	0.286	
Hydroelectric D1.	-5.0890	0.9443	-5.39	0.001	***
Hydroelectric LD.	-2.3700	0.6618	-3.58	0.007	***
Hydroelectric L2D.	-3.4571	0.7246	-4.77	0.001	***
Hydroelectric L3D.	-2.3804	0.8199	-2.90	0.020	**
Geothermal D1.	-0.3593	0.1554	-2.31	0.049	**

Renewable Energy Consumption and Energy Accessibility in Kenya

Variable	Coefficient	Std. Error	t-Statistic	p-value	Sig.
Constant	-411.0792	79.0502	-5.20	0.001	***

$R^2 = 0.9757$; Adj. $R^2 = 0.9119$; Root MSE = 0.8576; Sample: 1994–2023 ($n = 30$). *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$ Source: Research, 2026

The ARDL model exhibits strong explanatory power with $R^2 = 0.9757$, indicating that approximately 97.57% of variation in energy accessibility is explained by the included renewable energy variables. The adjusted R^2 of 0.9119 further confirms the model's goodness of fit.

Overall, the results show a clear contrast between the long run and the short run. In the long run, solar, hydroelectric, and geothermal energy all have a positive and significant effect on energy accessibility, while wind energy has a negative effect. In the short run, this pattern is largely reversed: solar, hydroelectric, and geothermal energy show negative effects across the lag periods examined, while wind energy shows a positive effect in the early periods that fades by the third year. Energy accessibility also carries some momentum of its own, with its first and second lagged differences positive and significant ($\beta = 3.2301$, $p = 0.002$; $\beta = 1.7425$, $p = 0.005$), though this effect is no longer significant by the third year.

The error correction term is negative and significant ($\beta = -5.472$, $p < 0.001$), confirming that energy accessibility and the renewable energy variables share a stable long-run relationship. The size of the coefficient shows that any gap between the short run and the long run closes within about a year. Because the coefficient is larger than one, the adjustment slightly overshoots before settling, a pattern consistent with a stable but oscillating return to equilibrium rather than a smooth one.

4.7 Hypothesis Testing

All four null hypotheses were tested based on long-run ARDL results at the 5% significance level.

Table 4.7: Hypothesis Testing Summary

H ₀	Statement	Result	Decision
H ₀₁	Solar energy consumption has no significant effect on energy accessibility in Kenya.	$\beta = 73.8975$, $p = 0.002$	Rejected: solar energy positively and significantly improves energy accessibility.
H ₀₂	Wind energy consumption has no significant effect on energy accessibility in Kenya.	$\beta = -0.2623$, $p = 0.023$	Rejected: wind energy has a significant but negative long-run effect.
H ₀₃	Hydroelectricity consumption has no significant effect on energy accessibility in Kenya.	$\beta = 0.8807$, $p < 0.001$	Rejected: hydroelectric energy positively and significantly improves energy accessibility.
H ₀₄	Geothermal energy has no significant effect on energy accessibility in Kenya.	$\beta = 0.1360$, $p < 0.001$	Rejected: geothermal energy positively and significantly improves energy accessibility.

Source: Research, 2026

4.8 Discussion of Findings

4.8.1 Solar Energy and Energy Accessibility

The positive and significant long-run effect of solar energy ($\beta = 73.90$, $p = 0.002$) reflects Kenya's transition toward decentralised renewable systems. Solar PV technology has become increasingly affordable due to global technological advancements and economies of scale, making it a key driver of rural electrification. This supports IRENA (2022), which identifies solar as the most rapidly deployable energy source for expanding electricity access in developing economies. Kenya's policy environment, particularly pay-as-you-go financing models enabled by mobile money platforms such as M-Pesa, has significantly lowered entry barriers for low-income households (Rolffs et al., 2015). Negative short-run coefficients across all lag periods suggest initial adjustment costs and infrastructure investment phases precede long-run benefits, consistent with Hansen et al. (2019), who note that solar energy effectiveness depends on complementary storage and distribution infrastructure.

4.8.2 Wind Energy and Energy Accessibility

The negative and significant long-run effect of wind energy ($\beta = -0.26$, $p = 0.023$) reflects documented structural inefficiencies rather than inherent resource limitations. The Lake Turkana Wind Power project has faced persistent transmission bottlenecks

Renewable Energy Consumption and Energy Accessibility in Kenya

and curtailment issues due to inadequate grid evacuation capacity (LTWP, 2022). Wind's inherent intermittency without adequate storage or balancing systems can destabilise energy supply, reducing effective accessibility (Lund et al., 2015). Short-run positive coefficients ($\beta = 2.94$, $p = 0.005$) suggest wind contributes to immediate accessibility improvements before systemic constraints emerge. These findings imply that addressing transmission and storage infrastructure is critical to converting wind's short-run contribution into positive long-run outcomes (IRENA, 2022).

4.8.3 Hydroelectric Energy and Energy Accessibility

The positive and highly significant long-run effect of hydroelectricity ($\beta = 0.88$, $p < 0.001$) confirms its continued dominance in Kenya's energy mix, consistent with World Bank (2021) reports confirming hydropower as a key pillar of electricity access in East Africa. Once infrastructure is established, low operational costs support affordable tariffs that enhance accessibility (Arango et al., 2018). However, significant negative short-run effects across all lag periods reflect climatic variability, particularly drought impacts on reservoir levels, documented by Opiyo et al. (2018) as a persistent vulnerability in Kenya's hydro-dependent system. Structural breaks in 2011 and 2016 correspond to major drought episodes, reinforcing the need for complementary climate resilience strategies in hydropower planning.

4.8.4 Geothermal Energy and Energy Accessibility

The positive and significant long-run effect of geothermal energy ($\beta = 0.14$, $p < 0.001$) confirms its strategic importance in Kenya's energy transition. KenGen (2022) reports that geothermal contributed over 40% of national electricity in 2021, making it the single largest power source. Geothermal energy has a baseload capacity, meaning it generates continuously regardless of weather conditions, which makes it highly reliable, particularly during dry seasons when hydropower output declines (Muchunku et al., 2019). The relatively smaller coefficient compared to solar and hydro reflects high upfront capital costs and long exploration timelines that constrain rapid expansion (IRENA, 2022). Structural breaks in 2008 and 2015 align with phased capacity additions at the Olkaria geothermal field, confirming that geothermal development proceeds in discrete investment cycles rather than continuous growth.

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusions

The study examined the contribution of four renewable energy types, namely solar, wind, hydroelectric, and geothermal energy, to energy accessibility in Kenya using annual time-series data from 1990 to 2023 and an ARDL econometric framework. The key findings highlight that renewable energy sources play a critical but heterogeneous role in determining energy accessibility. Solar, hydroelectric, and geothermal energy are positive long-run drivers of energy accessibility, reflecting their scalability, reliability, and integration within Kenya's energy infrastructure. Wind energy, however, presents a distinctive challenge, with its negative long-run relationship attributable to grid integration inefficiencies and intermittency constraints rather than inherent resource limitations. The significant error correction term ($\beta = -5.472$, $p < 0.001$) confirms a stable long-run equilibrium, and the model's high explanatory power ($R^2 = 0.9757$) validates its reliability. All short-run dynamics suggest transitional adjustment costs precede long-run gains, reinforcing the importance of sustained investment and complementary infrastructure development.

5.2 Policy Recommendations

Based on the findings, this study recommends several policy measures to enhance renewable energy deployment and accelerate energy accessibility in Kenya.

- Solar energy significantly improves energy accessibility; therefore, the government should strengthen support for pay-as-you-go solar models, reduce import duties on solar equipment, and provide tax incentives to attract private sector investment. Capacity-building programmes for local solar technicians will enhance sustainability and reduce dependence on imported expertise.
- Given the negative long-run relationship between wind energy and energy accessibility, policy efforts should prioritise upgrading transmission infrastructure in wind-rich regions such as Turkana County. Investment in energy storage and hybrid wind-solar or wind-hydro systems will reduce intermittency and improve grid reliability.
- Hydroelectric energy should be sustained through modernisation of existing installations and expansion of small hydropower projects. Climate resilience strategies, including water catchment conservation and climate-smart energy planning, should be integrated into hydropower planning to mitigate drought-related risks.
- Geothermal energy should be further expanded as a baseload source through increased investment in exploration and drilling at untapped fields. Concessional financing, international partnerships, and risk-sharing mechanisms with private investors should be pursued to address high upfront capital costs and accelerate development timelines.

5.3 Recommendations for Future Research

Future studies could investigate interaction effects and complementarities among renewable energy types, such as solar-wind-storage or hydro-geothermal hybrid systems. Panel data approaches across East African countries would enable cross-country comparisons and determine whether Kenya's experience reflects broader regional energy transition patterns. Research explicitly examining equity dimensions of renewable energy deployment, informed by Energy Justice Theory, would also generate valuable insights for inclusive policy design.

REFERENCES

- 1) Apergis, N., & Payne, J. E. (2014). Renewable energy, output, and growth dynamics. *Energy Economics*, 42, 226–232.
- 2) Bogdanov, D., Ram, M., Aghahosseini, A., Gulagi, A., Oyewo, A. S., Child, M., & Breyer, C. (2021). Low-cost renewable electricity as the key driver of the global energy transition towards sustainability. *Energy*, 227, 120467.
- 3) Cooper, D., & Schindler, P. (2008). *Business Research Methods* (10th ed.). McGraw-Hill/Irwin.
- 4) EPRA. (2022). *Energy and Petroleum Statistics Report 2022*. Nairobi: Energy and Petroleum Regulatory Authority.
- 5) Fashina, A., Mundu, M., Akiyode, O., Abdullah, L., Sanni, D., & Ounyesiga, L. (2018). The drivers and barriers of renewable energy applications and development in Uganda: a review. *Clean Technologies*, 1(1), 9–39.
- 6) Gujarati, D. N., & Porter, D. C. (2009). *Basic Econometrics* (5th ed.). McGraw-Hill Education.
- 7) IEA. (2023). *World Energy Outlook 2023*. Paris: International Energy Agency.
- 8) IRENA. (2020). *Renewable Energy Statistics 2020*. Abu Dhabi: International Renewable Energy Agency.
- 9) IRENA. (2022). *Renewable Power Generation Costs in 2021*. Abu Dhabi: International Renewable Energy Agency.
- 10) Jenkins, K., McCauley, D., Heffron, R., Stephan, H., & Rehner, R. (2016). Energy justice: A conceptual review. *Energy Research & Social Science*, 11, 174–182.
- 11) Karekezi, S., & Kithyoma, W. (2003). Renewable energy in Africa: Prospects and limits. AFREPREN.
- 12) KenGen. (2022). *Annual Report and Financial Statements 2021/2022*. Nairobi: Kenya Electricity Generating Company.
- 13) Kiplagat, J. K., Wang, R. Z., & Li, T. X. (2011). Renewable energy in Kenya: Resource potential and status of exploitation. *Renewable and Sustainable Energy Reviews*, 15(6), 2960–2973.
- 14) KIPPRA. (2023). Addressing high electricity prices to improve Kenyan households' welfare. Nairobi: Kenya Institute for Public Policy Research and Analysis.
- 15) KNBS. (2020). *Kenya Integrated Household Budget Survey 2019–2020*. Nairobi: Kenya National Bureau of Statistics.
- 16) LTWP. (2022). *Lake Turkana Wind Power Project Overview*. Nairobi: Lake Turkana Wind Power Ltd.
- 17) Mas'ud, A. A., Wirba, A. V., Muhammad-Sukki, F., Mas'ud, I. A., Munir, A. B., & Yunus, N. M. (2015). An assessment of renewable energy readiness in Africa. *Renewable and Sustainable Energy Reviews*, 51, 775–784.
- 18) Masera, O. R., Saatkamp, B. D., & Kammen, D. M. (2000). From linear fuel switching to multiple cooking strategies: a critique and alternative to the energy ladder model. *World Development*, 28(12), 2083–2103.
- 19) Ministry of Energy. (2023). *Kenya Energy Sector Overview*. Nairobi: Government of Kenya.
- 20) Mohammed, Y. S., Mustafa, M. W., & Bashir, N. (2013). Status of renewable energy consumption and developmental challenges in Sub-Sahara Africa. *Renewable and Sustainable Energy Reviews*, 27, 453–463.
- 21) Muh, E., & Tabet, F. (2019). Comparative analysis of hybrid renewable energy systems for off-grid applications in Southern Cameroons. *Renewable Energy*, 135, 41–54.
- 22) Murshed, M. (2020). An empirical analysis of the non-linear impacts of ICT-trade openness on renewable energy transition. *Environmental Science and Pollution Research*, 27(29), 36254–36281.
- 23) Ogola, P. F. A., Davidsdottir, B., & Fridleifsson, I. B. (2012). Potential contribution of geothermal energy to climate change adaptation. *Renewable and Sustainable Energy Reviews*, 16(6), 4222–4246.
- 24) Ondraczek, J. (2014). Are we there yet? Improving solar PV economics and power planning in developing countries: The case of Kenya. *Renewable and Sustainable Energy Reviews*, 30, 604–615.
- 25) Opiyo, N. N. (2018). Energy services for rural sub-Saharan Africa. *Renewable and Sustainable Energy Reviews*, 81, 1637–1648.
- 26) REN21. (2022). *Renewables 2022 Global Status Report*. Paris: Renewable Energy Policy Network for the 21st Century.
- 27) Rolffs, P., Byrne, R., & Ockwell, D. (2015). Financing sustainable energy for all: Pay-as-you-go vs traditional solar finance approaches in Kenya. *Energy Research & Social Science*, 5, 220–229.
- 28) Rotich, I. K., Chepkirui, H., Musyimi, P. K., & Kipruto, G. (2024). Geothermal energy in Kenya: Evaluating health impacts and environmental challenges. *Energy for Sustainable Development*, 82, 101522.

Renewable Energy Consumption and Energy Accessibility in Kenya

- 29) Sadorsky, P. (2009). Renewable energy consumption and income in emerging economies. *Energy Policy*, 37(10), 4021–4028.
- 30) Saidi, K., & Omri, A. (2020). The impact of renewable energy on carbon emissions and economic growth in 15 major renewable energy-consuming countries. *Environmental Research*, 186, 109567.
- 31) Salkind, N. J. (Ed.). (2010). *Encyclopedia of Research Design* (Vol. 1). Sage.
- 32) Shahbaz, M., Raghutla, C., Song, M., Nanthakumar, L., & Moinuddin, M. (2020). The effect of urbanization, affluence and trade openness on energy consumption. *Energy*, 203, 117556.
- 33) Sovacool, B. K., & Dworkin, M. H. (2014). *Global Energy Justice: Problems, Principles, and Practices*. Cambridge University Press.
- 34) World Bank. (2021). *World Development Indicators 2021*. Washington, DC: World Bank.
- 35) Wooldridge, J. M. (2013). *Introductory Econometrics: A Modern Approach* (5th ed.). South-Western Cengage Learning.
- 36) Zhao, J., Dong, K., Dong, X., & Shahbaz, M. (2022). How renewable energy alleviates energy poverty? A global analysis. *Renewable Energy*, 186, 299–311.



There is an Open Access article, distributed under the term of the Creative Commons Attribution – Non Commercial 4.0 International (CC BY-NC 4.0) (<https://creativecommons.org/licenses/by-nc/4.0/>), which permits remixing, adapting and building upon the work for non-commercial use, provided the original work is properly cited.