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BEYOND ENERGY: THE ROLE OF COLONIAL LEGACY IN THE EFFECT OF INSTITUTIONAL QUALITY ON RENEWABLE ENERGY CONSUMPTION IN WEST AFRICA

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Abstract
A stable institutional framework and colonial legacy are essential for ensuring environmental quality and economic growth. However, recent studies have overlooked these critical factors despite their significance. This study, therefore, explored the impact of institutional quality on renewable energy consumption in West Africa from 1990 to 2023 with a novel incorporation of the influence of colonial legacy. Using data from the World Bank's World Development Indicator, this study utilised the Pooled Mean Group technique. The study found that in the long run, GDP per capita, carbon dioxide emissions and urbanisation had a significant negative impact on renewable energy consumption whereas technology, institutional quality, and the interaction of institution with colonial legacy had a significant positive impact on renewable energy consumption. The study concludes that technology, institutional quality and the interaction of institution with colonial legacy exert a positive effect on renewable energy consumption while GDP per capita, carbon dioxide emissions and urbanisation exert a negative effect on renewable energy consumption. Hence, to achieve sustainable development, the study recommends that policymakers prioritise institutional stability while leveraging technological advancements to promote renewable energy production. Policymakers and international organisations should consider the unique historical and institutional context of West African countries when designing renewable energy policies and programmes.
Keywords: *Renewable energy, institutional quality, energy economics, colonial legacy.*
JEL Codes: Q42, D02, Q43, N40

1. Introduction

Evident by its vast distinction, West Africa is habitat to an estimated 400 million individuals, constituting roughly a third of the sub-Saharan Africa's populace. However, despite its many strengths, the region faces a significant challenge that unifies all: limited access to modern energy. Presently, 87% of West Africans lack accessibility to environmentally friendly cooking fuels and technology, and 47% lack electrical power (IRENA & AfDB, 2022).

The West African region is richly endowed with renewable energy resources including solar, wind and hydropower. These resources can be harnessed to drive regional integration and economic development. The region's energy sector is undergoing significant transformation, with large-scale renewable energy projects being developed. A notable example is the establishment of four 150 megawatt (MW) regional solar parks in Burkina Faso, The Gambia, Mali and Niger, supported by the World Bank. The ECOWAS Master Plan calls for these projects to reach a total capacity of 600 megawatts. The region's dedication to the expansion of renewable energy is demonstrated by the incorporation of these initiatives into the regional power pool (WAPP) (ECOWAS et al., 2018, as cited in IRENA, 2023).

Nonetheless, West Africa has numerous challenges, including a highly unstable energy system, volatile fuel prices, and an unsteady electrical grid. The lack of energy remains a significant obstacle to local economic and social development, with far-fetching consequences for the region's inhabitants. West Africa's energy sector is characterised by limited accessibility to clean energy sources, a heavy reliance on biomass fuels for cooking, and substantial indoor air pollution. While West Africa has made progress in expanding electricity access, with a rate of 53% over the past two decades, a substantial rural-urban divide persists. Moreover, electricity demand is expected to more than double by 2030 underscoring the need for sustainable energy solutions. (IRENA & AfDB, 2022).

Institutional development is a critical issue in Africa, where energy access remains a significant challenge. The prevalence of low-quality institutions has contributed to the economic vulnerability of many African states. Furthermore, the legacy of colonialism has had a lasting impact on institutional development, perpetuating decay and undermining economic growth, (Bertocchi & Guerzoni, 2012). At independence, many African countries inherited flawed institutions established during colonial rule, leading to widespread poverty across the continent, (Acemoglu & Robinson, 2010).

French, British, and Portuguese colonial rulers imposed varying degrees of political, economic, and cultural domination on West African countries over the course of history. These various colonial experiences will inevitably continue to have an impact in post-independence periods. The impacts have a variety of channels, some of which are positively or negatively related to economic growth. Whether this study has a positive or negative overall impact depends on empirical research.

Despite the growing importance of renewable energy, empirical research on the impact of institutions on renewable energy consumption remains scarce. Most studies such as Sultonov et al. (2024) and Yassin (2021) among others, focused on the effects of macroeconomic variables on renewable energy consumption. This study, therefore, sought to fill this knowledge gap by investigating the impact of institutional quality on renewable energy consumption in West Africa.

This study makes a unique contribution to the body of knowledge by examining the interaction of colonial legacy and institutional quality to capture the disparities in African nations. This study classified the 16 West African countries into three groups based on their colonial heritage: *British colonies* (Ghana, Nigeria, Liberia, Sierra Leone and Gambia), *French colonies* (Benin, Burkina Faso, Cote d'Ivoire, Guinea, Mali, Mauritania, Niger, Senegal and Togo) and *Portuguese colonies* (Cape Verde and Guinea-Bissau) to better capture the disparities in the region. Although, Liberia is not formally colonised by the British, it was established by the American Colonization Society and had strong British influence.

Another novelty of this study is concerned with the measure of institutional quality. This study adopts Country Policy and Institutional Assessment (CPIA) as a proxy, which makes it differ from the regular Rule of Law or Government effectiveness indices adopted by previous authors. CPIA public sector management and institutions cluster average (1=low to 6=high) evaluates how well a nation's policies and institutional structure promote sustainable growth and poverty reduction and, in turn, the efficient use of development aid.

2. Literature Review

Renewable Energy

Renewable energy, often known as clean energy, originates from naturally occurring processes or sources that are continuously renewed. For instance, wind and sunshine. Energy from all renewable sources, including hydro, solid biofuels, wind, sun, liquid biofuels, biogas, geothermal, marine, and waste, is referred to as *renewable energy consumption*, (IEA, 2020). Electricity is the foundation of Africa's new energy systems, which is fueled mostly by renewable sources. Africa has just 1% of the world's installed solar PV capacity, despite having 60% of the world's finest solar resources. By 2030, solar photovoltaics (PV), which is now the least expensive power source in many regions of Africa, will surpass all other sources on the continent. More than 80% of the Sustainable Africa Scenario (SAS's) new power production capacity until 2030 will come from renewable sources, (IEA, 2020).

Institutional Quality

Institutional quality, according to the World Bank (2023), is an indicator of a nation's level of institutions and governance. The quality of institutions and policies in each of the 39 international development association nations in Sub-Sahara Africa for the year 2022 based on four categories—economic management, structural policies, social inclusion and equality policies, and public sector management and institutions—reported that the average total CPIA score was constant at 3.1. Even while many nations improved their structural and social inclusion programs, these achievements were countered by stagnation in public sector management, institutions and economic management, (World Bank, 2023).

Colonial Legacy

Colonial legacy refers to the enduring effects and results of colonialism, revealing the interaction between colonial interventions and domestic policymaking in modern economic, political, and social structures (Rodney, 1972). During various historical periods, West African nations were subjected to differing degrees of political, economic, and cultural dominance by colonial masters—France, Britain, and Portugal. The effects of these divergent colonial experiences are bound to persist in post-independence eras.

Empirical Review

There is a significant push to diversify beyond the fossil fuel economy and quicken the shift to renewable energy and energy-efficient solutions as the global community deals with the conflicting demands to battle climate change and revitalize the economy. Recent increases in renewable energy capacity support the goals of many nations in the region, especially those with economies that rely heavily on energy imports, to abandon the fossil fuel-based model of development, lower the carbon intensity of growth, and increase access to energy for underserved and crisis-affected communities (Arab Future Energy Index 2023). In light of this, studies are being conducted to examine the effects of many factors on the use of renewable energy, including macroeconomic, investment, institutional quality, etc.

A study by Ragosa and Warren (2019), investigated the factors that influence international investment in emerging nations' renewable energy sectors. The findings indicated that international public finance, regulatory quality and political stability are crucial factors that drive investment in renewable energy sector. In contrast, the study found that the business environment did not have a statistically significant effect on renewable energy investment.

Haldar and Sethi (2020) investigated the moderating role of institutional quality on the impact of energy consumption on carbon dioxide emission in 39 developing countries for 1995 2017. The analysis incorporated other variables such as trade, capital formation, foreign direct investment, financial development and population. Employing a range of estimation techniques, the study revealed that institutional quality plays a crucial role in moderating the impact of energy consumption carbon dioxide emissions. The findings highlight the importance of institutional quality and renewable energy in mitigating CO2 emission, emphasising the need for policymakers to focus on improving institutional quality and promoting renewable energy to achieve sustainable climate goals.

In another study by Uzar (2020) examined the connection between renewable energy and institutional quality in 38 countries from 1990-2015. The analysis included economic growth and carbon dioxide emissions as control variables. The findings indicate that, in the long run, institutional quality and CO2 emission has a positive impact on renewable energy consumption. However, economic growth negatively affects renewable energy. The findings emphasise the importance of institutional quality promoting the use of renewable energy and addressing environmental problems. Dube and Horvey (2023) investigated the linear and nonlinear link between institutional quality and renewable energy capital flows in 20 African countries from 2002 to 2017. The study employed the generalised method of moments estimation technique to provide empirical evidence that institutional quality had a substantial and positive impact on renewable energy capital flows. The findings suggest that strong institutions are a crucial driver of investments in renewable energy in Africa.

A recent study by Chen et al. (2024) investigated the interrelationships between renewable energy, institutional quality, FDI, economic growth on environmental pollution in E7 countries. The study utilised annual data from 2002 to 2023 and employed the panel Nonlinear Autoregressive Distributed Lag (NARDL). The results show that carbon dioxide emission display an uneven response to positive and negative shocks in external factors. Gyimah et al. (2024) investigated how government institutions, economic growth, globalization, financial inclusion, and renewable energy affected carbon emissions between 1998 and 2021 using the Partial Least Squares method. The results show that while financial inclusion has a detrimental effect on the usage of renewable energy, globalization encourages the use of renewable energy. Additionally, the study discovered that carbon emissions are directly, favorably, and significantly reduced by renewable energy.

Using yearly data from 1980 to 2014, Rafiq et al. (2024) examined the effect of institutional quality on the advancement of renewable energy in 18 OECD economies. The analysis of the long-run estimations revealed that better institutional quality had a significant and positive impact on renewable energy consumption, highlighting the crucial role of institutional quality in promoting renewable energy.

Appraisal of previous studies showed that the area of the effect of institutional quality on renewable energy consumption has been underexplored while existing research often focused more on the macroeconomic effects of renewable energy either on the whole of Africa or country-specific, this study addresses the effect of institutional quality on renewable energy consumption while taking into consideration the colonial legacy in order to capture the disparity in the West African States.

3. Methodology

The following research model is used to evaluate the long-term association between institutional quality and renewable energy consumption based on the traditional neoclassical growth theory:

$$REN_{it} = \varphi_0 + \varphi_1 GDP_{it} + \varphi_2 CEM_{it} + \varphi_3 INS_{it} + \lambda_1 D_{BRI} + \lambda_2 D_{FRE} + \lambda_3 (INS_{it} \times D_{BRI}) + \lambda_4 (INS_{it} \times D_{FRE}) + \varphi_4 TEC_{it} + \varphi_5 URB_{it} + \varepsilon_{it}$$

where

REN = renewable energy consumption (% of total final energy consumption)

GDP = gross domestic product per capita growth (annual %)

CEM = Carbon dioxide (CO2) emissions (total)

INS = CPIA Institutions and policies are rated according to the CPIA for environmental sustainability (1=low to 6=high)

TEC = Energy intensity level of primary energy (MJ/$2017 PPP GDP)

URB = Access to electricity, (% of urban population)

D_{BRI} is a dummy variable (equals 1 for British colonies, and 0 otherwise), D_{FRE} is a dummy variable (equals 1 for French colonies, and 0 otherwise) while the reference category is Portuguese colonies.

Panel data covering 16 West African countries for the period between 1990 and 2023 sourced from World Bank Development Indicators were used for the variables.

GDP per capital is included because it is an economic indicator that influences investment and renewable energy consumption. It is informed by studies such as Haldar and Sethi (2020). In order to examine the influence of environmental factors as reducing carbon dioxide emissions is essential for sustainable economic development, *Carbon dioxide emission* is included. This is in line with previous studies such as Uzar (2020).

Institutional quality is considered in this study due to the fact that it facilitates the creation of trade agreements, safeguards intellectual property, and lowers costs associated with transactions, as well as encourage investments. The choice of this variable is informed by past research such as Dube and Horvey (2023).

Consistent with the methodology of some earlier research, including Wang and Zhang (2020), *Technology* is included as a variable to capture the energy efficiency as well as control for the effect of technology on renewable energy consumption. The inclusion of *Urbanisation* as a variable is done in order to capture the effect of access to energy on renewable energy consumption.

4. Results and Discussion

Table 1 presents the statistics that summarize the values and distributions of the variables.

Table 1 The Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
REN = renewable energy consumption (% of total final energy consumption)	544	69.15	20.83	17.1	95
GDP = gross domestic product per capita growth (annual %)	544	1.35	6.87	-44.42	90.76
CEM = Carbon dioxide (CO2) emissions (total)	544	9.01	24.11	0.05	123.31

INS = CPIA policy and institutions for environmental sustainability rating (1=low to 6=high)	544	3.58	0.45	2.97	4.63
TEC = Energy intensity level of primary energy (MJ/$2017 PPP GDP)	544	6.56	3.99	1.19	31.81
URB = Access to electricity, urban (% of urban population)	544	59.25	2.43	-27.89	102.5
D_{BRI} is dummy variable (equals 1 for British colonies, and 0 otherwise)	544	0.31	0.46	0	1
D_{FRE} is dummy variable (equals 1 for French colonies, and 0 otherwise)	544	0.56	0.49	0	1

Source: *Authors' calculation from Stata*

The results from Table 1 show that the mean score for the REN is 69.15 while the minimum and maximum values are 17.1 and 95 respectively. The average score for gross domestic product per capita was 1.35.

The CPIA index's indicator of institutional quality has a mean of 3.58, with lowest and maximum values of 2.97 and 4.63, respectively. This score, which is somewhat higher than the index's predicted average of 3.5, shows that the majority of the study's nations have significantly improved their institutional environment. The average is 6.56 for technology whereas the Urbanisation, which describes the access to electricity recorded an average value of 59.25.

The correlation matrix indicates the relationship between all the variables which is shown in Table 2 below.

Table 2 The Correlation Matrix

	REN	**GDP**	**CEM**	**INS**	**TEC**	**URB**	**$INSD_{BR}$**	**$INSD_{FRE}$**
REN	1							
GDP	-0.088	1						
	(0.040)*							
CEM	0.124	0.013	1					
	(0.003)*	(0.752)						
INS	0.176	-0.139	-0.043	1				
	(0.000)*	(0.001)*	(0.322)					
TEC	0.647	-0.113	0.082	0.202	1			
	(0.000)*	(0.008)*	(0.056)	(0.000)*				
URB	-0.538	0.077	0.335	-0.356	-0.456	1		
	(0.000)*	(0.071)	(0.000)*	(0.000)*	(0.000)*			
D_{BRI}	0.185	-0.029	0.381	0.000	0.215	-0.024	1	
	(0.000)*	(0.499)	(0.000)*	(1.000)	(0.000)*	(0.577)		
D_{FRE}	-0.021	-0.028	-0.266	0.000	-0.215	0.026	-0.765	1
	(0.634)	(0.514)	(0.000)*	(1.000)	(0.000)*	(0.546)	(0.000)*	

*P-values are in parentheses and *represents statistically significance at the 0.05 level.*

Source: *Original work, using Stata*

There is positive relationship observed between REN and variables such as carbon dioxide emission (CEM), institutional quality (INS), technology (TEC) and being a British colony (D_{BRI}), indicating that higher levels of these variables often correspond to increased consumption of renewable energy. On the other hand, there appears to be an inverse relationship between REN and variables such as gross domestic product per capital (GDP) and urbanization (URB), suggesting an inverse relationship with these variables.

Table 3 Results of the ADF Unit Root Tests

Variable	*Critical value 5%*	*P-value*	*Order of Integration*	*Conclusion*
REN	3.057	0.998	I(0)	Stationary at first
	-11.493	0.000	I(1)	difference
GDP	-9.309	0.000	I(0)	Stationary at level
CEM	-11.405	0.000	I(0)	Stationary at level
INS	-4.258	0.000	I(0)	Stationary at level
TEC	-2.003	0.022	I(0)	Stationary at level
URB	-0.845	0.198	I(0)	Stationary at first
	-13.294	0.000	I(1)	difference

Explanatory note: *The decision rule is to reject the null hypothesis that a variable has unit root if the p-value is less than the chosen 5% significance level.*

Source: *Original work, using Stata*

As seen from the Table 3, the results reveal that all the variables, except REN and URB, were stationary at levels at the 5% significance level. This means that the variables had a mixture of I(0) and I(1) series, implying the use of Kao Cointegration test, which is suitable for testing the long-run co-integration. The result of the Kao Cointegration t-stats was -8.975 with p-value of 0.000 which is less than the 0.05 significance level. Accordingly, the null hypothesis was rejected, and it was concluded that the dependent and independent variables had a long-term relationship. This suggests that the equation be estimated using the Panel ARDL method.

4.2 Estimation Results of the Panel Regression Parameters

In this subsection, an evaluation of the diagnostic tests is presented and discussed, followed by the results and discussion of the performance of each of the explanatory variables.

Table 4 Panel ARDL Estimates of the Regression Equation

The pooled mean group (PMG) is the most efficient estimator out of the three (mean group, pooled mean group, and dynamic fixed effect), according to the Hausman test p-value of 0.959. As a result, the PMG results are the only basis for the discussion of the outcome below. Note that only the long-term outcomes are covered below for the sake of conciseness.

PMG Estimation Results

Variables	**Coeff.**	**Z-Stat**	**P-value**
GDP	-0.280	-1.49	0.028
CEM	-0.527	-2.11	0.030
INS	10.322	1.47	0.012
TEC	0.657	1.28	0.019
URB	-0.315	-3.73	0.034
D_{BRI}	7.876	10.21	0.037
D_{FRE}	11.908	12.09	0.012
$INS \times D_{BRI}$	1.404	0.17	0.026
$INS \times D_{FRE}$	10.856	1.37	0.013

Note: *A coefficient is statistically significant if the associated P-value is not more than 0.05. A negative adjustment coefficient indicates the presence of long run convergence.*

Source: *Original work, using Stata*

The results in Table 4 reveal a positive effect of institutional quality (INS) on renewable energy consumption with a coefficient of 10.322 (p = 0.012). This implies that nations with high-quality institutions may draw in investments in renewable energy, and that any country's efforts to strengthen its institutions would be repaid with a rise in investor trust in the renewable energy

industry. Thus, in order to increase the consumption of renewable energy, African nations need to provide a robust institutional framework. This result is in line with Dube and Horvey (2023). The negative but significant coefficient of GDP per capita (GDP) of -0.280 with p-value of 0.028 shows that as a country's GDP per capita increases, it may actually decrease its consumption of renewable energy sources as higher GDP per capita may lead to increased energy demand, which is met by fossil fuels rather than renewable energy consumption. Previous studies, such as Uzar (2020), have found similar results.

The negative coefficient of carbon dioxide emission (CEM) of -0.527 with p-value of 0.030 is not in line with previous studies such as Uzar (2020) where a positive coefficient and significant effect was found. The negative coefficient suggests that as carbon dioxide emission increases, renewable energy consumption decreases, indicating a positive relationship between renewable energy and environmental sustainability. This further suggests that renewable energy sources are being used as alternatives to fossil fuels, which are major contributors to carbon dioxide emissions.
The positive coefficient of technology (TEC) which is 0.657 with a p-value of 0.019 indicates that a percentage increase in technology intensity increases the consumption of renewable energy by about 66%. This shows that advances in technology have enabled the development of new renewable energy sources such as advanced solar panels which have increased renewable energy consumption. The negative coefficient of urbanisation (URB) -0.315 with p-value of 0.034 implies that a percentage increase in urbanisation leads to 0.3% decrease in renewable energy consumption. This indicates that as the urban population grows, the consumption of renewable energy decreases, suggesting that urbanisation may not be conducive to renewable energy. Urban areas may have limited access to renewable energy technologies, such as rooftop solar or community wind projects, due to infrastructure or regulatory barriers.

The positive coefficients of the interaction of institutional quality and colonial legacies ($\mathrm{INS} \times \mathrm{D}_{\mathbf{BRI}}$ *and* $\mathrm{INS} \times \mathrm{D}_{\mathbf{FRE}}$) which are 1.404 and 10.856 with their respective p-values of 0.026 and 0.013 suggest that colonial legacy influences the development of institutional frameworks that support renewable energy growth which can increase investor confidence and promote sustainable development in West Africa.

5. Conclusion

This study investigates the effect of institutional quality on renewable energy consumption while interacting the influence of colonial legacy on institutional quality in West Africa. It establishes that the interaction of institutional quality with colonial legacy and technology has a positive and significant impact on renewable energy consumption whereas GDP per capita, carbon dioxide emission and urbanisation have a negative and significant impact on renewable energy consumption.

In the light of the above findings, the study recommends that policymakers should prioritise institutional stability while leveraging technological advancements to promote renewable energy production. Policymakers should consider unique historical and institutional context of West African countries when designing renewable energy policies and programmes. Policymakers should improve technology in order to facilitate the integration of energy sources into the energy mix, making it easier for countries to transition to a more sustainable energy system. Policies aimed at reducing carbon dioxide emissions such as carbon pricing or clean energy targets, should be developed to promote the adoption of renewable energy technologies.

Despite contributing to the existing literature by exploring the moderating effect of colonial legacy and adopting the Country Policy and Institutional Assessment (CPIA) as a proxy for institutional quality, this study has some limitations. One of the primary limitations is that it only considers a limited set of variables, including institutional quality, carbon dioxide emission, GDP per capita, technology and urbanisation to measure their impact on renewable energy consumption. While these variables provide a fundamental foundation for analysing renewable energy, they represent a limited perspective. This study therefore opens up new avenues for future research, including comparative studies that can deepen our understanding of the complex dynamics between institutional quality and renewable energy consumption.

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