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Energy importation and consumption of renewable energy in Ghana

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Abstract
Renewable energy is considered critical to addressing climate change and its associated challenges. However, Ghana's renewable energy development is comparatively lower than the case of many other developing countries in Asia particularly. Since the late 1980s, the country has been more open to energy importation, which literature shows has some influence on energy usage for a country. That notwithstanding, not much analysis exists on the effect energy trade has on consumption and hence the development of a country's renewable energy. This study seeks to examine how energy importation affects Ghana's quest to develop its renewable energy potential. The study relied on time series data from 1971-2019 to model Ghana's renewable energy consumption as a function of energy imports, official development assistance, natural resource rents and post-commercial production of oil effect. Regression analysis was employed to estimate the effect of selected explanatory variables on three indicators of renewable energy development namely, total renewable energy, combustible renewable and waste, and access to clean fuels and technologies for cooking. The results revealed that Ghana's total renewable energy consumption is negatively affected by energy imports but positively affected by official development assistance and natural resources rent. However, the post-commercial production of oil dampens the positive effect of natural resources rent. A similar effect was found for combustible renewables and waste except that it was negatively affected by official development assistance. Appropriate policy implications are discussed.

Keywords
Energy Trade; Renewable Energy; Climate Change; Natural Resources

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1. Introduction

The devastating effects of global warming and climate change have been felt by all countries whether developing or developed. To prevent a worsening situation, world leaders, policymakers and environmentalists have argued that there is the need to halt the pace of Green House Gases (GHG) emissions, especially carbon dioxide to reduce global temperature. In light of this, the need to resort to the usage of renewable energy has increasingly been trumpeted on many occasions by climate change experts, academicians and policymakers. This stems from the fact that renewable energy is cleaner and emits less carbon dioxide emissions and is thus regarded as environmentally friendly (Kwakwa 2020).

Efforts to boost global production and usage of renewable energy have increased over the years. For instance, investment in renewable energy in 2010-2019 was triple the amount spent in 2001-2009. There is a 10% increment in the amount devoted to research and development of renewable energy (UNEP, 2019). Consumption of renewable energy has also seen a tremendous increase over the years (World Bank, 2022). It is however observed that there is a clear disparity in the development of renewable energy among economic regions and countries. Many of the huge investments into renewable energy come from developed countries with fewer developing countries like China also making great strides.

In the case of Sub-Saharan African countries like Ghana, despite the plans to increase the share of renewable energy in the total energy mix (Government of Ghana, 2019; Adobea-Oduro et al., 2020), renewable energy development and usage have not been encouraging. Fossil fuels still dominate electricity generation and renewable energy consumption has been decreasing over the years (World Bank, 2022). For instance, Ghana's renewable energy consumption has reduced from over 80% in the 1990s to about 30% of total energy consumption currently (World Bank, 2022). Ghana has for a long time engaged in the importation of oil and petroleum products to support energy demand in the country. Although since 2011 Ghana commenced commercial production of oil, it still imports oil.

The literature on renewable energy documents a number of factors that influence its development, production and consumption. For many years variables like income, technology, population, price, cost and urbanisation among others have been investigated (Kwakwa 2021; Bourcet 2020; Rafiq et al., 2014; Chen et al., 2021; Papież et al., 2018; Alagappan et al., 2011; Ahmad et al., 2022). Recently some researchers have thrown some light on the effect of energy import on renewable energy development (Vaona, 2016; Murshed and Tanha, 2021). They argue that energy imports, especially crude oil could increase or decrease renewable energy development. This is because the availability of imported energy could delay attention that needs to be given to the development of renewable energy and eventually its consumption. However, energy importation sometimes denotes dependence on other countries for energy (Marques et al., 2010) which brings to bare energy security concerns. To avoid any crisis related to energy imports, among other things, policymakers in a country may devote resources to develop their renewable energy resources. With the declining trend in renewable energy consumption in Ghana as shown above alongside the increasing trend of energy import (World Bank, 2022), it becomes necessary to ascertain the effect of energy import on renewable energy consumption and its development in Ghana.

The paper is relevant in the Ghanaian context to offer guidelines for effective policy formulation. It is also expected to contribute to the literature on energy in the country. This is because while there are studies on Ghana's energy, the emphasis has predominantly been on such issues as determinants of energy demand, factors of hydropower generation, effects of energy on carbon dioxide emissions and drivers of electricity power loss (Kwakwa 2018; Adom 2013; Abokyi et al., 2019), with little known on the nexus between energy imports and renewable energy consumption. This paper also adds to the body of global literature by using three indicators to represent renewable energy development. Thus, instead of using a single variable (aggregate/total renewable energy consumption), the analysis in this study focuses on the different aspects of renewable energy including total renewable energy consumption, combustible renewables and waste, as well as access to clean cooking energy and technologies. Such analysis is relevant as it provides evidence in support of efforts aimed at promoting the adoption and use of renewable energy.

2. Literature Review

Many nations are transitioning from fossil fuels to alternative, cleaner energy sources. This has been based on policy recommendations made by global institutions and domestic policies pursued in other countries. Similarly, there has been a surge in research into renewable energy, with a focus on finding motivating factors and impact assessment of burning fossil fuels among others. In this regard, some studies have investigated the role energy trade plays in the energy-environment nexus. This is crucial for the world's least developed, developing, and emerging economies, which rely heavily on fossil fuels and import a lot of energy to facilitate their quest for industrialization (Aboagye et al., 2020).

While many factors including income, population, urbanization, trade openness, financial development and technological development have been identified to affect the level of energy demand (Adom, 2013), factors affecting renewable energy consumption or development go beyond these. For instance, energy importation which has been found to be one of the useful ways of meeting countries' energy needs (Adewuyi, 2016; Zhao and Wu, 2007). The fear that some have entertained is that importing more energy may dampen their efforts to develop renewable energy domestically and this could have stern environmental implications since imported energy has been fossil fuel-based. Comparatively, importing fossil fuel energy is cheaper in the short term than committing resources to develop renewable energy (Kwakwa et al., 2021). Similarly, York (2012) suggested that the development of renewable energy may replace fossil fuels. Empirically, researchers have found negative, positive, and no significant effects of energy imports on renewable energy development. Researchers who found no correlation between energy import and renewable energy use include Chien and Hu (2008). Similarly, Aguirre and Ibikunle (2014) in their study found energy imports to not affect renewable energy expansion. On the other hand, Marques et al. (2010) found energy imports to boost renewable energy consumption while Da Silva et al., (2018) reported a negative effect of energy imports on renewable energy consumption.

In summary, while there is a vast literature on renewable energy development and its consumption, an observation of the literature suggests a concentration of these studies in European and other developed countries. Trade effect is gaining attention in recent times. The measurement of renewable energy consumption has been done utilising aggregate renewable energy. Yet, disaggregating the data for analysis will offer further insight to guide policy formulation. This current study which seeks to provide evidence peculiar to a typical developing country, therefore, uses Ghana to demonstrate the effect of energy imports on the development of renewable energy by employing different components of renewable energy development.

3. Methodology

3.1 Theoretical and empirical model

The drivers of renewable energy consumption can be explained using the basic demand/consumption theory. Following this theory, the main drivers of renewable energy consumption are price and income (Kastrati, 2015; Kwakwa, 2020). Higher price is expected to reduce energy consumption because of the inverse relationship between renewable energy consumption and price. Likewise, income is argued to increase renewable energy consumption as energy is viewed as a normal good. Energy import reflects the effects of fossil fuel energy prices on an economy, which may affect renewable energy consumption adversely or favourably. Increasing energy import dependency may have a direct positive effect on fossil fuel energy prices which may reduce (complements) or increase (substitute) renewable energy consumption. Reduction in energy import reduces the effect of fossil fuel energy prices and this increases renewable energy consumption (Ackah & Kizys, 2015). Based on the fact that energy import affects energy prices, this study used energy import as an indicator for energy prices.

Natural resource rents are used as an indicator of income since they could capture the wealth of a nation. It is expected to have a positive effect on renewable energy consumption as it increases funds available for investment towards renewable energy development (Hartwick, 1977; van der Ploeg, 2011). Renewable energy production requires innovation and diversification of the economy, and thus natural resource rents have the potential to facilitate the transition to renewable energy by absorbing the cost associated with its production. Contrarily, post-commercial production of oil, can be detrimental to renewable energy development because the rents from oil production may act as an economic disincentive for innovation required for the development of renewable energy (Ahmadov, 2014). To understand the joint effects of post-commercial production of oil and natural resource rent on renewable energy consumption, natural resource rent is interacted with post-commercial production of oil and is included as an additional covariate in the model. In addition to the above, the study controls for development assistance/aid since through development assistance and aid, renewable energy technology can be easily transferred across countries and this may increase renewable energy consumption (Pfeiffer & Mulder, 2013).

Following from the above arguments and adopting the Cobb Douglas consumption function, the drivers of renewable energy consumption in Ghana are expressed as;

$$RENt = A(ODA)^{\beta} * e^{Ela}(NAT)^{\mu} * (NAT * PO)^{\Omega} e^{\varepsilon} \quad [1]$$

Taking the natural logarithm of all the variables in equation (1) gives,

$$InREN_t = a + \beta InODA_t + \alpha EI_t + \mu InNAT_t + \Omega InNAT_t * PO_t \varepsilon_t \quad [2]$$

where a, β, α, μ and Ω are the parameters to be estimated, t is time and ε is the random error term. lnREN is the natural log of renewable energy consumption which is measured using three indicators: renewable energy development, combustibles renewables and waste, and access to clean fuels and technologies for cooking. Likewise, EI, lnODA and lnNAT represent energy import, natural log of official development assistance and aid and natural resource rent. Also, lnNAT*PO denotes the effect of post-commercial production of oil and natural resources rent on renewable energy development.

3.2 Econometric Technique

Econometrically, it is established that to avoid possible spurious regression when using time-series data, the unit root properties of the series should be examined to determine whether they are stationary at a level or not. Several methods have been proposed for examining the unit root properties of variables adopted in time series modelling. In this study, the Augmented Dickey-Fuller, (ADF) and Phillips-Perron (PP) unit root tests are used to test for the existence of unit root properties in the series. After the unit root test, the Johansen Cointegration test is used to determine the existence of a long-run relationship among the variables. The parameters of equation (2) are estimated using the Fully Modified Ordinary Least Squares (FMOLS) technique because it can correct potential endogeneities and serial correlation (Amuakwa-Mensah and Adom, 2017). Finally, the variance decomposition approach is used to examine the contribution of each of the variables to changes in the level of renewable energy consumption.

3.3 Data Description and Sources

The data adopted for the study are sourced from the world development indicators (WDI) of the World Bank (2022). Three indicators of renewable energy consumption namely, renewable energy consumption, combustible renewable and waste, and access to clean fuels and technologies for cooking were used in this study. Renewable energy consumption is defined as the percentage of renewable energy in total final energy consumption. Combustible renewable and waste, on the other hand, is measured as the percentage of combustible renewable and waste in total energy while access to clean fuels and technologies for cooking is defined as the proportion of the total population primarily using clean cooking fuels and technologies for cooking. Energy import measures the net energy imports as a percentage of energy use and development assistance and aid and is defined as the net official development assistance and official aid received (constant 2018 US$). Natural resource rent is defined as total natural resource rents as a percentage of GDP. To assess the post-commercial production of oil effect natural resources rent has on renewable energy development, a dummy variable, PO, was created for post-commercial oil and multiplied by lnNAT. In creating PO, all periods before 2011 when Ghana started commercial production of oil were coded 0 and the remaining years took a value of 1. The descriptions of the other variables are in Appendix 1.

4. Results and Discussions

4.1 Unit Root Results

The results of the stationarity test as presented in Table 1, indicate all the variables are I(1) which suggests that the series are not stationary in levels. Non-stationarity implies the absence of mean reversion and the possibility of the OLS estimator producing spurious results, except in instances where the series are cointegrated and the regressors are strictly exogenous. This informed the choice of the Johansen test for cointegration.

Table 1. Unit root test

	ADF, T-stat		**PP, Adj T-Stat**	
Variable	At levels	At first difference	At levels	At first difference
Energy import	-1.6147	-6.997***	-1.2599	-7.0456***
Log of Development Assistance and aid	0.8047	-10.8374***	0.8499	-11.1756***
Log of Natural resource rent	-3.2051	-8.1208***	-3.3039	-8.1208***
Log of renewable energy consumption	0.1622	-5.8093***	-3.5986	-8.4724***
Log of Combustible renewables	0.4263	-6.1597***	-2.0273	-6.2935***
Log of Clean fuels and technology	2.3709	-4.0887**	0.7934	-4.0896**

Note: ***, ** and * represents 1%, 5% and 10% level of significance respectively.

4.2 Cointegration results

The test results for cointegrating relationships (see Table 2) implies that there is a consistent and stable cointegration between the three indicators of renewable energy development and the variables. This further implies that a long-run relationship exists among the model variables for the sample period.

Table 2. Johansen Cointegration Test Results For Combustible Model

		Trace test		
Hypothesized No. of CE(s)	Eigenvalue	Statistic	0.05 Critical Value	Probability
None **	0.464455	53.59107	47.85613	0.0131
At most 1	0.299468	25.48992	29.79707	0.1447
At most 2	0.105545	9.473730	15.49471	0.3234
At most 3 *	0.094245	4.454402	3.841466	0.0348
		Maximum Eigen-value		
Hypothesized No. of CE(s)	Eigenvalue	Statistic	0.05 Critical Value	Prob.**
None **	0.464455	28.10115	27.58434	0.0429
At most 1	0.299468	16.01619	21.13162	0.2239
At most 2	0.105545	5.019328	14.26460	0.7394
At most 3 *	0.094245	4.454402	3.841466	0.0348

Note: ** denotes 1 cointegrating equation at a 5% level of significance

Table 3. Johansen Cointegration Test Results For Total Renewable Energy Model

		Trace test		
Hypothesized No. of CE(s)	Eigenvalue	Statistic	0.05 Critical Value	Probability
None **	0.677914	57.17176	47.85613	0.0052
At most 1	0.489791	26.58249	29.79707	0.1123
At most 2	0.203752	8.413251	15.49471	0.4223
At most 3	0.080345	2.261437	3.841466	0.1326
		Maximum Eigen-value		
Hypothesized No. of CE(s)	Eigenvalue	Statistic	0.05 Critical Value	Prob.**
None **	0.677914	30.58927	27.58434	0.0199
At most 1	0.489791	18.16924	21.13162	0.1236
At most 2	0.203752	6.151814	14.26460	0.5938
At most 3	0.080345	2.261437	3.841466	0.1326

Note: ** denotes 1 cointegrating equation at a 5% level of significance

Table 4. Johansen Cointegration Test Results For Access To Cleaner Energy Model

		Trace test		
Hypothesized No. of CE(s)	Eigenvalue	Statistic	0.05 Critical Value	Probability
None **	0.878176	60.73903	55.24578	0.0152
At most 1	0.601424	22.84585	35.01090	0.5189
At most 2	0.293186	6.288399	18.39771	0.8456
At most 3	0.002365	0.042628	3.841466	0.8364
		Maximum Eigen-value		
Hypothesized No. of CE(s)	Eigenvalue	Statistic	0.05 Critical Value	Probability
None **	0.878176	37.89318	30.81507	0.0058
At most 1	0.601424	16.55745	24.25202	0.3696
At most 2	0.293186	6.245771	17.14769	0.7924
At most 3	0.002365	0.042628	3.841466	0.8364

Note: ** denotes 1 cointegrating equation at a 5% level of significance

Table 3 presents the long-run results for the three indicators of renewable energy development using the FMOLS. The results show a decline in renewable energy development in Ghana as the country's energy import expands, evident by the fall in total renewable energy consumption as well as combustible renewables and waste. Access to clean fuels and technologies for cooking is however unaffected by the extent of the country's energy import. This demonstrates that Ghana's efforts towards developing its renewable energy portfolio is impeded by energy import even though this does not translate into a similar decline in access to modern cooking fuels and technologies. A major implication is that importing more energy tends to exert pressure on the country to delay growing the share of renewable energy in the basket of total energy consumption. This is because energy import is an indicator of energy dependency and as energy dependency increases, the development of its renewable energy sector is hampered. Invariably, this is a signal that energy import is not in the best interest of Ghana if it desires to increase the share of renewable energy in the total energy mix. This conclusion corroborates the findings of Marques and Fuinhas (2012) and da Silva et al. (2018) but is in sharp contrast to Marques et al. (2010).

Also, while development assistance and aid contribute favourably to the country's renewable energy development through expansion in total renewable energy consumption and access to clean fuels and technologies for cooking, the contrary is established for combustible renewables and waste. The finding points to the assertion that foreign assistance and aids when directed towards development, rather than recurrent consumption, tend to drive the development of advanced technologies including but not limited to renewable energy. A plausible pathway underpinning this finding relates to the evidence that most renewable energy projects require considerably large initial investment outlay which many developing countries such as Ghana perhaps cannot execute entirely with only domestic state revenue. As a result, foreign assistance and aid targeted towards development could productively bolster domestic revenue to facilitate the implementation of renewable energy projects.

Interestingly, rent accrued from natural resources is observed to exert mixed effects on the various measures of Ghana's renewable energy development efforts. For instance, natural resources rent tends to reduce access to clean fuels and technologies for cooking but increases total renewable energy consumption while for the case of combustible renewables and waste, natural resources rent has no statistically significant effect. Reasonably, these findings could be resulting from the perspective that, natural resource rents as a source of revenue may have been allocated disproportionately towards renewable energy mix other than and/or at the expense of ensuring clean cooking fuels and technology. These other sources could include electrification from hydro, solar, wind etc. This could as well explain the nearly 86% rate of access to electricity as against the about 22% access to modern cooking fuels with electricity generation gradually but steadily increasing the share of renewable energy in the country (World Bank, 2022).

Additionally, it is observed that the coefficients on interacting natural resource rent and the dummy have mixed effects. This shows that commercial oil production in Ghana tends to dampen the effect natural resource rent has on total renewable energy consumption but improves the effect it has on access to clean fuels and technologies for cooking. This is an indication that the natural resource rent after the commercial production of oil in the country has enhanced access to clean fuels and technologies for cooking but reduced the overall renewable energy development. Reconciling this finding with the evidence established for natural resources rent, it is not unreasonable to assert that the commercial production of oil may have incentivized Ghana to channel an appreciable proportion of its natural resource rent towards other developmental projects to the detriments of renewable energy development.

The variance decomposition analysis to ascertain the contributions of official development assistance and natural resource rent and energy trade on renewable energy consumption, access to clean energy and combustible waste are reported in Tables 4, 5 and 6 respectively. From the tables, the effect of energy trade on the indicators of renewable energy development growth over the period. Its effect is greatly felt for access to clean energy models followed by combustible renewable and waste, and renewable energy consumption models

Table 5. Long-run results from FMOLS

Variable	Access to clean fuels and technologies for cooking model	Combustible renewables and waste model	Total renewable energy consumption model			
	Coefficient	Std error	Coefficient	Std error	Coefficient	Std error
Energy import	0.0058	0.0073	-0.0157***	0.0021	-0.0156***	0.0019
Development Assistance and aid	0.4336**	0.2031	-0.1297***	0.0383	0.1250*	0.0701
Natural rent	-0.9065***	0.1255	-0.0924	0.0572	0.1812***	0.0473
Natural rent *post comm	0.3832***	0.1262	-0.4304***	0.0347	-0.3845***	0.0324
Constant	-4.8949	4.0138	7.2633***	0.7157	1.6718	1.4427

Note: ***, ** and * represents 1%, 5% and 10% level of significance respectively.

Table 6. Long-run results from FMOLS

Period	S.E.	lnREN	lnODA	lnNATU	EI
1	0.034282	100.0000	0.000000	0.000000	0.000000
2	0.038432	86.16337	5.728174	8.058129	0.050326
3	0.046320	82.45784	6.872295	6.527991	4.141870
4	0.052115	74.35671	10.41508	7.370729	7.857481
5	0.057940	69.76690	10.02466	7.163344	13.04510
6	0.063033	66.09936	9.168519	6.804256	17.92787
7	0.067897	63.51765	7.970259	6.334525	22.17757
8	0.072342	61.50371	7.037360	5.888776	25.57015
9	0.076553	59.99431	6.459778	5.463141	28.08277
10	0.080451	58.84484	6.186946	5.105964	29.86225

Note: ***, ** and * represents 1%, 5% and 10% level of significance respectively.

Table 7. Variance Decomposition Analysis For Renewable Energy Consumption

Period	S.E.	lnCOMB	lnODA	lnNATU	EI
1	0.052422	100.0000	0.000000	0.000000	0.000000
2	0.068303	93.82636	2.468939	0.260230	3.444471
3	0.082998	80.46787	7.442111	0.785283	11.30474
4	0.098284	65.66653	13.04252	0.980525	20.31042
5	0.113825	53.34213	18.25838	0.909798	27.48969
6	0.128952	44.13266	22.90716	0.742542	32.21764
7	0.143259	37.40673	27.02157	0.602557	34.96915
8	0.156632	32.41604	30.67610	0.547850	36.36001
9	0.169101	28.60312	33.91317	0.594345	36.88937
10	0.180753	25.59723	36.76571	0.735848	36.90121

Table 8. Variance Decomposition Analysis For Combustible Renewable

Period	S.E.	lnREN	lnODA	lnNATU	EI
1	0.034282	100.0000	0.000000	0.000000	0.000000
2	0.038432	86.16337	5.728174	8.058129	0.050326
3	0.046320	82.45784	6.872295	6.527991	4.141870
4	0.052115	74.35671	10.41508	7.370729	7.857481
5	0.057940	69.76690	10.02466	7.163344	13.04510
6	0.063033	66.09936	9.168519	6.804256	17.92787
7	0.067897	63.51765	7.970259	6.334525	22.17757
8	0.072342	61.50371	7.037360	5.888776	25.57015
9	0.076553	59.99431	6.459778	5.463141	28.08277
10	0.080451	58.84484	6.186946	5.105964	29.86225

Table 9. Variance Decomposition Analysis For Access To Clean Energy And Technology

Period	S.E.	lnACCES	lnODA	lnNATU	EI
1	0.038582	100.0000	0.000000	0.000000	0.000000
2	0.051686	76.92012	1.725236	3.811734	17.54291
3	0.081113	47.85972	1.046394	11.12862	39.96526
4	0.101462	37.25959	2.675319	10.02821	50.03688
5	0.117591	30.02215	6.448404	12.07441	51.45504
6	0.135425	23.65158	10.06061	13.49886	52.78895
7	0.152515	19.61905	11.81832	13.01269	55.54994
8	0.166608	17.03666	13.21097	11.64276	58.10961
9	0.177485	15.26906	14.63456	10.56448	59.53191
10	0.186190	13.96539	15.87209	9.717079	60.44544

4.3 Conclusion and Policy Implications

Energy sources emanating from fossil fuels and other non-renewables have been cited as major underlying drivers of greenhouse gas (GHG) emissions, climate change and many environmental problems. In the era where the entire world is concerting various policy actions to tackle climate change and its concomitant repercussions, the development/consumption of renewable energy is becoming increasingly central in many development agendas. Ghana's nationally determined contributions (NDC) towards the fight against climate change include among other things increasing the share of renewable energy in its total energy mix. In addition to contributing to the global fight against climate change, renewable energy offers many other beneficial opportunities to Ghana in attaining SDG 7.1 by facilitating universal access to affordable modern cooking fuels and energy security. Furthermore, it can be harnessed productively to improve rural electrification through mini/local grids, and off-grid. Thus, renewable energy development could be linked to environmental quality, favourable climate change, economic growth and improved human livelihoods. To that end, this study, based on Johansen cointegration and FMOLS estimation strategies, has evaluated the role played by energy import in Ghana's renewable energy development efforts utilising annual time series spanning 1971-2019.

The long-run evidence suggests that Ghana's efforts towards developing its total renewable energy portfolio are generally hampered by energy imports. Furthermore, development assistance act as a critical catalyst for the country's renewable energy development through expansion in total renewable energy consumption and access to clean fuels and technologies for cooking. In the same way, natural resources rent tends to increase total renewable energy consumption. Nevertheless, a few aspects raise major concerns for worry. For instance, the country's natural resources rent tends to reduce access to clean fuels and technologies for cooking while foreign assistance and aid also reduce efforts towards the development of combustible renewables and waste. Also, the post-commercial production oil era is associated with a reduction in the effect that natural resources have on total renewable energy consumption. Based on the foregoing, the following recommendations are suggested for policies targeted towards renewable energy development in Ghana.

The most obvious policy action is that policy must aim at reducing the country's dependency on energy imports as a pragmatic approach to creating fiscal space to develop its renewable energy. Energy import, apart from swallowing funds that could have been invested in renewable energy infrastructure, also exposes the country to various degrees of energy crises and shocks that can threaten domestic energy security, and increase debt distress levels among others. Thus, reducing energy imports provides some leverage for renewable energy development. Since it appears the country cannot immediately wean itself from energy importation it is important to commit resources to facilitate the development of renewable energy in the country to gradually reduce its dependence on imported energy.

Additionally, even though aid can invariably contribute to the already unsustainable debt levels of the country if effectively channelled towards development, aid and grants are critical revenue sources to bolster the country's renewable energy development agenda. Thus, it is incumbent on policymakers to redirect the focus of development assistance towards renewable energy. Similar reallocation is required in the use of natural resource rents that accrue to the country. Fortunately, unlike development aid, resource rents do not contribute to further debt accumulation.

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4.4 Appendices

Table 10. Appendix 1: Description of data and source

Variable	Symbol	Measurement	Source
Energy import	EI	Energy imports, net (% of energy use). A negative value indicates that the country is a net exporter.	World Bank (2022)
Development Assistance and aid	ODA	Net official development assistance and official aid received (constant 2018 US$)	World Bank (2022)
Natural resource rent	NAT	Total natural resources rents (% of GDP)	World Bank (2022)
renewable energy consumption	REN	Renewable energy consumption (% of total final energy consumption)	World Bank (2022)
Combustible renewables	COMB	Combustible renewables and waste (% of total energy)	World Bank (2022)
Clean fuels and technology	ACCESS	Access to clean fuels and technologies for cooking (% of the population)	World Bank (2022)