IMPACT OF RENEWABLE ENERGY CONSUMPTION ON UNEMPLOYMENT IN SOME SELECTED SUB-SAHARAN AFRICA: EVIDENCE FROM A DYNAMIC FRAMEWORK

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Abstract

This study aims to provide an empirical answer to the question of whether renewable energy consumption affect unemployment in sub-Saharan African countries. The data for this study was secondary and was collected from African Development Indicators (ADI), International Energy Agency (IEA), International Monetary Fund (IMF), World Development Indicators (WDI), Energy Information Administration (EIA) of United State and United Nations Statistical Division (UNSD). This was done using data from 45 sub-Saharan African countries with three years average data from 2001 to 2021. The model was estimated using the generalised method of moments (GMM) technique, 2 step system GMM. The results revealed that renewable energy consumption has a significant negative impact on the region's unemployment rate. Policy makers therefore need to (i) ensure adequate and affordable clean energy, (ii) consider adequate investment in renewable energy sector (iii) increase in the production and consumption of renewable energy in order to boost employment levels.

Keyword: Renewable Energy consumption, Unemployment rate, system Generalised Method of Moments

1.1ntroduction

In recent years, the importance of renewable energy consumption has greatly increased. Compared with non-renewable energy, the consumption of renewable energy including wind, hydropower, and solar energy is considered to be labour-intensive and can increase employment opportunities (IRENA, 2011). There are some potential job creations from renewable technology in the manufacturing technology, factory construction and raw material processing, some jobs may be created. The renewable energy sector is considered fertile ground for job creation because it is labour-intensive (Baruah, 2015; Pandey et al., 2012). Due to the role of renewable energy in creating jobs and improving social well-being, it has been included in the Sustainable Development Goals (SDGs). In September 2015, world leaders adopted the

sustainable development agenda of the 2030 UN Sustainable Development Goals Summit. Part of the agenda is affordable and clean energy, which is the development of renewable energy. The renewable energy industries have been providing jobs for many unemployed.

The analysis of global renewable energy employment technology provides some interesting insights. According to the annual report released by IRENA (2019), renewable energy technology created approximately 11 million direct and indirect jobs worldwide in 2018.Solar photovoltaic technology provides the largest number of employment opportunities, followed by hydropower. For example, China is the beneficiary of the largest employment opportunities generated by this industry. According to the (IEA, 2020) report, renewable energy accounted for 18.1% and 26% of global energy consumption in 2017 and 2018, respectively. Therefore, renewable energy can be defined as energy that comes from the source and significantly consumed due to use, such as sunlight, wind, and geothermal energy etc.

In sub-Saharan Africa, there is a significant potential for the use and consumption of renewable energy such as wind, solar, and hydropower. However, due to the limited policy interest and investment levels, sub-Saharan Africa has not been exploiting and harnessing its use of renewable energy seriously. For example, South Africa and Ghana in sub-Saharan African region are the countries to take some important steps to increase their potential for renewable energy consumption (Bekker et al., 2008). Solar energy can provide an alternative to electrification to accommodate many geographically isolated rural areas in sub-Saharan Africa. Unfortunately, there are very few plans and initiatives to develop and exploit solar energy in sub-Saharan Africa. In addition, within the framework of the Global Environment Facility (GEF), a concerted effort has been made to use solar systems to decentralize electricity production in rural Zimbabwe. Besides the financial support provided by the government, most rural solar projects are sponsored or supported by donor agencies (Subern et al., 2013). So far, only 5 gigawatts (GW) of solar PV have been installed in the region which has the world's

most abundant solar resources, but it has less than 5% of the global total of renewable energy consumption.

Since 1960 to date more than 50% of the population in the region is dominated by the working class aged 15-64 (World Bank, 2018). It is predicted that the 5.5% growth in 2019 is not being translated into the jobs of 10 million graduates who join the labour market each year (International Labour Organization, 2020). The sub-Saharan African region has the 2nd highest number of populations in the world, with unemployed people covering nearly 60% to 70% of the population (World Bank, 2020). The lack of full utilization of the productive labour force poses a huge threat to sub Saharan Africa's strength and growth. Although the problem of unemployment is seeing as a general problem and manifested all over the world but, the situation in sub-Saharan Africa is very dilapidating, even though some countries have regained success in recent years. In sub-Saharan Africa, many people are unemployed and they have been looking for work but they couldn't find it over time. Therefore, if renewable energy consumption creates jobs, it is expected that the unemployment rate in sub-Saharan Africa will decrease over time.

Theoretically, energy consumption especially renewable energy consumption, may have a positive impact on growth, leading to a decline in unemployment. However, this is not the case in sub-Saharan African countries, because the consumption level of renewable energy has been low for many years, and the unemployment rate is still high. The level of unemployment is riddled with problems such as insufficient investment, limited financing channels among others. Therefore, it is worrying that the rapid increase in unemployment will affect the growth and development of countries in sub-Saharan Africa. However, to understand whether renewable energy consumption affects the unemployment rate, in sub-Saharan Africa, is subject to empirical research and investigation. This study will empirically investigate the possible impact of renewable energy consumption on unemployment in sub-Saharan Africa.

This study will be different by including additional variables such as financial development along with government expenditure .This study will also include an additional control variable such as Population growth rate. From the literature examined so far, only few have included these variables in their analysis. Including these variables will help to explain the extent to which government expenditure variable is relevant in the formulation of renewable energy consumption and unemployment policies in the region under consideration.

2. Literature review

A few studies questioned the relationship between renewable energy consumption and unemployment. Some of the studies focus on single countries study and employed a time series analysis; others focus on group of countries study and thus employed a panel method of analysis. Despite these, there is still no consensus among the various studies resulting from peculiarities of the country under study; nature of data employed; variable measurement and combination; sample size and the methodology employed.

One strand of literature investigated the relationship between renewable energy consumption and unemployment and found a positive relationship, for instance. Bulavskaya and Reynès (2017) used the neo-Keynesian CGEM Three ME model to investigate the impact of renewable energy on job creation in the Netherlands. Their results reveal that by 2030, the transition to renewable energy could create nearly 50,000 jobs, thereby contributing 1% of GDP. Khodeir (2016) employed the ARDL method to establish an inverse correlation between the renewable energy generation and the unemployment rate in Egypt from 1989 to 2013. The study aimed to test and detect the short-run and long-run effects during the study period, but it has been found that this hypothesis is only realized and achieve in the long-run. Ragwitz et al. (2009) employing input-output frameworks and macro models, the result reveals that EU-wide renewable energy policies have a positive impact on employment. Lehr et al. (2008) examined

the renewable energy- unemployment relationship in Germany and the result shows that the net impact of renewable energy on unemployment is positive.

Ali et al. (2017), Nasreen et al. (2017), Saidi and Hammami (2015), Salahuddin et al. (2015), Alanazi et al. (2020), Andjarwati et al. (2020),Nathaniel and Iheonu (2019), Mensah et al. (2019), Akadiri, Bekun and Sarkodie (2019), Ozturk (2015), Ali et al., (2019), Hassan et al., (2020) and Begum, Sohang, Abdullah and Jaafar (2015). Apergis and Salim (2015) employed advanced unit root generation, cointegration and non-linear Granger causality methodologies in panel data to examine 80 countries over the period of 1990-2013.Mixed result was obtained regarding the impact of renewable energy consumption on unemployment. However, the overall findings found that renewable energy consumption has a positive impact on unemployment, and disaggregated data in specific regions (such as Asia and Latin America) highlight the favourable and beneficial effects of unemployment, which means that the impact of renewable energy consumption on job creation depends on the costs of adopting the renewable energy technologies and energy efficiency that seems to be different across to the investigated regions.

Rivers (2013) used a three-sector general equilibrium model to investigate the impact of renewable electricity support policies on the equilibrium unemployment rate. The result reveals that renewable electricity support policies have led to an increase in unemployment rate. However, the study has identified the conditions under which renewable energy support policies can reduce the equilibrium rate of unemployment. The study recorded, that when the substitution elasticity between labour and capital is low, capital does not flow internationally, and the labour intensity of renewable energy is higher than that of conventional energy generation, renewable electricity support policies may reduce the unemployment rate.

Krishna (2020) examined the growth of sources of renewable energy, especially solar photovoltaic (PV) technology affecting employment opportunities in India. The results show

that, despite the substantial and huge investment in India's solar photovoltaic technology, the number of jobs created by this sector has decreased marginally from 164,000 in 2017 to 114,000 in 2018. Rafiq, Sgro, and Salim (2018) investigated the energy, unemployment and trade relationship in 41 countries from 1980 to 2014. The findings reveals that service sector, trade openness industrialization and government spending have a positive effect on reducing unemployment while renewable energy and agriculture increase the unemployment rate. This may be partly due to recent technological advancements and substantial capital-intensive investments in agriculture and renewable energy sectors.

Another strand of literature investigated the relationship between renewable energy consumption and unemployment and found a negative relationship for instance. Khobai et al. (2017) used the Autoregressive distributed lag (ARDL) model to test the long-term and short-term effects of renewable energy consumption on unemployment and to also investigate the renewable energy consumption and unemployment relationship in South Africa from 1990 to 2014. Their findings show that, in the long run, the consumption of renewable energy has a negative and significant impact on unemployment. However, in the short run, the relationship between variables is insignificant. Therefore, their study advocates for an increase production and consumption of renewable energy to increase employment levels.

Bekmez and Ağpak (2016) examined the non-hydro renewable energy-employment relationship for a panel 80 countries, and their results provide no support for the view that renewable energy has a positive effect on unemployment. Bilgili et al., (2017), investigated the impact of energy consumption on youth unemployment from 1990 to 2011 by using panel data sets from 20 European countries. Their study followed the panel of completely modified ordinary least squares (FMOLS) and panel dynamic ordinary least squares (DOLS). The results of the FMOLS and DOLS estimator groups reveal that energy consumption has a negative impact on youth unemployment. Their results explore the importance of energy policy in

reducing youth unemployment. Therefore, it may indicate that policymakers should follow policies that encourage energy consumption and new potential energy investments to reduce youth unemployment.

The results have demonstrated clear evidence on the absence of consensus and also pave way for the study because the literature reviewed shows that the impact of renewable energy consumption on unemployment has received relatively less attention especially in sub Saharan African region. This provides the research gaps that this study intends to fill in order to contribute to scientific knowledge and in order to contribute to ongoing scientific debate.

3. Methodology

This Section focuses on the theoretical framework as well as the methodological approach of the study, the data used for this study was secondary and was collected from African Development Indicators (ADI), International Energy Agency (IEA), International Monetary Fund (IMF), World Development Indicators (WDI), Energy Information Administration (EIA) of United State and United Nations Statistical Division (UNSD). This was done using data from 45 sub-Saharan African countries with three years average data from 2001 to 2021. The model was estimated using the generalised method of moments (GMM) technique, 2 step system GMM.The modelling methodology for this study is based on the well-known and famous Okun's law models and the model specification is based on the augmented and extended Okun's law models Apergis and Salim, (2015), with modifications. Where renewable energy consumption and other independent variables are included in a data panel framework. After substituting the capital stock with real GDP as it is in the original Okun’s law and also by replacing real exchange rate with investment and by adding population growth as part of the contribution to the study and converted into panel specification. Thus, the study arrives at this model:

$$U_{i,t} = \pi_0 + \pi_1 U_{i,t-1} + \pi_2 REC_{ji,t} + \pi_3 Y_{i,t} + \pi_4 INV_{i,t} + \pi_5 FD_{i,t} + \pi_6 GOV_{i,t} + \pi_7 POP_{i,t} + \vartheta_{i,t} \quad (1)$$

where U subscript $i = 1, \ldots, N$ represent country-specific effect and $t = 1, \ldots, N$ denotes time-specific effect, the symbol π_0 is the intercept of the model, $\pi_1 - \pi_5$ are the coefficient of the independent variables, ϑ_t is the stochastic error term

$$\vartheta_{i,t} = \sigma_i + \epsilon_t + e_{i,t} \quad (2)$$

where $U_{i,t-1}$ is the lagged dependent variable indicator for unemployment rate of country i at period t, π_0 is the intercept, $\pi_1 - \pi_6$ are coefficients of the independent variables. $\vartheta_{i,t}$ is the two-way residual term, σ_i is the country-specific effect, ϵ_t is the time-specific effect, $\varepsilon_{i,t}$ is the residual while other variables are as defined earlier. A check for robustness is conducted to check the relationship between renewable energy consumption and male and female unemployment in sub Saharan African region. The essence of a robustness check is to test the validity and reliability of inferences. Therefore, this study performs robust tests to ascertain the consistency of the results. First, the study re-estimated the models using male and female unemployment in sub Saharan African region, as another alternative proxy of renewable energy consumption. That is to ensure robustness of the results, the re- estimated models are (3, 14, 5 & 6), considering the male and female unemployment as a dependent variable. The essence is to verify if renewable energy consumption would have an impact on male and female unemployment in sub Saharan African region. The result reveals consistency with models (1&2).

Table 1. Definition and sources of variables

Variables	Proxy	Unit of measurement	Source of data	Expected sign
U	Unemployment rate	Share of total labour force that are not working	WDI, World Bank	Dependent variable
REC	Renewable energy consumption	% of total energy consumption final	WDI, World Bank	Negative
Y	GDP per capita	GDP growth rate	WDI, World Bank	Negative
FD	Financial development	Domestic credit to the private sector as a percentage of GDP	WDI, World Bank	Negative
GOV	Government expenditure as a percentage of GDP	In billions of constant US dollars	WDI, World Bank	Negative
INV	Gross fixed capital formation	As a percentage of GDP	WDI, World Bank	Negative
POP	Population growth rate	Share of total living population	WDI, World Bank	Positive

(Source: Author's compilation, 2024)

4. Result and discussion

The estimation techniques for this study is the system Generalized Method of Moments (GMM). The motivation to use the system GMM is due to the nature of our data which has large cross-section and small-time period. System GMM also takes into account the dynamic nature of economic data by consideration of lagged dependent variable. To capture the dynamic nature of panel data, the Arellano and Bond (1991) have advanced a Generalized Method of Moments (GMM) estimation technique that yields consistent and unbiased estimators. The GMM estimator possesses a lagged dependent variable that assists in solving the problem of heteroscedasticity and endogeneity of the independent variable in a panel data that neither the

random effects nor fixed-effect models can solve. Because, in GMM estimator both the autocorrelation and hetroskedasticity are robust. Therefore, both the problem of endogeneity and simultaneity bias are controlled, this is done by using the lags dependent as instruments in the model. According to Arellano and Bond (1991), supplementary instruments can be generated from a dynamic panel data if the orthogonality conditions that occur between lagged dependent variable and the stochastic error terms are employed. This will then pave the way to addressing the problem of country-specific effects and time-specific effects using the first difference and instrumental variables.

However, the first difference GMM overlooks information on the level relationship between one variable and the other and thus, influence the reliability of the outcome of the estimator (Ahn and Schmidt, 1995). As a result of this limitations the system GMM which has the capacity to resolve the limitations of the first difference GMM was developed (Arellano and Bover, 1995; Blundell and Bond, 1998). In Addition to this, the system GMM estimator can address country's time-specific effects problem and country heterogeneity problem (Arellano and Bover, 1995; Blundell and Bond, 1998). Diagnostic tests were carried out on the system GMM models. These include test for first and second autocorrelations [AR (1) and AR (2)] and Sargan test for over-identification restriction.That is the Sargan tests, use estat to get Sargan of the null hypothesis in which the model and the over identifying conditions are specified correctly, it also evaluates the validity of the instruments used in the model. While the second order serial correlation tests for the assumption that the error term is serially uncorrelated. Before estimating the GMM model, some preliminary tests were conducted to make sure the suitability and normality of the series for analysis. These tests includes correlation matrix and descriptive statistics. The results of the correlation matrix and descriptive statistics are shown in Tables 2 and 3, respectively. The results of the descriptive statistics reveals that the series are well spread and normally distributed. The correlation matrix

result shows that there is no high correlation between the explanatory variables, because all the values fall below Prodan (2013)'s benchmark of 0.80, for ruling against multicollinearity.

Table 2: Summary statistics for sub Saharan Africa

Variables	Mean	Standard Dev.	Minimum	Maximum	Observation
U_{it}	7.436409	6.53242	0.45	33.15	405
REC_{it}	64.80127	26.66313	0.78025	98.1212	405
Y_{it}	3.198424	4.782925	-36.39198	20.71577	405
INV_{it}	22.82614	8.952389	3.55412	68.1217	405
GOV_{it}	16.23674	5.940704	4.61776	33.1662	405
FD_{it}	20.45277	22.91462	4.61776	33.1662	405
POP_{it}	2.480319	0.8932788	-0.554002	4.64002	405

Notes: U_{it} is the unemployment rate, REC_{it} is the renewable energy consumption, Y_{it} is economic growth rate, INV_{it} is the investment, GOV_{it} is government expenditure, POP_{it} is population growth and FD_{it} financial development and i and t are country and period, respectively.

Table 3. Correlation Matrix

Variables	U_{it}	REC_{it}	Y_{it}	INV_{it}	GOV_{it}	FD_{it}	POP_{it}
U_{it}	1.0000						
REC_{it}	-0.5187	1.0000					
Y_{it}	0.3922	-0.6867	1.0000				
INV_{it}	0.1957	-0.2940	0.2896	1.0000			
GOV_{it}	0.1751	-0.0997	-0.0780	-0.0295	1.0000		
FD_{it}	0.4431	-0.5499	0.3521	0.0484	0.1520	1.0000	
POP_{it}	-0.4137	0.4165	-0.1329	0.0785	-0.2353	-0.4587	1.0000

Notes: $U_{it}$is unemployment rate, REC_{it} is renewable energy consumption, Y_{it} is the economic growth rate, INV_{it} is investment, POP_{it} is population growth, GOV_{it} is the government expenditure and FD_{it} is the financial development and i and t are country and period, respectively.

(Source: Author's compilation, 2024)

4. Results and Discussion

Table 4 presents the estimates of the impact of renewable energy consumption on unemployment in sub-Saharan Africa, the results from model (1) & (2) reveals that renewable energy consumption has a negative and significant impact on unemployment rate in sub Saharan Africa. This means that increase in renewable energy consumption leads to a decreased in unemployment rate in the region. This is consistent with the findings of Bulavskaya aneynès (2017); Khobai et al. (2017) & Bilgili et al., (2017).Both the system and the difference GMM estimators show that gross domestic product per capita (Yit) is negative and significant, this implies that as GDP per capita increases, sub-Saharan Africa's unemployment rate reduces.

Fnancial development (FD_{it}) coefficient is found to be significant and positive under the system GMM and difference GMM estimators, which is contrary to our a priori expectation suggesting that financial development in the region increases the unemployment rate, this does not come as a surprise because the sub Saharan domestic credit to private sector is not fully developed to reduce the unemployment rate. Government expenditure (GOV_{it}) coefficient is found to be negatively significant on unemployment rate. Investment (INV_{it}) under difference GMM is negative and significant but insignificant under the system GMM which shows that investment does not affect unemployment rate in the region. Population growth (POP_{it}) coefficient is found to be negative but insignificant under the difference GMM and significant but positive in system GMM, indicating that population growth increases the rate of unemployment in the region.

Table 4 Estimated results of the panel difference and system GMM on the impact of renewable energy consumption on unemployment in sub Saharan Africa with unemployment as dependent variable.

	Model (1)	Model (2)
VARIABLES	Diff. GMM	Sys GMM
U_{it-1}	0.559***	0.850***
	(0.010)	(0.003)
REC_{it}	-0.026***	-0.019***
	(0.010)	(0.001)
Y_{it}	-0.010***	-0.016***
	(0.002)	(0.001)
GOV_{it}	-0.018***	-0.020***
	(0.004)	(0.001)

FD_{it}	0.001**	0.031***
	(0.001)	(0.002)
INV_{it}	-0.005***	0.008
	0.009	(0.001)
POP_{it}	-0.023	0.003***
	(0.026)	(0.002)
Constant	1.679	1.180***
	(0.247)	(0.102)
AR (1)	0.056	0.0494
AR (2)	0.0602	0.1183
Sargan p-value	0.1032	0.2259
Number of groups	45	45
Number of Observations	315	297
Number of instrument	35	27

Notes: ***indicates significant at 1%, **indicates significant at 5%, *indicates significant at 10%. Parenthesis are the standard errors. U is unemployment, POP is population growth, Y is GDP growth, REC is renewable energy consumption, INV is investment, FD is financial development, GOV is government expenditure. Also, i and t are country and period, respectively.

The essence of a robustness check is to test the validity and reliability of inferences. Therefore, this study presented both the difference and system GMM in Table 5.The models were re-estimated using male and female unemployment as dependent variables to replace the total unemployment rate. The essence is to verify if renewable energy consumption would have an impact on female and male unemployment in sub Saharan African region. Table 5 presents the estimates of the impact of renewable energy consumption on female and male unemployment in sub-Saharan Africa, the results from model (1- 4) reveals that renewable energy consumption has a negative and significant impact on both the male and female unemployment rate in sub Saharan Africa. This means that increase in renewable energy consumption leads to a decreased in female and male unemployment rate in the region, the results confirmed our earlier findings. Both the system and the difference GMM estimators show that gross domestic product per capita (Yit) is negative and significant, Fnancial development (FD_{it}) coefficient is found to be significant and positive, which is contrary to our a priori expectation suggesting that financial

development in the region increases the unemployment rate, this does not come as a surprise because the sub Saharan domestic credit to private sector is not fully developed to reduce the unemployment rate. Government expenditure (GOV_{it}) coefficient is found to be negatively significant on unemployment rate. Investment (INV_{it}) is positive and significant. Population growth (POP_{it}) coefficient is found to be positive and significant, indicating that population growth increases the rate of female and male unemployment in the region. It is important to note that all the diagnostic test's results are satisfactory. Meaning the model is free from simultaneity bias and second order serial correlation as the study failed to reject the null hypothesis of Sargan and AR(2) test.

Table 5 Robustness Check Results with Female and Male unemployment as dependent Variables using both the Difference and System GMM

Female Unemployment			Male Unemployment	
VARIABLES	Model (3)	Model (4)	Model (5)	Model (6)
FU_{it-1}	0.495***	0.929***		
	(0.015)	(0.004)		
MU_{it-1}			0.835***	0.709***
			(0.019)	(0.005)
REC_{it}	-0.061***	-0.016***	-0.055***	-0.037***
	(0.009)	(0.001)	(0.004)	(0.002)
Y_{it}	-0.119***	-0.014**	-0.096*	-0.133***
	(0.016)	(0.005)	(0.032)	(0.010)
INV_{it}	0.025***	0.024***	0.008**	0.042***
	(0.006)	(0.002)	(0.004)	(0.002)
GOV_{it}	-0.007***	-0.015**	-0.019**	-0.042
	(0.025)	(0.003)	(0.005)	(0.002)

FD_{it}	0.018***	0.006***	0.010***	0.004***
	(0.002)	(0.001)	(0.001)	(0.0003)
POP_{it}	0.079***	0.022***	-0.082	0.014*
	(0.080)	(0.112)	(0.059)	(0.001)
Constant	1.334**	1.031***	0.939***	1.774***
	(0.772)	(0.133)	(0.476)	(0.767)
AR (1)	0.0366	0.0478	0.0271	0.0174
AR (2)	0.3348	0.4305	0.2705	0.1375
Sargan p-value	0.4828	0.2767	0.3211	01934
No. of groups	45	45	45	45
No. of Observations	243	360	315	360
No. of instrument	35	32	35	32

Notes: ***indicates significant at 1%, **indicates significant at 5%, *indicates significant at 10%. Parenthesis are the standard errors. UF is the female unemployment rate, REC is renewal energy consumption, Y is gross domestic product growth GOV is the government expenditure, UM is the male unemployment rate, INV is the investment, FD is the financial development, and POP is population growth. Also, i and t are country and period, respectively.

5. Conclusion and Policy recommendation

This paper examined the impact of renewable energy consumption on unemployment rate in sub–Saharan African region. Data were collected from a sample of 45 sub–Saharan African countries. System Generalised Method of Moment (GMM) has been employed as the estimation approach. The results reveal that renewable energy consumption has a negative significant impact on unemployment rate in sub–Saharan African region. These are some of the policy recommendations: First, since renewable energy consumption has been empirically tested to have a negative impact on unemployment rate, the results from the robustness checks from female and male unemployment also confirmed the findings in sub–Saharan Africa. Then, policy makers need to intensify commitment to providing adequate renewable energy that will help in reducing the unemployment rate in sub–Saharan African countries. Policymakers may consider investment levels of more renewable energy sources. Since Sub-Saharan Africa has abundant solar power, policy makers may consider inventing solar energy and other renewable

energy sources to reduce the rate of unemployment which will eventually improves employment opportunities. In sub-Saharan Africa, there is a significant potential for the use and consumption of renewable energy such as wind, solar, and hydropower.

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