

# Innovations

## Renewable energy consumption and sustainable development nexus: insights from Nigeria

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### Abstract

*The global community is increasingly debating the need to increase the share of renewables in the energy mix. Nigeria, poised to contribute about 69% of Africa's total energy consumption, has the potential to drive renewable energy consumption in the continent and beyond. This study aims to analyze the relationship between renewable energy consumption and Adjusted Net Savings (ANS) in Nigeria, a measure of the genuine or true saving in an economy after accounting for pollution damages and depletion of natural resources. Using secondary data from 1990 to 2019, this study presents a preliminary analysis of the central, correlation and dispersion behaviour of renewable energy consumption and ANS in Nigeria, and provides background information and recommendations for future studies. This study finds that Nigeria's renewable energy consumption remains low, with non-renewable sources accounting for about 90% of total energy consumption, despite the country's potential for renewable energy. The preliminary analysis suggests the possibility of Nigeria being an exception to the trend in literature that states a positive and significant relationship between renewable energy consumption and ANS. Further research is necessary to empirically test the cause-effect relationship between these variables and verify this hypothesis. This study contributes to the literature by serving as a reference point for further research on the nexus between renewable energy consumption and ANS in Nigeria, which is lacking in the Nigerian energy literature. It also underscores the importance of considering ANS as a measure of sustainable development in energy policy and investment decisions.*

**Keywords:** 1. Renewable energy consumption, 2. Adjusted Net Savings, 3. Sustainable Development, 5. Nigeria

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### 1. Introduction

There is an expanding debate on the need to increase the share of renewables in the global energy mix. World population is steadily growing, projected to be about 9 billion from the current 7 billion by 2050. This implies there is a huge need to consider options for access to energy that will be available, sufficient and sustainable. Renewable energy fits this bill quite satisfactorily as it can be replenished within a comparatively short time, is environmentally friendly and cleaner than its non-renewable counterparts such as coal, crude oil and natural gas.

Also, there is a growing awareness by organizations such as United Nations Framework Convention on Climate Change (UNFCCC) and Intergovernmental Panel on Climate Change (IPCC) and the Nigerian Federal Ministry of Environment (FME) on the need to encourage the consumption of renewable energy. About 81% of primary energy consumption globally is from non-renewable energy sources. This is counter to global sustainable expectations as renewable energy is preferred for the process of economic growth even though it makes up a smaller portion of the global energy mix because its byproduct is less harmful to the environment. Nigeria is poised to contribute about 69% of Africa's total energy consumption with reference to global expectations by 2040. This makes the country a potential major player in driving renewable energy consumption in the continent and in the world. This consideration of a sustainable future has led to a recently increasing conversation on how the wealth of such a country should be measured. Different measures of national wealth from literature are Gross Domestic Product (GDP), Gross Domestic Product per capita (GDP per capita), GDP growth rate, Genuine Wealth, Genuine Wealth per capita and Adjusted Net Savings, to mention but few. The measure of national wealth considered in this study is Adjusted Net Savings.

Economic well-being and national income are influenced by a country's wealth, specifically its natural, social, human, and financial capital. Adjusted net savings is defined as the rate of genuine or true saving in an economy after human capital investments, damages caused by pollution and depletion of natural resources have been taken into consideration. It is an indicator that assesses the economic sustainability of a region, especially in terms of the investment policies made by the government. An account of the net creation or destruction of a country's wealth is provided by adjusted net savings (ANS), which sheds light on the viability of an economy. It is calculated as what is left when energy depletion, mineral depletion, net forest depletion as well as carbon dioxide and particulate emissions damage are all deducted from the addition of net national savings and education expenditure. It is a fairly recent measure of sustainable development in the literature.

This study is preliminary in nature as its aim is to show the central, correlation and dispersion behaviour of renewable energy consumption and adjusted net savings in Nigeria. Quite a number of studies have examined the behaviour of renewable energy consumption in Nigeria. Much fewer studies have observed the tendency of adjusted net savings in Nigeria. There is a dearth of studies on the link between renewable energy consumption and adjusted net savings in Nigeria. This study seeks to present background information from the data on the variables of interest and draw inferences and recommendations that can guide future studies on the relationship between renewable energy consumption and adjusted net savings.

The study has the following structure. Section one deals with the introduction. Section two presents the literature review. Section three shows the method of data analysis. Section four is for the discussion of the findings derived from the analyzed data, while section five provides the summary, recommendations and conclusion.

## 2. Literature Review

The relationship between renewable energy consumption and adjusted net savings is a current issue in the literature. Empirical literature in this area seems to be divided into different strands. These strands include renewable energy consumption and other variables, adjusted net savings and other variables, then renewable energy consumption and adjusted net savings. The literature of interest to this study are those on renewable energy consumption and adjusted net savings.

Studies with the inclusion of adjusted net savings started to become prominent from late 1990s considering the work of Pearce, Hamilton and Atkinson (1996), Hamilton and Clemens (1999). Adjusted net savings started to show up in energy literature in the early 2000s with the work of Al-Mulali, Lee, Mohammed and Sheau-Ting (2015). They found a positive a significant influence of renewable energy consumption on genuine savings in Latin America and the Carribean. In a study on OECD countries, Eddine, Hassoun and Hicham (2020) used the panel random effect and panel autoregressive distributed lag (ARDL) cointegration method to examine the relationship between renewable energy consumption and adjusted net savings. Findings showed that renewable energy consumption has a negative influence on adjusted net savings in the

short run, while a positive and significant relationship exists in the long run. Using the two-stage least squares method for a similar OECD study, Guney (2021) found a positive relationship between renewable energy consumption and adjusted net savings. Guney (2019) and Guney (2021) followed the trend as a positive and significant relationship was found for related studies on 40 developed and 73 developing countries.

In a study by Lin et al. (2020), the authors analyzed the relationship between renewable energy consumption and ANS in 16 Asian countries. The study found that renewable energy consumption had a positive impact on ANS, indicating that renewable energy consumption contributes to sustainable development in the region. Similarly, a study by Shahbaz et al. (2018) investigated the relationship between renewable energy consumption and ANS in the context of the Sustainable Development Goals (SDGs) in Asian countries. The study found that renewable energy consumption had a positive impact on ANS, indicating that renewable energy consumption contributes to achieving SDGs in the region.

In Europe, a study by de Arce et al. (2019) analyzed the relationship between renewable energy consumption and ANS in European Union (EU) countries. The study found that renewable energy consumption had a positive impact on ANS, indicating that renewable energy consumption contributes to sustainable development in the region. Another study by Zhu et al. (2021) investigated the relationship between renewable energy consumption and ANS in the context of the Belt and Road Initiative (BRI) countries, including those in Europe and Asia. The study found that renewable energy consumption had a positive impact on ANS, indicating that renewable energy consumption contributes to sustainable development in the region.

In Latin America, a study by Vargas et al. (2020) analyzed the relationship between renewable energy consumption and ANS in five Latin American countries. The study found that renewable energy consumption had a positive impact on ANS, indicating that renewable energy consumption contributes to sustainable development in the region. Similarly, a study by de la Hoz et al. (2020) investigated the relationship between renewable energy consumption and ANS in the context of the SDGs in Latin America. The study found that renewable energy consumption had a positive impact on ANS, indicating that renewable energy consumption contributes to achieving SDGs in the region.

Overall, the above studies indicate that there is a positive relationship between renewable energy consumption and ANS in various regions, including Asia, Europe, and Latin America. However, the relationship between renewable energy consumption and ANS in Nigeria remains underexplored, highlighting the need for further research in this area.

Solarin and Bello (2021) in a study on India used the ridge regression technique to evaluate the impact of renewable energy consumption on adjusted savings. A positive and significant relationship was found, even more so with the combination of GDP as a measure of economic sustainability. Ahmad, Jawadi and Azam (2022) got similar findings using panel OLS for 76 countries. In an Iranian study, Behboudi, Mohamadzadeh and Moosavi (2017) used the Bayesian vector autoregressive (VAR) approach to deduce a positive and significant bi-directional relationship between renewable energy consumption and adjusted net savings. Behboudi, Mohamadzadeh and Moosavi (2022) had the same findings after including CO<sub>2</sub> emissions as a control variable.

On the flip side, Qasim Alabed et al. (2021) analyzed the impact of renewable energy consumption on adjusted net savings in the MENA region using quadratic regression. They found a generally positive relationship for the developed countries in the region and a generally negative relationship for the developing

countries in the region. Bello and Ch'ng (2022) found a positive but insignificant relationship from renewable energy consumption to adjusted net savings after using the ARDL method to investigate the relationship. Nigerian studies such as Van der Ploeg (2010) insisted that genuine savings is zero when the substitutability of sectoral labour for capital in an economy is high where there is a common stock of capital and zero property rights. Nigeria was used to validate this argument. Adekunle et al. (2021) examined electricity supply and sustainable development in Nigeria using genuine savings as the measure of sustainable development and found a positive relationship. Abdulkareem, Jimoh and Shasi (2022) looked the effect of GDP per Capita and foreign direct investment on sustainable development in Nigeria through adjusted net savings and found a positive and significant relationship. Ojike, Uwajumogu and Didigu (2022) studied education outcomes and adjusted net savings in Nigeria and their findings followed the trend.

In a study by Adewuyi et al. (2020), the authors analyzed the relationship between renewable energy consumption and economic growth in Nigeria using data from 1986 to 2018. The study found a positive and significant relationship between renewable energy consumption and economic growth in Nigeria. However, the study did not investigate the relationship between renewable energy consumption and ANS. Another study by Oyewole et al. (2019) examined the impact of renewable energy consumption on economic growth and carbon emissions in Nigeria. The study found a positive relationship between renewable energy consumption and economic growth but did not establish a significant relationship between renewable energy consumption and carbon emissions. However, the study did not investigate the relationship between renewable energy consumption and ANS.

In a study by Amadi et al. (2018), the authors examined the relationship between renewable energy consumption and economic growth in Nigeria using data from 1970 to 2014. The study found a positive relationship between renewable energy consumption and economic growth but did not investigate the relationship between renewable energy consumption and ANS. In the same vein, a study by Adom et al. (2020) investigated the relationship between renewable energy consumption and economic growth in Nigeria using data from 1980 to 2016. The study found a positive relationship between renewable energy consumption and economic growth but did not examine the relationship between renewable energy consumption and ANS.

Another study by Ganiyu et al. (2018) analyzed the relationship between renewable energy consumption and economic growth in Nigeria using data from 1981 to 2015. The study found a positive relationship between renewable energy consumption and economic growth in Nigeria. However, the study did not investigate the relationship between renewable energy consumption and ANS. In a study by Oyedepo et al. (2019), the authors analyzed the potential of renewable energy sources in meeting the energy demand of Nigeria. The study found that renewable energy sources could contribute significantly to meeting the country's energy needs, but did not investigate the relationship between renewable energy consumption and ANS. In another study by Aliyu and Lawal (2019), the authors investigated the relationship between renewable energy consumption and economic growth in Nigeria using data from 1986 to 2016. The study found a positive relationship between renewable energy consumption and economic growth in Nigeria. However, the study did not examine the relationship between renewable energy consumption and ANS.

A study by Folarin and Usman (2019) examined the impact of renewable energy consumption on economic growth and CO<sub>2</sub> emissions in Nigeria. The study found a positive relationship between renewable energy consumption and economic growth but did not establish a significant relationship between renewable energy consumption and CO<sub>2</sub> emissions. However, the study did not investigate the relationship between renewable energy consumption and ANS. In a study by Olabode et al. (2020), the authors investigated the role of

renewable energy in achieving sustainable development in Nigeria. The study found that renewable energy sources could contribute significantly to achieving sustainable development goals, but did not specifically examine the relationship between renewable energy consumption and ANS.

Despite the significant progress in renewable energy development in Nigeria, the relationship between renewable energy consumption and ANS remains largely unexplored. The few studies that have examined the relationship between renewable energy consumption and economic growth in Nigeria did not investigate the relationship between renewable energy consumption and ANS. Thus, there is a gap in the literature regarding the relationship between renewable energy consumption and ANS in Nigeria.

A phenomenon is seemly from the literature. Regardless of the methodology used in a study, the scope of the study or even the control variables used in a mathematical model to explain the relationship, when adjusted net savings is the dependent variable proxying sustainable development, the influence of the independent variable will be positive and significant. This includes renewable energy consumption in this case. It also shows that when adjusted net savings is the independent variable, it usually has a negative and significant or a positive but negligible influence on renewable energy consumption.

From the literature, to the best of knowledge, there are no studies in the Nigerian region that have considered the relationship between renewable energy consumption and sustainable development using adjusted net savings as the measure of sustainable development. In consideration of this, the study will be running background checks on the variables to observe and report their behaviour using descriptive statistics. These background checks with enable the extraction of inferences that can be subjected to further analyses.

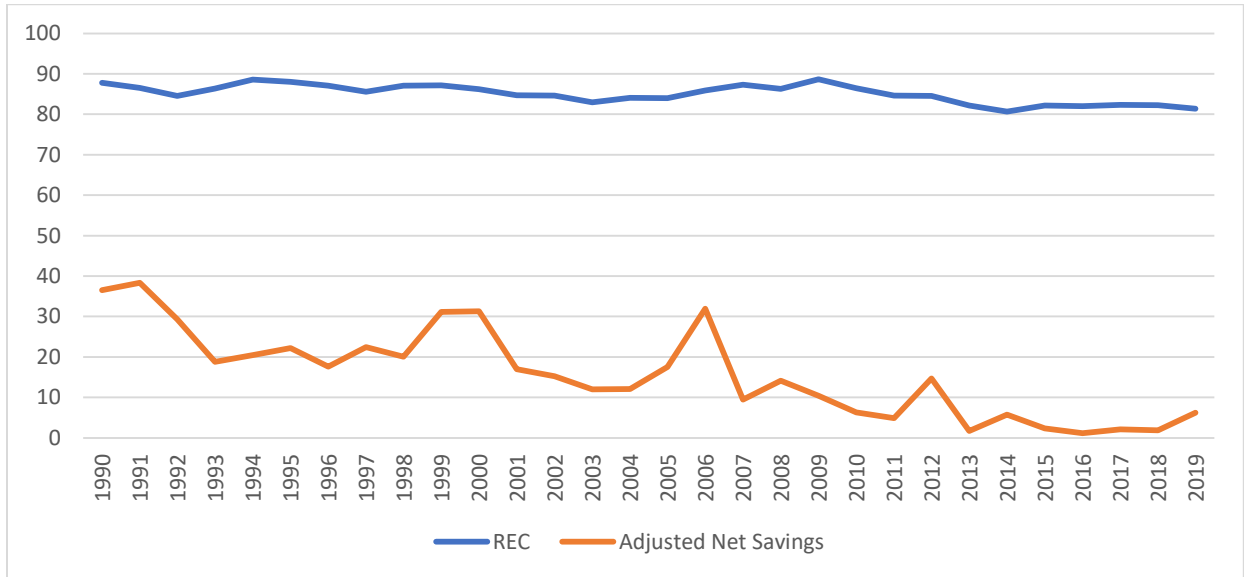
### **3. Methodology**

The variables considered in this study are renewable energy consumption and adjusted net savings for Nigeria between 1990 and 2019. The trend analysis for each variable, as well as their summary statistics and a correlation matrix are presented and explained in this section.

The chart 1 below shows the trend of renewable energy consumption and adjusted net savings in Nigeria between 1990 and 2019. There is a very slow decline in renewable energy consumption during the period. The two highest peaks occur in 1994 and 2009, while the lowest point of renewable energy consumption in the country occurred in 2014. 2019 is a close second lowest point, with the trend taking a downward turn.

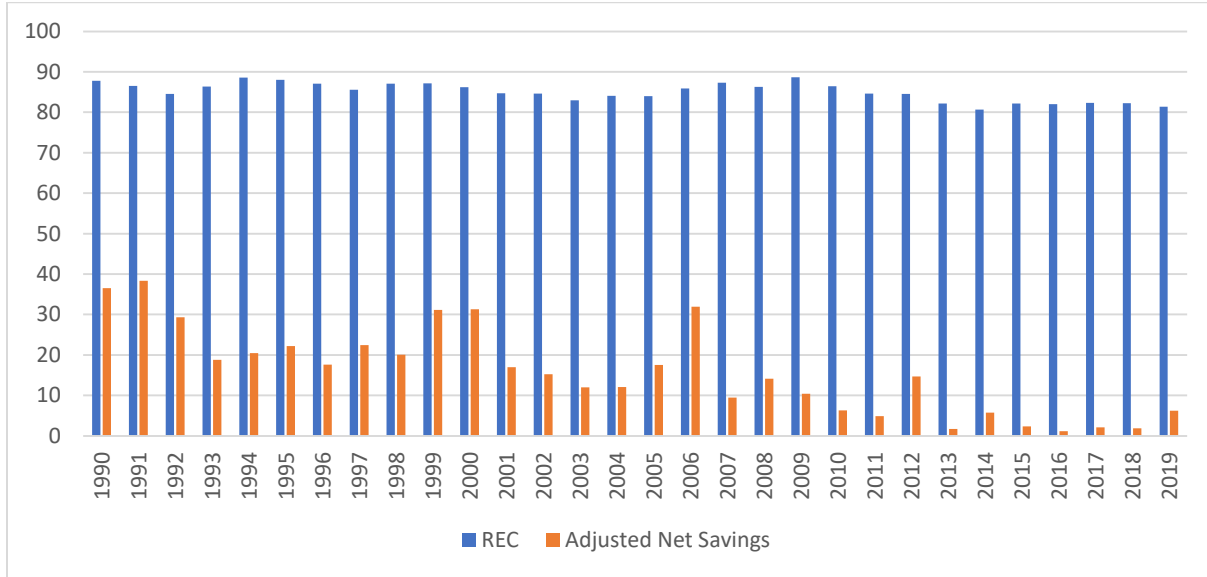
The adjusted net savings also has an overall downward sloping trend, though with steeper slopes than that of renewable energy consumption over the period. Nigeria had its highest adjusted net savings in 1991, after which there was a sharp decline in the variable until it hit a low in 1993, there were only a slight set of small rises and falls until 1998 where there was a sharp spike which remained the same for 2 years. Another sharp rise and fall occurred between 2005 and 2007, since after which there has been a continued decline. A rise in adjusted net savings seemed to be underway from 2018.

One interesting observation is that in the periods where renewable energy consumption rose, adjusted net savings seemed to fall and vice versa. This is enough to hypothesize that there could be a negative and significant relationship between the variables in the Nigerian case. This hypothesis negates the consensus from the literature.



**Figure 1: Trend Analysis of Renewable Energy Consumption and Adjusted Net Savings in Nigeria**  
**Source: Authors' compilation**

Chart 2 below corroborates chart 1. Between 1990 and 2019, adjusted net savings never grew to be half as much as renewable energy consumption. This also makes it safe to imply that if adjusted net savings does not grow even half as much as renewable energy consumption all through the period, then the link between them may be quite weak. For Nigeria, this consideration seems appropriate because of the high rate of energy depletion and mineral depletion. The energy and mineral depletion rates have remained high, even though the energy mostly depleted is the non-renewable energy source depletion such as crude oil, coal and natural gas. Nigeria earned about 600 billion naira from solid mineral depletion between 2007 and 2019. It is worthy of note that non-renewable energy and solid minerals have a very low replenishment rate. Renewable energy is also depleted in the generation of energy, but its replenishment rate is very high. Investment in human capital has remained low as expenditure in education has remained below UNICEF's benchmark 26% for the entire period of interest to this study. Also, Nigeria's net national savings has been on a steady decline, even more since 2010. If the addition of net national savings and education expenditure is shrinking, while the energy and mineral depletion are high, the steady decline of adjusted net savings is logical.



**Figure 2: Comparison Chart between Renewable Energy Consumption and Adjusted Net Savings in Nigeria**

Source: Author’s Compilation

**Table 1: Correlation Matrix**

	REC	Adjusted Net Savings
REC	1	
Adjusted Net Savings	0.615901754	1

Source: Author’s Computation

**Table 2: Summary Statistics**

REC		Adjusted Net Savings	
Mean	85.06475332	Mean	15.83691411
Standard Error	0.416086467	Standard Error	1.999107408
Median	85.11064459	Median	14.98864008
Mode	#N/A	Mode	#N/A
Standard Deviation	2.278999436	Standard Deviation	10.94956222
Sample Variance	5.193838428	Sample Variance	119.8929129
Kurtosis	-1.006751096	Kurtosis	-0.702459837
Skewness	-0.252541031	Skewness	0.465597057
Range	8.04	Range	37.15187767
Minimum	80.64	Minimum	1.163061169
Maximum	88.68	Maximum	38.31493884
Sum	2551.9426	Sum	475.1074234
Count	30	Count	30
Largest(1)	88.68	Largest(1)	38.31493884
Smallest(1)	80.64	Smallest(1)	1.163061169

Source: Author’s Computation

Table 1 presents the correlation matrix for renewable energy consumption and adjusted net savings. 0.62 depicts a moderately strong correlation between renewable energy consumption and adjusted net savings. Even though Figure 1 claims that there may be a negative relationship between renewable energy consumption and adjusted net savings, the correlation between them is above average. This tilts towards the fact that correlation is not necessarily causation. Furthermore, a correlation value of 0.62 means that if both renewable energy consumption and adjusted net savings are considered as independent variables in a study, there may be weak multicollinearity between them. This could make them a good fit to be considered in a multiple regression analysis to explain a phenomenon in Nigeria.

The summary statistics of this study are shown in Table 2. The summary statistics give quick information about the measures of central tendency and dispersion for the variables of consideration. They are very useful in showing data behaviour and in the formulation of hypotheses around different phenomena. The mean of renewable energy consumption is 85.06, the standard deviation is 2.27, the minimum is 80.04 while the maximum value is 88.68. This means that the average value of how much renewable energy has been consumed in Nigeria in 30 years has experienced very little changes over time. This could be because biomass energy has remained the highest renewable energy consumed over the period, reaching as high as 90% of total renewable energy consumption in Nigeria which is consumed areas that have very limited grid access (International Energy Association, 2020). Despite increasing interventions to increase the contribution of other renewable energy sources to the energy mix, biomass has remained the highest contributor, with hydroelectric sources coming in second. It is the highest contributor to electricity generated in Nigeria, but it is not the highest renewable energy source consumed.

The mean of adjusted net savings is 15.84. The standard deviation is 10.94, while the minimum and maximum values are 1.16 and 38.31 respectively. The implication of this is that there is a wide variation in adjusted net savings over the period, and the haphazard nature of its trend in Figure 1 proves it. The component of net adjusted savings that seem to be the reason for the high variation are the depletion rates of energy and solid minerals.

## Conclusion

This preliminary study has provided an introduction and a literature review. It has also analyzed and interpreted the summary statistics. From what was found, there is the possibility of Nigeria being an exception to the trend in literature that states that there is a positive and significant relationship between renewable energy consumption and adjusted net savings. There is the need for further research to test the cause-effect relationship between the variables empirically to verify this hypothesis.

This study contributes to literature as a reference point for further research on the nexus between renewable energy consumption and adjusted net savings in Nigeria. It is novel in this regard. There is also the need for further studies to examine the relationship between non-renewable energy consumption and adjusted net savings in Nigeria. Nigerian energy literature lacks the consideration of interaction with adjusted net savings as a measure of sustainable development.

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