NANGARHAR UNIVERSITY
INTERNATIONAL JOURNAL OF BIOSCIENCES
ORIGINAL ARTICLE
e-ISSN: 2957-9988
NUIJB Special Issue, 2024

Received: 27 Dec 2023 Accepted After Revision: 22 Jan 2024 Published Online: 10 Feb 2024

The Impact of Renewable Energy on Sustainable Economic Growth in Afghanistan

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ABSTRACT
The present study has been conducted to investigate the impact of renewable energy on the sustainable economic growth of Afghanistan. This research focuses on examining the ranking of the effects of renewable energy sources on economic growth. In this study, secondary data sources were utilized to describe the situation in Afghanistan regarding renewable energy and its utilization possibilities. Meanwhile, primary data from 195 experts in energy, water, and electricity, environmental specialists, economists, and several firms in Kabul were collected to assess its economic impacts. The sample was selected through simple random sampling. A questionnaire was used as the data collection tool, designed structurally based on the Likert spectrum and theoretically supported by various economic theories. The reliability of the questionnaire was ensured using Cronbach's alpha, which yielded satisfactory results ($\alpha = 0.94$). The collected data were analyzed using SPSS software through various statistical methods such as KMO, Bartlett's test, factor analysis, composite reliability, convergent validity, discriminant validity, analysis of variance, Pearson correlation, regression analysis, and the coefficient of variation. The findings indicate that hydro energy can significant contribute to a positive change of 0.358% and solar energy can significant contribute to 0.412% in sustainable economic growth in Afghanistan. But wind energy has insignificant impact on economic growth in Afghanistan. The results of the study suggest that solar, hydro, and wind energy can have considerable effects on sustainable economic growth in Afghanistan. In conclusion, the research results confirm the hypothesis, asserting that the uses of renewable energy contribute to improving the sustainable economic growth in Afghanistan.

Keywords: Renewable Energy, Solar Energy, Hydropower Energy, Wind Energy, Economic Growth

INTRODUCTION
The securing of energy, energy resources, and the observed impacts on living standards and the environment has garnered significant attention from economists and policymakers. Energy and its resources are considered limited within the economic domain, representing fundamental elements of production necessary for sustainable economic growth. Currently, fossil fuels and coal are perceived as exploitable resources for productive activities. Additionally, oil and its derivatives constitute valuable national assets, and their suboptimal utilization can sometimes lead to irreparable losses. Furthermore, the consumption of energy from fossil fuels and coal contributes to air and water pollution as well as global warming. The use of renewable energy sources while preserving the environment can serve as a highly suitable alternative to the utilization of energy from fossil fuels (Sharifpur et al., 2022). Investing in renewable energy is a new driver of economic growth, contributing to increased national income, improved trade balance, industrial development, and job creation (Li et al., 2022) . The development and utilization of renewable energy can directly and indirectly create a substantial number of jobs in the country's economy, reaching into the millions (Markaki et al., 2013) .Xie et al. (2018) conducted a study utilizing panel data across seven energy-intensive countries to explore the nonlinear relationship between renewable energy consumption and economic growth. The research findings indicated a positive correlation, suggesting that the consumption of renewable energy, coupled with technological advancements, leads to economic growth. Destek and Sinha (2020) observed that the relationship between renewable energy and economic growth in 24 OECD countries resembles a U-shaped curve. As a result, economic experts are seeking sources that gradually replace fossil fuels. Consequently, the combustion of fossil fuels introduces harmful gases into the environment, affecting human respiration, and polluting the environment. On the other hand, the

accumulation of these gases in the Earth's atmosphere impedes the escape of heat from the planet's surface, leading to an increase in atmospheric temperature and widespread climate change. For this reason, the use of fossil fuels and coal has become a serious concern, prompting efforts to transition from fossil fuel and coal energy to renewable energy in many countries and regions around the world (Pye et al., 2015).

Afghanistan is recognized as a developing country actively engaged in industrialization and economic modernization. This has led to an increased demand for energy in the country. The anticipated rise in energy demand in the coming years is expected to continue in pursuit of economic and social development goals, as well as environmental conservation toward sustainable development. Considering environmental concerns, the reduction of harmful emissions such as carbon and air pollution, and renewable energy sources, particularly water, wind, and solar, are regarded as the optimal alternatives for industrialization and modernization in the country. These resources can be utilized without causing harm to the environment and the Earth's atmosphere, fostering sustainable economic growth. As a result, it is essential to conduct comprehensive research on the status of renewable energy in Afghanistan and its development potential, given that renewable energy addresses crucial issues related to the economy and society. The results of this study are expected to provide an overview of the significance of renewable energy for the economy, society, and its development potential in Afghanistan. This will assist existing investors in making further efforts to invest and develop the renewable energy sector, where they focus, and stimulate potential investors to make investment decisions in renewable energy development systems with the highest confidence. Additionally, this study provides stakeholders with a more comprehensive understanding of renewable energy and its important roles in social and economic development, shaping policies to encourage investors to continue investment and development. In essence, the overall and ultimate goal of the present study is to investigate and present a comprehensive framework of the role of renewable energy in the sustainable economic growth of Afghanistan.

MATERIALS AND METHODS

In this study, a quantitative research method was employed for scientific and logical inference, aiming to examine the effects of renewable energy on sustainable economic growth in Afghanistan. The research utilized both primary and secondary data sources. Secondary data, sourced from the Ministry of Energy and Water of Afghanistan, was used to describe the current state of the country concerning energy resources, particularly renewable energy. This included information on renewable energy production capacity, its economic impacts, and its utilization, presented through descriptive statistics. On the other hand, primary data for this research was gathered through a Likert-scale questionnaire, focusing on variables to estimate parameters and the influence of explanatory variables on the dependent variable (sustainable economic growth). The study relied on anticipated evidence to make scientific inferences regarding the subject based on the estimations.

First-hand data for this research was collected from energy and water specialists, environmental experts, economists, and several firm managers in Kabul. The questionnaire used in this study has a Likert-scale structural dimension and a theoretical dimension based on various theories in this field, which have been discussed in the research background. Different weights from one to five have been assigned to the designed questions in the questionnaire, where a weight of one indicates very low and a weight of five signifies very high.

In this study, various software programs such as EXCEL and SPSS were used for calculations. Preliminary computations, such as data and figure preparation and adjustment, were carried out using EXCEL. The estimation of the specified model in the context of Afghanistan, as well as other relevant tests for model evaluation, was performed using SPSS (as this software program is suitable for primary data).

Given the nature of the research, several tests were employed. Firstly, to assess the questionnaire's reliability, the Cronbach's Alpha test was utilized. For questionnaire validity, a convergent validity method was applied. To ensure the discrimination of the desired variables, a tool for measuring discriminant validity was employed. Sample size adequacy was evaluated using the KMO[1] test, and the interdependence of research variables was examined using the Bartlett test. Additionally, ANOVA[2] was used to validate the research model.

[1] Kaiser-Meyer-Olkin
[2] Analysis of Variance

Finally, various tests such as Pearson correlation, EFA[3], regression analysis, F-Stat, P-Value, R-Square, and Durbin-Watson were employed for logical inference and hypothesis testing.

RESULTS

Assessing the Reliability of the Scales

To assess the reliability of the questionnaire, Cronbach's Alpha test was employed, yielding a coefficient of 0.944 for all formulated questions. This coefficient indicates a high level of reliability and overall satisfaction. Before delving into the tool's validity, it is necessary to conduct a factor analysis.

Factor Analysis of the Questionnaire: Before conducting factor analysis, it is essential to perform the KMO test for sample adequacy and Bartlett's test for the presence of correlation in the data of the variables used. The results are presented in Table 1:

Table 1. Results of KMO and Bartlett's Test

KMO Numerical Value	Chi-Square for Bartlett	Degree of Freedom	Significance
.929	6758.001	276	.000

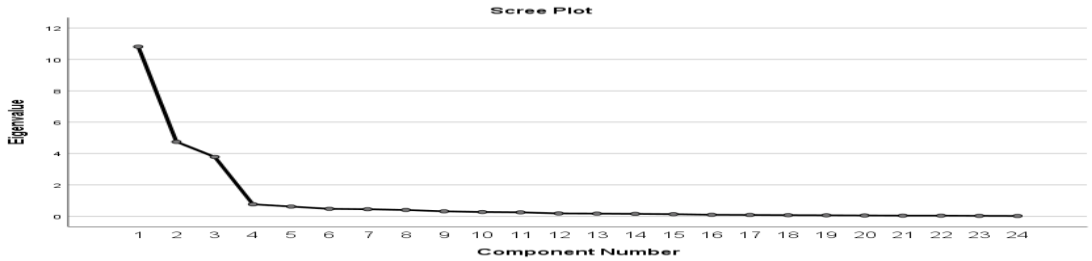
The KMO value (0.929 > 0.81) indicates sample adequacy, and the significance of Bartlett's test with a value of 0.05 suggests that in the population, there is a meaningful correlation among the collected data, and a significant relationship exists. Based on this correlation, the factorial analysis of the study is justifiable. Principal Component Analysis and Scree plot have been utilized to identify the key indicators of renewable energy in Afghanistan. Table (2) elaborates on the findings of this analysis.

Table 2. Extracted Principal Indicators Considering Eigenvalues and Variance

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	10.809	45.039	45.039	7.551	31.460	31.460
2	4.746	19.775	64.814	6.670	27.792	59.252
3	3.784	15.765	80.579	5.118	21.327	80.579
4	.762	3.174	83.753			

Extraction Method: Principal Component Analysis.

In Table 2 above, the primary factors of renewable energy, recognized as the main sources of renewable energy, are described. These determining factors of renewable energy resources in the country are categorized into three main components, which can account for 80.57% of the total questionnaire variance. This is further illustrated in the Scree plot graph below.



[3] Exploratory Factor Analysis

Assessing Composite Reliability

The researcher seeks to determine the extent to which the various utilized variables are interrelated in this tool and confirm the stability of the scale. Therefore, composite reliability is used as the objective. (Hair et al., 2016). The following table illustrates the composite reliability results for the variables used in the study.

Table 3. Cronbach's Alpha Results and Composite Reliability with Consideration of Main Variables

Variables	Cronbach's alpha	Composite reliability
Water	0.98	0.98
Solar	0.97	0.96
Wind	0.91	0.92

The above table indicates that for hydropower, solar, and wind energy, the composite reliability is 0.98, 0.96, and 0.92, respectively, all of which exceed 0.80, ensuring satisfactory reliability.

Assessing Convergent Validity

Convergent validity is employed when we want to ensure the reliability of a measurement tool or scale. This type of validity assesses whether the tool truly measures what we intend to measure. Convergent validity allows us to confirm the reliability of the tool in measuring a specific variable. It is measured using the AVE[4]. (Hair et al., 2010). In Table (4), the results of convergent validity are reflected using the AVE method.

Table 4. Convergent Validity Results Based on the AVE Method

Variables	AVE
Water	0.89
Solar	0.77
Wind	0.61

Assessing Discriminant Validity

It allows us to ensure differentiation among various variables in measurement tools, meaning to what extent a group of sub-variables used by a main variable is distinct from other groups of sub-variables in measuring it. The more noticeable the distinction, the more effective a group of sub-variables can be in measuring a main variable. The SQRTAVE method has been employed to measure discriminant validity, and its results are reflected in the following table.

Table 5. Discriminant Validity Results Based on SQRTAVE

Variables	Solar	Water	Wind
Solar	0.883		
Water	0.391	0.945	
Wind	0.318	0.221	0.783

Regression Analysis

A step-by-step regression model has been designed for estimating and predicting sustainable economic growth through the use of renewable energy resources in Afghanistan.

$$Y = \beta + \beta 1X1 + \beta 2X2 + \beta 3X3$$

[4] Average Variance Extracted

The econometric model above represents a research model in which Y stands for sustainable economic growth in Afghanistan, β represents the coefficient, x1 signifies hydropower, x2 represents solar energy, and x3 denotes wind energy in the model. Before drawing logical and scientific conclusions, it is necessary to analyze the variance of the research model, considering the theoretical framework of the study. To ensure the validity of the research model and its variance, the present study first analyzes variance. The results indicate that significance is observed only for two main variables in the model (0.05 > 0.000).

Table 6. Results of Explanatory Variables on SEG Using Stepwise Regression

Variable	Beta	Std. Error	T	Sig.T	R-Square	Adjusted R-Square
HE	.358	.016	22.464	0	.883	.881
SE	.412	.021	19.447	0		
WE	.36		---	0.78		
Constant=1.046			F= 378.183		Sig.F=0.000	

Given the R-squared value of 88%, the independent variables in the current study can estimate approximately 88% of the variations in the dependent variable (sustainable economic growth). Considering the results from the above table, the regression model of the study can be formulated as follows:

$$Y = 1.046 + 0.358x1 + 0.412x2 + 0.36\ X3$$

The above equation suggests if we increase hydropower energy by one unit, then the economic growth will increase by 0.358%. Similarly, the use of solar energy by one unit can increase economic growth by 0.412% in Afghanistan. But wind energy has an insignificant effect on economic growth, without considering the confidence level (alpha 5%), the finding of the above table suggests if we increase wind energy by one unit, then the economic growth will increase by 0.36%.

DISCUSSION AND CONCLUSION

The increase in population and the limitation of energy resources have had an impact on energy consumption. Limited fossil fuel resources and the increasing threat of pollution pose significant challenges to human societies. These factors emphasize the importance of energy resources. The use of renewable energy affects economic growth. All new energy sources, including renewable energies, are crucial for the economic development of countries. For this reason, the present study has been conducted to identify the effects of renewable energy on sustainable economic growth in Afghanistan. Data collected through a Likert-scale questionnaire have been utilized in the current research. Various statistical and econometric methods have been employed for logical and scientific inference in this study. The reliability of the questionnaire in the research is indicated by the numerical value of alpha (0.94). This value underscores the reliability of the questionnaire used in the study. Subsequently, factor analysis was employed to determine and obtain the key indicators of the research, and the subdivision of the sub-variables was carried out. As a result, three main variables were deduced from this analysis. The numerical value of Kaiser-Meyer-Olkin (KMO), which is 0.92, indicates the adequacy of the sample size and the meaningfulness of Bartlett's test (0.05), suggesting a logical relationship among the research variables. The scree plot was used to classify and consider solar energy, hydro energy, and wind energy as the main independent variables in the current research. Composite reliability was used to ensure the correlation of different variables in the study. For each variable, the value exceeded 0.80, indicating satisfactory reliability. To ensure that the sub-variables can be used to measure the main variables, convergent validity was assessed using the average variance extracted (AVE) method. The extracted values for each variable exceeded 0.50, indicating that the extracted factors are more suitable than any other combination of sub-variables for measuring the main variables. To investigate the relationship between the main factors using a group of sub-variables, the method of discriminant validity was employed. The results indicated that a group of variables has correlations with the main factors at percentages of 88%, 94%, and 78%, respectively. This

suggests that the sub-variables are distinct in measuring the main variables, with each contributing uniquely to the understanding of the main factors. Based on this, a regression model for the research was designed step by step. However, before the regression results, ANOVA was conducted to assess the validity of the research model. The results showed that, among the renewable energy sources in Afghanistan, only hydro and solar energy are significantly meaningful as explanatory factors. Next, to estimate sustainable economic growth in Afghanistan and its responsiveness to renewable energy, a step-by-step regression analysis was employed. The findings indicate that hydro energy can contribute to a positive change of 0.358% in sustainable economic growth in Afghanistan, and solar energy can contribute to 0.412% of sustainable economic growth in the country. The adoption of solar and hydro energy can have significant impacts on the country's gross domestic product (GDP) through increased domestic production, attracting investments, aligning import substitution policies, enhancing government revenues, saving electricity consumption from non-renewable sources, and reducing the trade deficit. However, wind energy can have an insignificant impact on economic growth in Afghanistan. The current conclusion supports the alternative hypothesis, indicating that solar, hydro, and wind energy, among renewable energy sources, can have positive effects on sustainable economic growth in Afghanistan. In light of the findings and the aforementioned conclusion, the following recommendations are proposed to relevant government and private sectors, particularly to the esteemed Ministry of Energy and Water in Afghanistan:

- ✓ Increased attention to water and power specialists for the effective and efficient utilization of renewable energy resources;
- ✓ Formulating evidence-based policies for the use of renewable energy, considering the findings of scientific and green economic research;
- ✓ Focusing on the uneconomical consumption of non-renewable energy to achieve long-term economic goals and using suitable alternatives (renewable sources);
- ✓ Managing renewable energy resources to reduce air pollution and conserve underground resources.

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