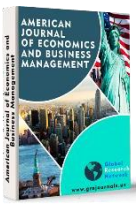

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Environmental Impacts of Renewable Energy Use and Economic Growth within the Framework of Sustainable Development Goal

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Abstract:

The traditional model of economic growth heavily reliant on fossil fuels, has contributed to environmental degradation, climate change, and resource depletion. This path poses significant risks to ecological balance, public health, and long-term economic stability. This requires a paradigm shift toward cleaner, more sustainable energy systems. Sustainable development seeks to align economic progress with social justice and environmental responsibility to ensure that the needs of the present are met without compromising the ability of future generations to meet their needs. The essence of this vision is to shift to renewable energy sources as a pivotal strategy for achieving comprehensive and sustainable economic development which provides a path to separate economic growth from environmental damage. Accordingly, the aim of this study is to analyze the implications of economic performance and the resulting justifications that contribute to supporting and enhancing the use of renewable energy, the transition to a low-carbon economy and a clean environment within the framework of the Sustainable Development Goals, and providing insights to policy makers on the transition to sustainable renewable energy. The study's results were consistent with the economic theory of development, which states that renewable energy has an impact on reducing carbon dioxide emissions and enhancing sustainable development, while the variables of urban expansion, foreign direct investment, and economic growth have shown negative impacts on the environment despite their positive effects towards sustainable development. The main challenge therefore lies in identifying strategies that enhance economic growth within the framework of mitigating environmental damage and ensuring energy security especially since renewable energy sources represent a promising solution to this challenge by providing clean and sustainable energy alternatives compared to fossil fuels.

Keywords: Renewable Energy, Economic Growth, Sustainable Development, Dynamic Ordinary Least Squares (DOLS).

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Introduction

The increasing reliance on fossil fuel energy sources (such as coal, oil, and natural gas) as a result of the increasing population growth and economic growth has negative effects on the environment, humans, and the economy, through gas emissions that contribute significantly to global warming and climate change, and the resulting degradation of the ecosystem and the increase in natural disasters such as floods and drought, in addition to air and water pollution, which threatens human health and well-being, and threatens the sustainability of development in the long term.

The importance of the research lies in the fact that renewable energy (such as solar energy, wind energy, water energy, and bioenergy) as potential sustainable alternatives to fossil fuels are among the most prominent main solutions that can contribute to facing the environmental and economic challenges that the world is witnessing at the present time which is characterized by its ability to produce clean, sustainable energy without polluting water or air emissions that negatively impact the ecosystem. This contributes to reducing the effects of climate change, achieving energy independence, alleviating the economic burden on the balance of payments, and achieving environmental sustainability.

This study aims to analyze the pathways renewable energy plays in economic growth and environmental performance, and assess its role in achieving environmental sustainability. It also seeks to examine the environmental challenges associated with expanding its use and propose strategic solutions to mitigate these negative impacts. The study also contributes to the development of strategies and policies to promote the use of renewable energy globally and support the transition to a low-carbon economy, contributing to achieving the Sustainable Development Goals and providing insights to policymakers on the transition to sustainable renewable energy.

The research hypothesis, based on its mechanisms derived from the economic theory of development, is that renewable energy has an impact on reducing carbon emissions, improving environmental quality, and positively supporting sustainable development goals in the long term, urban expansion, which is a major hub for local production, has its own direct side effects, including increased carbon emissions and irreversible impacts on supporting sustainable development goals in achieving long-term success. Therefore, an accurate answer is required between energy data and its recent sustainability.

The methodology used in this research relies on adopting the descriptive approach in analyzing and discussing the literature related to renewable energy and its environmental impacts within the framework of sustainable development goals, and adopting the statistical and metric approach based on the dynamic ordinary least squares method for panel data (PDOLS) for a group of countries that are among the largest generators of electricity in the world and the percentage of electricity derived from renewable sources, namely (Brazil, Canada, China, France, the United States of America, Japan, India, Russia and South Korea) as the balanced panel data covers 30 years from 1995 to 2024 in order to measure and analyze the existing relationships between the variables derived from previous literature and the vision of the economic theory of development in studying the environmental impacts of renewable energy projects.

The research covers two main sections. The first section discusses the theoretical literature on the relationship between some previous studies on renewable energy, environmental pollution, and sustainable development. It defines renewable energy and its sources, the importance of the transition to renewable energy, discusses the relationship between renewable energy and economic growth, and reviews the sustainable development goals related to renewable energy. Finally, the study highlights the important role of government policies in promoting the use of renewable energy and its environmental impacts compared to fossil fuels.

The second section explains the nature of the model used to estimate the relationship between economic growth and renewable energy at the level of carbon dioxide emissions on the one hand, and its impact on sustainable development on the other hand, and discusses the results obtained from these relationships, in addition to the most important conclusions and proposals that emerged from the study.

Literature Review

The study presented by (Fumey et al., 2024) explains the nature of the relationship between renewable energy consumption, economic growth, and environmental pollution

in Ghana (1993-2020). The results indicate a positive impact of renewable energy on carbon dioxide emissions, while economic growth showed a slight negative relationship with carbon dioxide emissions. The study recommended the importance of strengthening policies that support renewable energy and tightening environmental regulations to achieve a balance between economic growth and environmental protection.

The study presented by (Adanma and Ogunbiyi, 2024) included an analytical view of the economic and environmental impacts of adopting renewable energy. The results showed that renewable energy contributes to job creation, energy price stability, and the reduction of greenhouse gas emissions and environmental pollution. The study also emphasized the importance of government policies in facilitating and promoting the transition to renewable energy, and the importance of technical innovation in improving efficiency and reducing costs, within the context of the financial and technical constraints facing developing countries in this transition. It also suggested the need to enhance international cooperation to overcome these obstacles.

The study of (Aouini et al., 2023), explained the nature of impact economic growth, renewable energy consumption on the environmental pollution in (34) African countries for the period (1990-2020). The mentioned study used advanced estimation techniques for second-generation panel data, economic growth initially increases environmental pollution and then begins to decline after reaching a certain point similar to the inverted U which is consistent with the Environmental Kuznets Curve (EKC) hypothesis that indicates a nonlinear relationship between economic growth and environmental degradation. It also revealed that renewable energy consumption is inversely related to carbon dioxide emissions, highlighting its significant role in reducing environmental damage. The study recommends the importance of promoting the use of renewable energy, adopting strict environmental laws, and adopting sustainable growth practices that protect the environment.

As for (Gavkalova et al., 2022), they reviewed the impact of renewable energy development on the environment in (78) countries during the period (2000-2020), where four groups of countries were adopted based on the growth rates of renewable energy generation, and through the use of standard analysis to study the relationship between renewable energy and carbon dioxide emissions. The study came with the fact that there is a link between increased renewable energy and reduced pollution in most countries, and the economic growth was linked to increased pollution in China, India and Brazil. It has been also clear that the impact is not always positive, and some countries did not experience a significant impact between increased renewable energy and decreased pollution. The research recommends strengthening environmental policies that balance economic growth with environmental protection.

(Farhana et al., 2022) reviews the impact of energy consumption and environmental impacts in the textile industry focusing on the use of renewable energy to enhance sustainability. The results showed that renewable energy contributes to improving energy efficiency and reducing environmental impacts such as carbon dioxide emissions, water consumption and waste while the relationship between fossil energy and the environment showed a negative impact as reliance on renewable energy technologies leads to increased pollution and higher energy costs. The study recommends adopting renewable energy technologies to reduce environmental impacts and promote sustainable production, in addition to the importance of investing in modern technologies to improve energy efficiency.

The study presented by (Anser et al., 2021) which examined the impact of renewable energy sources on the economic growth of a group of Asian countries for the period (1900-2018) where the panel data analysis system was adopted using fixed effects models. Here the results show that wind energy, geothermal energy and bioenergy contribute positively

to economic growth, and the impact of hydropower and solar energy was found to be insignificant. The researchers also point out that increased consumption of these energy sources can stimulate long-term economic growth. The study recommends adopting policies that encourage the use of renewable energy to support sustainable economic growth and ensure future energy needs are met.

In his research, (Güney, 2019) reviews the impact of renewable and non-renewable energy consumption on sustainable development in developed and developing countries showing that renewable energy has a significant positive impact on sustainable development in both types of countries, while the impact of non-renewable energy was weak. In conclusion increasing the use of renewable energy enhances sustainable development and its goals until the year 2030, which calls for supporting policies that enhance investments in renewable energy at the global level.

(Nazir et al., 2019) study showed that the environmental challenges associated with wind energy development in Pakistan, in addition to renewable energy sources, technological developments, government policies and investment as independent variables, using environmental impact variables (noise pollution, wildlife impacts, and carbon emissions) as dependent variables, the results showed that increasing investment in technology and improving government policy performance can improve energy production and reduce environmental impacts.

The research presented by (Soukiazis et al., 2017) examines the relationship between sustainable economic development and renewable energy consumption and their impact on environmental pollution using a simultaneous equations model. The study results showed that renewable energy consumption plays an effective role in promoting sustainable growth and economic development and reducing environmental pollution, while enhancing education and technological innovation. The study also emphasized the importance of adopting policies that encourage investment in research and development to ensure a rapid transition to renewable energy. The study recommended adopting policies that support renewable energy and technological innovation to ensure sustainable development and achieve a balance between economic growth and environmental protection and achieve a balance between economic growth and environmental protection.

The study of (Ocak et al., 2004) identified the positive impacts of renewable energy consumption, compared to the negative impact of fossil fuels, on environmental performance in the Republic of Turkey. The use of fossil fuels leads to increased environmental pollution through emissions of sulfur dioxide and nitrogen oxides. The results also indicate that reliance on renewable energy sources contributes to reducing environmental pollution. However, the renewable energy infrastructure does not keep pace with the increase in energy consumption to meet the requirements of economic growth in Turkey. This necessitates the adoption of government policies that support innovation in the use of renewable energy to reduce environmental degradation and promote sustainable development goals.

2.1 Definition and Sources of Renewable Energy.

Renewable energy is defined as energy that has the ability to be continuously renewed or inexhaustible. Natural resources are an important source of this type of energy, making it sustainable in the long term (Sharaf al-Din et al., 2020). Renewable energy, represented by solar energy, wind energy, hydropower, geothermal energy, and bioenergy (organic materials such as wood and organic waste), is considered a sustainable energy source and an alternative to fossil fuels, which have negative environmental impacts.

3.1 The Importance of Switching to Renewable Energy.

The current environmental and economic challenges facing the developing and developed world are a result of the widespread reliance on fossil fuels over the past century, which is

a major source of gas emissions, global warming and climate change. Therefore, the transition to renewable energy has become a necessity to confront these challenges (Alhazmi, 2022), as it is a source of clean energy that contributes to reducing environmental pollution (water, air and soil) and reducing greenhouse gas emissions. It is also considered an important source for promoting sustainable development (Abd el Razik & El Sayed, 2022). It also contributes to promote sustainable development and provides clean reliable energy for future generations, while conserving natural resources and protecting the environment. The shift to renewable energy also contributes to improving energy efficiency and reducing costs in the long term, enhancing economic sustainability and contributing to the preservation of the global ecosystem (Abboud, 2024).

4.1 The Relationship Between Renewable Energy and Economic Growth

The relationship between renewable energy and economic growth emerges through direct and indirect pathways by contributing to the provision of job opportunities in the fields of manufacturing, installation, maintenance, and research and development. It also stimulates technical innovation in the fields of energy, storage, and smart grids, directly contributing to the realization of commercial and export opportunities that can enhance economic competitiveness and thus economic growth.

Diversifying energy sources and increasing renewable energy makes economies less dependent on fossil fuel imports and less vulnerable to fluctuations in global energy prices, thus reducing the economic and geopolitical risks associated with this type of fuel and achieving energy independence which will positively impact economic stability and growth. (Chou et al., 2023).

5.1 Sustainable Development Goals Related to Renewable Energy

Renewable energy is considered an essential part of the goals of sustainable economic, social and environmental development by the year 2030 (Abd el razik & El sayed, 2022), as the seventh goal of the Sustainable Development Goals indicates ensuring access to modern, sustainable and affordable energy services. Therefore, increasing the share of renewable energy in the global energy mix, improving energy efficiency, reducing environmental pollution and improving the quality of life for the population. This is especially because reliance on fossil fuels as an energy source causes the emission of greenhouse gases that pollute the environment, which requires increasing the share of renewable energy in the total energy mix in order to reduce gas emissions and pollution and achieve energy security through diversifying energy sources (Agbakwuru et al. 2024).

The positive effects of adopting renewable energy sources are represented by the preservation of natural resources, as adopting this type of energy can significantly reduce the depletion of non-renewable natural resources (such as oil, coal, and natural gas), which cause environmental pollution and negatively affect public health. The use of renewable energy also contributes to the preservation of biodiversity and the protection of the ecosystem, in addition to improving air and water quality, since the use of renewable energy reduces air and water pollution resulting from the burning and extraction of fossil fuels, improves air quality and does not destroy aquatic ecosystems. Improving air and water quality will improve public health and reduce pollution-related diseases, thus improving the quality of life and increasing productivity, especially since these positive effects are indirectly linked to the third and sixth goals of the Sustainable Development Goals, which are achieving good health and well-being, and providing clean water to the population (Sachs et al., 2024).

6.1 The Role of Government Policies in Promoting the Use of Renewable Energy

Achieving the goal of sustainable development requires government policies that support investment in renewable energy projects, improve energy efficiency, and reduce pollution. These policies include, first, financial and tax incentives for individuals and companies

investing in renewable energy projects and technological innovation. This also includes tax reductions and the provision of loans with easy repayment terms to support the use of solar panels, wind turbines, and other renewable energy equipment, making them more competitive compared to fossil fuels. Second: Legislation and standards, represented by laws that require the use of renewable energy (such as solar panels and geothermal heating and cooling systems) in new buildings. Third: International cooperation: represented by the exchange of expertise and technology in the field of renewable energy, in addition to international agreements to reduce greenhouse gas emissions and promote the use of renewable energy (Sharaf el-Din et al., 2020).

2. The Model Description [*,**]

This study aims to measure the impact of renewable energy on per capita carbon dioxide emissions and the Sustainable Development Index. The balanced panel data covers a 30-year period, from 1995 to 2024 including nine countries[***] it is one of the world's largest electricity generators, and the percentage of electricity derived from renewable sources, according to data issued by the Climate Energy Research Center "Ember" for the year 2023. The variable data for these countries are derived from the United Nations and the World Bank's World Development Indicators. Accordingly, the first and second models will take the following form:

$$\boldsymbol{CO2 = f\ (REC, GDP, FDI, URB)} \dots\dots\dots\dots \boldsymbol{Model(1)} \dots\dots\dots\dots (\mathbf{1})$$

$$\boldsymbol{SDI = f\ (REC, GDP, FDI, URB)} \dots\dots\dots\dots \boldsymbol{Model(2)} \dots\dots\dots\dots (\mathbf{2})$$

Therefore, the standard form of the two models will take the following form:

$$\begin{bmatrix} \boldsymbol{CO2_{it}} \\ \boldsymbol{SDI_{it}} \end{bmatrix} = \boldsymbol{\beta_0 + \beta_1 REC_{it} + \beta_2 GDP_{it} + \beta_3 FDI_{it} + \beta_4 URB_{it} + \varepsilon_{it}} \dots\dots\dots (\mathbf{3})$$

From formula (3), the study variables and their data sources can be described through the following table:

Table 1. Variables Description and Data Sources.

Series ID	Description	Source
CO2	The first dependent variable, Average per capita annual total carbon dioxide emissions (tons CO2 equivalent/capita)	World Bank
SDI	The second dependent variable, expressed by the Sustainable Development Index, has a value between (0 and 1), where (1) indicates that the country is achieving very good performance in the areas of sustainable development, while (0) indicates that there is a significant weakness in achieving sustainable development.	United Nations
REC	Share of renewable energy in final energy consumption (renewable energy consumption as % of total final energy consumption).	World Bank
GDP	Economic growth, expressed as the GDP growth	

(*): (***, **, *, n.s) indicate a significance level (1%, 5%, 10%, not significant) respectively.

(**): All tables included were prepared by researchers based on the outputs of the Eviews 13.

(***): According to data released by the Climate Energy Research Center "Ember" ID for 2023, the countries with the highest electricity generation and percentage of electricity derived from renewable sources in the world are (Brazil, Canada, China, France, the United States of America, Japan, India, Russia and South Korea). To view, click on the following link: https://www.ap.org/

	rate (annual percentage).	
FDI	Foreign direct investment inflows (% of GDP).	
URB	Urbanization, expressed as urban population (% of total population).	
ε_{it}	Error term	
i and t	i=1….N and t=1…T	

2.2 Estimation Model

In order to estimate formula (3) in the long run, the panel model will be used using the Panel Dynamic Ordinary Least Squares (PDOLS) method, which was developed by (Saikkonen, 1991) and generalized by (Stock & Watson, 1993) and was partially developed by (Kao & Chiang, 2000) and (Mark & Sul, 2003). This method has many advantages, the most important of which is that it leads to direct estimates if the study variables are stationary at level "I(0)" or the first difference "I(1)" or a combination of the two "I(0) and I(1)". It also leads to obtaining efficient estimators, in addition to addressing the problems of autocorrelation between the residuals and collinearity between the independent variables and the error variable.

3.2 Cross-Section Dependence Test

It is clear from Table (2) that the probability values of the Pesaran CD test, which is specific to detecting the independence of cross-sections, are greater than (5%). Accordingly, we accept the null hypothesis, which indicates the absence of cross-sectional dependence in the study data. In other words, the cross-sections are independent of each other. Accordingly, the first-generation unit root test will be used.

Table 2. Cross-Section Dependence Test Results.

Cross-Section Dependence Test				
Pesaran CD Test	**Model (1)**		**Model (2)**	
	Statistic	Prob.	Statistic	Prob.
	1.120	$0.263^{n.s}$	1.237	$0.216^{n.s}$

4.2 Panel Unit Root Test

Since the number of time periods in the study is (30) and the cross-sections are (9) as well as being independent of each other, the best way to test the unit root in this case is to use the (Im, Pesaran and Shin "IPS") test, as it is clear from Table (3) that the first and second dependent variables (CO2 and SDI) and the first independent variable (REC) appeared to be unstable in the level, meaning that these variables contain a unit root; since their probability values are greater than (5%). As for the rest of the independent variables (GDP, FDI and URB), they appeared to be stable at the level. Therefore, we reject the null hypothesis and accept the alternative hypothesis, which indicates that these variables do not contain a unit root (are stable).

Table 3. Panel Unit Root Test (Stability).

Panel Unit Root Test Test Type: Im, Pesaran and Shin						
Series		**Level**		**1st difference**		**Decision**
		Individual Intercept	**Individual Intercept and Trend**	**Individual Intercept**	**Individual Intercept and Trend**	
CO2	Statistic	2.8748	-1.8584	-8.5856	-8.4234	I(1)
	Prob.	$0.9980^{n.s}$	0.0316^{**}	0.0000^{***}	0.0000^{***}	
SDI	Statistic	-1.0826	-0.7299	-5.9721	-6.2302	I(1)

	Prob.	0.1395$^{n.s}$	0.2327$^{n.s}$	0.0000***	0.0000***	
REC	Statistic	-0.3882	-3.1469	-9.7510	-8.3425	I(1)
	Prob.	0.3489$^{n.s}$	0.0008***	0.0000***	0.0000***	
GDP	Statistic	-7.8948	-10.3983	-14.6594	-10.1600	I(0)
	Prob.	0.0000***	0.0000***	0.0000***	0.0000***	
FDI	Statistic	-3.8307	-3.0421	-14.7066	-11.7157	I(0)
	Prob.	0.0001***	0.0012***	0.0000***	0.0000***	
URB	Statistic	-2.6148	-2.9215	-11.2368	-9.2658	I(0)
	Prob.	0.0045***	0.0000***	0.0000***	0.0000***	

5.2 Cointegration Test

In order to confirm the existence of a long-term relationship between the study variables for both models or not, the "Johansen Fisher" measure was used to diagnose the existence of a cointegration relationship (a long-term stable equilibrium relationship) based on the Max Eigen Test Trace Test & thus the number of cointegration vectors was determined. It is clear from Table (4) that the probability values for all study variables and for both models are less than (5%). Therefore, we reject the null hypothesis and accept the alternative hypothesis, which indicates the existence of first-degree joint integration, and thus there is a stable long-term equilibrium relationship between them. This is consistent with the statement of economic theory, which indicates that all study variables are long-term variables.

Table 4: Cointegration Test Results.

Johansen Fisher Panel Cointegration Test				
Model (1)				
Series: CO2, REC, GDP, FDI, URB				
Hypothesized No. of CE(s)	Fisher Stat.* (Trace Test)	Prob.	Fisher Stat.* (Max Eigen Test)	Prob.
None	350.3	0.0000***	227.4	0.0000***
At most 1	207.8	0.0000***	114.8	0.0000***
At most 2	118.3	0.0000***	67.03	0.0000***
At most 3	73.96	0.0000***	50.81	0.0001***
At most 4	59.83	0.0000***	59.83	0.0000***
Model (2)				
Series: SDI, REC, GDP, FDI, URB				
Hypothesized No. of CE(s)	Fisher Stat.* (from trace test)	Prob.	Fisher Stat.* (from max-eigen test)	Prob.
None	362.3	0.0000***	245.0	0.0000***
At most 1	204.4	0.0000***	129.8	0.0000***
At most 2	101.1	0.0000***	66.85	0.0000***
At most 3	54.48	0.0000***	40.89	0.0016***
At most 4	44.90	0.0004***	44.90	0.0004***
* Probabilities are computed using asymptotic Chi-square distribution.				

6.2 Model Estimation and Interpretation of Results

Table (5) shows the results of estimating the parameters of the two models in the long term, as it is noted that there is a negative and significant effect of renewable energy consumption on the per capita share of CO2, meaning that an increase in renewable energy consumption by (1%) will lead to a decrease in the per capita share of CO2 by (-0.147) tons. This result is actually consistent with many studies, as the results obtained

from previous studies, represented by the study (Adanma and Ogunbiyi, 2024; Aouini et al., 2023; Gavkalova et al., 2022; Farhana et al., 2022; Soukiazis et al., 2017; Ocak et al., 2004) The increase in the use of renewable energy will lead to a reduction in the level of environmental pollution. As for the effect on the sustainable development index, the effect was positive and significant, meaning that an increase in the consumption of renewable energy by (1%) will lead to an increase in the sustainable development index by (0.003) points, studies (Soukiazis et al., 2017; Güney, 2019) indicated that encouraging investments in research and development is a key factor in the shift towards increased use of renewable energy, which will contribute to promoting sustainable development in developing and developed countries.

As for the impact of the remaining independent variables, the results showed positive effects of economic growth, foreign direct investment and urbanization on per capita CO2 and the sustainable development index, as an increase in economic growth, foreign direct investment and urbanization by (1%) will lead to an increase in per capita CO2 by (0.122, 0.229, 0.141) tons, respectively, which is an economically logical result, as it is consistent with the study of (Gavkalova et al., 2022; Aouini et al., 2023) urban expansion as an industrial area subject to local and foreign direct investment, at the expense of rural agricultural areas, will in turn have positive effects towards enhancing economic growth at the expense of negative effects towards increasing pollution levels occurring in those countries. These variables will also contribute to enhancing sustainable development through sustainable economic growth, the estimates of the parameters of these variables showed their positive effects on the Sustainable Development Index by (0.018, 0.049, 0.004) points, respectively.

Finally, the value of the coefficient of determination (R2) in both models was high, as its value in the first model reached (97%) and (95%) in the second model. This means that the independent variables in the two models have a strong relationship with the dependent variables.

Table 5. Results of Estimating the Parameters of the Two Models Using the Dynamic Ordinary Least Squares Method (PDOLS).

Panel Dynamic Least Squares (PDOLS)				
Model (1)				
Dependent Variable: CO2				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
REC	-0.147319	0.020054	-7.346214	0.0000***
GDP	0.221761	0.064305	3.448559	0.0009***
FDI	0.229370	0.113958	2.012770	0.0473**
URB	0.141187	0.004725	29.88019	0.0000***
R^2	0.969943	Adj. R^2	0.918566	
Model (2)				
Dependent Variable: SDI				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
REC	0.002991	0.000842	3.550254	0.0010***
GDP	0.017979	0.006832	2.631488	0.0119**
FDI	0.049109	0.013075	3.755882	0.0005***
URB	0.004489	0.000525	8.542649	0.0000***
R^2	0.954502	Adj. R^2	0.751424	

Conclusions and Suggestions

Continued reliance on unsustainable fossil fuels is a major source of both human health deterioration and environmental pollution. Therefore, it has become necessary to shift to

the use of renewable energy due to its positive environmental and economic impacts, as it contributes to reducing pollution and providing economic opportunities due to its ability to secure new jobs and achieve qualitative stability in energy prices, especially in achieving energy independence, the transition to renewable energy is a fundamental step towards ensuring environmental sustainability and achieving economic growth and sustainable development.

The study results concluded that the adoption of renewable energy in the study countries has an impact on reducing carbon dioxide emissions and enhancing sustainable development. Meanwhile, the variables of urban expansion, foreign direct investment, and economic growth have shown negative impacts on the environment, despite their positive impacts on sustainable development.

The study suggests the importance of promoting the use of renewable energy by adopting a set of measures, including providing financial and tax incentives and encouraging investment in renewable energy research and development projects as this represents an investment in a better future for all.

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CONFLICT OF INTEREST

The researcher supports the idea that this work does not conflict with the interests of others.

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