Examining the relationship between renewable energy adoption and economic development in the United Arab Emirates

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ABSTRACT

Purpose: This paper explores the intricate relationship between renewable energy adoption and economic development in the United Arab Emirates (UAE), highlighting how increased utilization of renewable resources correlates with various economic indicators.

Design/Methodology/ Approach: This paper examines a number of important factors using a large dataset covering the years 2000–2022, including GDP per capita growth, energy consumption, research and development spending, renewable energy capacity, investment in renewable energy, total greenhouse gas emissions, job creation, public awareness of renewable energy, and foreign direct investment (FDI).

The study offers a detailed examination of the ways in which the UAE's adoption of renewable energy affects economic growth, energy security, and environmental sustainability, taking into account positively skewed distributions through the use of a log-log model.

Findings: According to the findings, the UAE's planned transition to a greener economy is supported by the substantial economic benefits that expanded renewable energy capacity is linked to, including the creation of jobs, higher foreign investment, and lower greenhouse gas emissions.

Conclusion: In addition to advancing knowledge of the financial effects of renewable energy, the article supports the UAE's 2050 energy diversification plan and international sustainability objectives.

Research Limitations/Implications: The study's use of national-level data may cause it to ignore regional or sector-specific factors. Although relationships are found, it does not demonstrate that GDP growth is directly influenced by renewable energy. The results are unique to the UAE, which limits their generalisability to other nations, and the linear regression model might overlook intricate interactions. Important elements like the state of the world economy and geopolitics are not taken into account.

Practical strategies: These obstacles can be addressed and a more favourable climate for renewable energy projects can be created with the use of doable tactics like offering subsidies, tax breaks, and advantageous regulatory frameworks.

Contribution to literature: By examining the financial effects of renewable energy adoption in the United Arab Emirates and emphasising its role in both sustainability and economic growth, this study contributes significant insights to the body of knowledge. It adds to the larger conversation about striking a balance between environmental objectives and economic development by highlighting the significance of public awareness and policy in promoting the use of renewable energy.

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Keywords: *Economic development, Energy security, Environmental sustainability, Greenhouse gas emissions, Renewable energy adoption, United Arab Emirates (UAE).*

1. INTRODUCTION

Nowadays, the analysis of the relation between the use of renewable energy and economic growth is the important field.

Instead of using energy from fossil fuels, alternative sources like solar, wind, hydro, and geothermal power are becoming increasingly sustainable and economically viable. Transitioning to renewable energy would provide a variety of economic opportunities while simultaneously reaping significant environmental benefits, including decreased greenhouse gas emission, and reduced consumption of non-renewable resources. One of the countries that is actively trying to achieve its climate commitments and reduce its carbon footprint is the United Arab Emirates (UAE). Renewable energy adoption may increase green technology innovation, attract investment, enhance energy security by reducing import dependence, and increase employment opportunities. Renewable energy has become appealing in the economic sense in the United Arab Emirates (UAE).By 2030, increasing renewable energy to 10% of the nation's energy mix and 25% of its overall power generation could result in lower energy costs and yearly savings of USD 1.9 billion by reducing the use of fossil fuels.

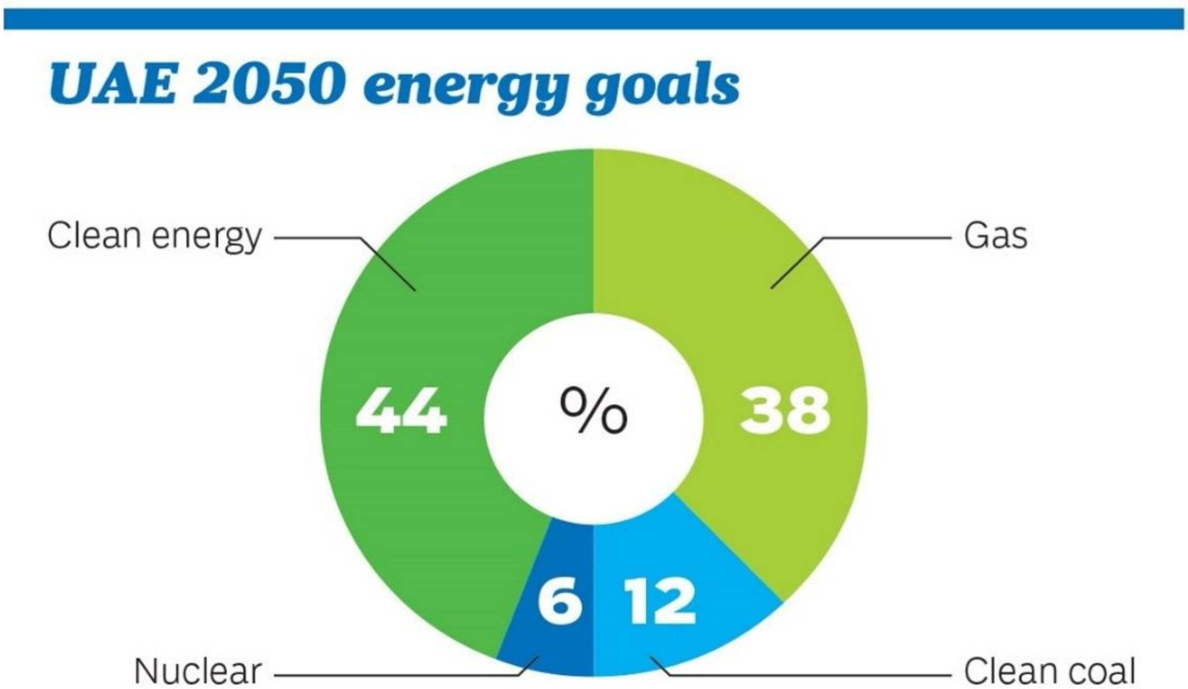

Figure 1. The UAE 2025 energy strategy goals.

Figure 1 presents the UAE energy strategy goals, where 38% have Gas, 44% have the highest percentage have clean energy, 12% Clean Coal, and 6% Nuclear.

Even while the use of renewable energy has increased globally, little is known about how it directly affects economic growth, especially in developing nations like the United Arab Emirates (UAE). Empirical research frequently ignores the relationship between the use of renewable energy and important economic metrics like GDP growth, foreign direct investment (FDI), and job creation, despite the UAE's notable progress towards a greener economy. Additionally, current research frequently overlooks the economic opportunities and trade-offs related to renewable energy programs in favour of concentrating on environmental sustainability. By offering a thorough examination of the financial ramifications of the UAE's embrace of renewable energy, this paper aims to close this gap.

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Therefore, this study's main goal is to examine the connection between the UAE's economic growth and the use of renewable energy. The study's specific objectives are to:

1. Assess how renewable energy capacity affects the growth of GDP per capita.
2. Evaluate the impact of investments in renewable energy on foreign direct investment and job creation.
3. Analyse how research and development (R&D) spending and public awareness might promote the use of renewable energy.
4. Examine how the usage of renewable energy and environmental sustainability are related, especially with regard to greenhouse gas emissions.

The research question addressed in this paper is: What is the overall impact of renewable energy adoption on economic development in the UAE?

2. LITERATURE REVIEW

The intricate balance between economic growth and energy resources is something that is receiving massive amounts of focus these days, especially as countries try to develop solutions that contribute to the climate goal objectives. The United Arab Emirates (UAE), which used to depend on fossil fuels for a long time, now serves as a case study for the transition toward renewable energy. This transition is necessary not only for lowering carbon emissions but also for providing stability in the economy and diversification in response to the volatile oil price changes. This sector traditionally served as a bottleneck to economic growth, but recent studies argue that using renewable energy technology enables new job opportunities, stimulates innovations, and brings investments, turning this sector into a growth driver instead (Melkumyan, 2023). Some primary understandings have formed from the research done regarding the relationship between energy and the economy. For example, the UAE's Vision 2021 plan aims at increasing the clean energy percentage in the total energy mix (Aldulaimi & Abdeldayem, 2022). Research highlights the UAE's astute investments in solar energy and other renewables (Payamfar, Seyed Shokri, Shojaei, & Mohammadzadeh Asl, 2023).

Furthermore, as the declining costs of wind and solar energy are believed to reduce total energy prices and stimulate economic activity, the competitiveness of renewable energy technologies is often emphasised (Shadab & Alam, 2024).

Nonetheless, there are still significant research gaps that require further study. The majority of recent research has mostly focused on particular initiatives or technological advancements, frequently ignoring the intricate public policies that influence energy transitions as well as more general social and economic repercussions (Moore, 2024).

Furthermore, there is a dearth of thorough research on the relationships between the adoption of renewable energy and other industries, such as manufacturing, services, and tourism, all of which are critical to the UAE's diversification efforts (Alnaqbi & Alami, 2023).

Additionally, little is known about the social and political elements that influence public support and government support for renewable energy projects, which could clarify the complexities of this relationship (Chen et al., 2022). Additionally, although environmental advantages have been the focus of many conversations, actual research linking the usage of renewable energy to tangible economic results such as GDP growth, job creation, and foreign direct investment is desperately needed (Vakulchuk, Overland, & Scholten, 2020). Understanding how renewable energy can successfully integrate into the UAE's economy will be essential for creating policies that are both successful and equitable as the country moves closer to a sustainable energy future (Sim, 2023). The purpose of this literature review is to provide an overview of the state of the art on the relationship between the UAE's economic growth and the use of renewable energy, highlighting key findings and potential directions for further study.

This review of the existing literature will support future policy discussions regarding strategic planning and socio-economic impacts by examining sustainability efforts in the Gulf region (Alsayegh, Abdul Rahman, & Homayoun, 2020). Again, the focus is on policies for the United Arab Emirates (UAE) that further economic growth and energy development through renewable energy sources (Jamaledini & Bayat, 2024).

The assessments of the application of renewable energy technologies in the context of the economic development of the United Arab Emirates (UAE) implicitly contain a complex of reasons both from within and outside the country. In the beginning, there was a focus on the considerable fossil fuel resources of the UAE and the oil

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industry as a major pillar of the economy. This focus was to some degree built upon the fossil fuel resource focus that was installed in the UAE (Melkumyan, 2023). With the increasing global awareness about climate change, however, the UAE had to shift towards renewable energy, this marked a new reality for the research focus and regulations of the new energy paradigm. Plus, the commitment supporting the diversification of energy supplies through sustainable development, like establishing the Masdar Institute of Science and Technology in the mid 2000s, as a government comprehensive toehold to further claimable development (Shadab & Alam, 2024). Discussions have progressed by 2010s, and additional research has been done on the financial implications of switching to renewable energy.

Whether oil is present or not, investing in renewable energy has the potential to increase technology advancement and job opportunities. According to Payamfar et al. (2023) the UAE used this logic to justify its excess spending on solar energy projects such as the Mohammed Bin Rashid Al Maktoum Solar Park. The investment greatly aids the UAE in demonstrating the profitability of renewable resources and also assists in Moore (2024) capital expenditure. According to Ubaid and Gulrez (2025) the Integrating Renewable Technologies along with Moore (2024) suggests that UAE's policy towards economic diversification heavily hinges on energy transition.

Information has also been collected by AlHammadi et al. (2022) where private-public innovation will assist in advancing the energy sphere within the UAE. Understanding these relationships will help advanced sustainable energy practices and foster UAE's economic development. Moreover, pursuing a deeper understanding of the link between renewable energy and economic progress may aid the UAE in gaining itself new opportunities and solving existing problems (Jamil, Ahmad, & Jeon, 2016).

Examining UAE's investment in renewable energy with its corresponding economic development yield some significant patterns. One of these trends that stands out is the interdependence between energy spending and economic diversification (El Anshasy & Khalid, 2023).

Furthermore, knowing how the general public views and accepts renewable technology offers important insights into the social issues influencing their adoption (Melkumyan, 2023). Research indicates that local support for renewable projects is significantly impacted by community involvement and awareness initiatives (Shadab & Alam, 2024). This social element is crucial since the success of technological adoption can be greatly impacted by public support. Lastly, despite the obvious economic benefits of renewable energy, obstacles like upfront capital expenditures and the requirement for a trained labour force continue to be major concerns in the literature (Moore, 2024). Unlocking the economic potential of the UAE's renewable energy plans requires addressing these challenges, which will also serve as a roadmap for future studies and legislative initiatives (Graf-Vlachy, Buhtz, & König, 2018).

Numerous research techniques have been used in the study of the UAE's economic growth and adoption of renewable energy, and each has provided insightful information. There is a considerable correlation between investments in renewable energy and Gross domestic product (GDP) growth in the region, according to quantitative studies that use econometric approaches to emphasise statistical linkages and causal relationships (Melkumyan, 2023).

According to Sadar Din and Ishak (2024) these studies typically use time-series data, which may successfully detect trends but may overlook socioeconomic aspects or localised consequences. However, qualitative approaches offer an alternative perspective, focussing on the opinions of stakeholders and the implications for policy. Research that employs case studies and interviews highlights the role of public awareness campaigns and government initiatives in encouraging the adoption of renewable energy, emphasising that social factors and financial investment are not the only factors that affect economic development (Payamfar et al., 2023). The complex character of this interaction has been particularly well captured by combining qualitative and quantitative methods.

Mixed-method studies, for instance, have demonstrated that while infrastructure investment can spur economic growth, community involvement and environmental concerns are essential to the projects' success (Samour, Baskaya, & Tursoy, 2022).

The distinct socio political environment of the UAE creates unique challenges and opportunities which become apparent when comparative studies relate this nation to other countries. The comparison analysis reveals that an effective research strategy must integrate both quantitative data and qualitative insights because the choice of methods can greatly affect the study results (Moore, 2024). Current research demonstrates that a range of methodologies should be used to fully grasp the complex relationship between renewable energy and economic

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growth in the UAE (AlHammadi et al., 2022). The relationship between the adoption of renewable energy and economic growth in the UAE requires investigation through a theoretical analysis that includes multiple perspectives. First, according to the theory of sustainable development, environmental balance and economic progress should coexist. This means that renewable energy may both promote economic growth and lessen ecological harm. Research supports this opinion by demonstrating that investments in renewable technology can improve economic stability and generate jobs, which will aid in the achievement of sustainable development goals (Melkumyan, 2023).

Additionally the innovation diffusion hypothesis explains how new technologies such as renewable energy sources spread throughout communities and impact economic systems. Research suggests that the UAEs early adopters of renewable technology have spurred broader adoption suggesting a positive correlation between economic growth and investments in renewable energy (Sadar Din & Ishak, 2024). Dependency theory proponents however argue that reliance on renewable energy could worsen already-existing economic disparities if the benefits are not shared fairly (Hamdan, 2024). Institutional theory also highlights how regulations can help or hurt renewable energy initiatives. Due in large part to the UAEs progressive policies the adoption of renewable technologies has prompted economic diversification away from reliance on oil (Ubaid & Gulrez, 2025). Hence the interaction of these concepts reveals a nuanced relationship that emphasizes the necessity of implementing renewable energy for the UAEs economic growth while simultaneously drawing attention to potential issues with disparate institutional support and economic inequality. Combining different viewpoints makes it evident that a comprehensive approach is needed to understand and control the effects of renewable energy in the UAEs economic environment (Moore, 2024). An interesting story that demonstrates the potential for significant economic changes in the new energy situation is shown by the research of the relationship between the usage of renewable energy and economic growth in the United Arab Emirates (UAE). The UAE's commitment to renewable energy, especially through landmark initiatives like the Mohammed bin Rashid Al Maktoum Solar Park, aligns with the national objectives outlined in Vision 2021, as detailed in a thorough review of the existing literature (Xie, Zhu, Hu, & Hung, 2023). This connection reinforces the core argument of this analysis, which points to a notable transition away from fossil fuels toward a more diversified and sustainable economy. It suggests that the UAE, in the face of global energy transitions, could secure long-term growth by harnessing the potential of renewable energy (Melkumyan, 2023).

Key findings reveal that the successful integration of renewable technologies not only attracts foreign investments but also fosters innovation and generates employment opportunities. Research underscores the positive impact of robust policy frameworks and government incentives in cultivating a flourishing renewable energy sector that contributes to broader economic development (Hamdan, 2024). Moreover, as the cost of solar and wind energy continues to fall, these resources have become increasingly competitive, leading to stronger local economies and enhancing national resilience amid the volatility of global oil markets (Ubaid & Gulrez, 2025). However, while these insights are promising, this review also highlights critical gaps in the literature. Often, studies tend to focus narrowly on specific projects or technological advancements, neglecting broader socio-economic factors and the policy implications needed to understand the full scope of the UAE's economic landscape (Moore, 2024). Additionally, limited research has been conducted on how renewable energy intersects with other key sectors such as manufacturing and tourism. This suggests a need for a more holistic perspective to fully assess the broader impacts of the UAE's energy transition (AlHammadi et al., 2022).

More research on how political environments and public sentiments affect renewable energy projects is needed in order to boost public support and involvement for these important initiatives (Chen et al., 2022). Furthermore, the urgent need for additional research in this area is highlighted by the paucity of reliable studies that directly connect renewable energy initiatives to measurable economic outcomes, such as GDP growth, job creation, and foreign direct investment. It is crucial to create clear connections between the use of renewable energy and economic indicators in order to support policy decisions and create a strong framework for the UAE's energy transition (Vakulchuk et al., 2020). In conclusion, despite the significant advancements, more study is still required to fully understand the connection between economic development and renewable energy. Future studies could compare various regions and look at how political processes impact the effectiveness and adoption of renewable energy projects. Policymakers in the United Arab Emirates and other countries taking similar paths may find value

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in the findings of these studies. In order to lay the foundation for upcoming discussions, the creation of strategic policies, and collaborative projects in the United Arab Emirates and other regions, the review ends by offering a basic understanding of the transformative potential of renewable energy for sustainability and economic stability (Alsayegh et al., 2020).

This literature review contributes to the larger objective of attaining a sustainable and diverse economic future for the United Arab Emirates by elucidating the process of incorporating renewable energy into the national economic framework.

Therefore, the current study will test this hypothesis: Adoption of renewable energy boosts GDP, generates jobs, and draws foreign direct investment (FDI), all of which have a positive impact on economic growth in the United Arab Emirates.

3. METHODOLOGY

This study shall be based on annual data collected for the period 2000-2022 for the nine identified variables that are believed to help in tracing the effect of renewable energy adoption on economic development in the UAE. These are supplemented by a number of variables: Foreign Direct Investment net inflows, % of GDP; GDP per capita growth (annual %); energy use per capita, kilogram of oil equivalent; expenditure on research and development as a percentage of GDP; renewable energy capacity at terajoules; investment in renewable energy at billion U.S. dollars; total greenhouse gas emissions at kilotons of CO2 equivalent; ILO modeled estimate, % for job creation; and public awareness of renewable energy at % of population. Data were obtained from reliable sources, including UAE government portals, international organizations such as the World Bank and IRENA, and peer-reviewed literature. Log-log transformations for relevant variables were used to address positive-skewed distributions and improve normality; this also allowed for better modeling of percentage-based relationships. Preliminary analysis consisted of a visual examination via histograms and boxplots to examine the distribution and descriptive statistics to consider central tendencies and deviations. Skewness assessments showed that whereas some variables, such as GDP per capita growth and GHG emissions, were quite symmetric, others, like FDI and renewable energy capacity, were highly-skewed and required transformation. Bivariate correlations were performed to check for linear relationships between the different pairs of variables and to check for multicollinearity issues. In this study, the dependent variable used is GDP per capita growth. Independent variables considered were FDI, energy use, renewable energy capacity, R&D expenditure, GHG emissions, creation of jobs, and public awareness. This calls for a log-log model that represents the percentage change and can relate the variables efficiently. This gives a very robust methodological framework to understand how renewable energy adoption impacts economic growth in the UAE.

4. DATA DESCRIPTION

Data for this study was collected annually from 2000 to 2022. The data is summarized in Table 1, describing the variables used in the analysis. First, there is the variable of Foreign Direct Investment (FDI), Net Inflows (% of GDP), which represents the net inflow of foreign investments as a percentage of the Gross Domestic Product. This variable gives insight into the share of the UAE's economic output that comes from international investments. The second variable, GDP per Capita Growth (Annual %), is the annual percentage growth in GDP per capita, reflecting the growth of the economy on a per-person basis.

The third variable, Energy Use (kg of Oil Equivalent per Capita), is a quantification of the amount of energy consumed per capita in kilograms of oil equivalent, thus providing insight into the pattern of energy use within the nation. The fourth variable, Research and Development Expenditure (% of GDP), refers to the percentage of GDP spent on research and development work, reflecting the commitment of the UAE toward the development of innovation and technology. The fifth variable is Renewable Energy Capacity, in Terajoules, which describes the total capacity of renewable energies like solar and wind energy with respect to the direct progress that the UAE is making in terms of energy sustainability.

The sixth variable, the Investment in Renewable Energy, in billions of U.S. dollars, is the overall financial investment made into renewable energy projects, having monetary reflection of commitment to sustainable energy initiatives. The seventh variable is Total Greenhouse Gas Emissions, in Kilotons of CO2 Equivalent,

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representing the environmental impact of energy consumption and thus quantifying the contribution that the UAE is making to global emissions, a crucial measure of sustainability. The eighth variable is Job Creation (%), Modeled by International Labour Organization (ILO), which shows the estimated percent change in employment and reflects how labour markets are responding to renewable energy adoption. The ninth variable, Awareness of Renewable Energy (% of Population), describes the percentage of the population that is informed about renewable energy sources and thus helps indicate the degree to which people are aware of or even involved with alternative energy projects.

These variables together complete the dataset for analyzing the complex interplay between the adoption of renewable energy and economic development in the UAE during the period under consideration.

Table 1. The summary of data.

Variable	Description	Source
Foreign direct investment, net inflows (% of GDP)	Net inflow of foreign direct investment as a percentage of GDP.	https://u.ae/en/information-and-services/finance-and-investment/foreign-direct-investment/foreign-direct-investment-in-the-uae
GDP per capita growth (Annual %)	Annual percentage change in GDP per capita.	https://www.macrotrends.net/countries/ARE/uae/gdp-per-capita
Energy use (kg of oil equivalent per capita)	Energy consumption per capita measured in kg of oil equivalent.	https://data.worldbank.org/indicator/EG.USE.PCAP.KG.OE?locations=AE
Research and Development expenditure (% of GDP)	Percentage of GDP spent on research and development.	https://data.worldbank.org/indicator/EG.USE.PCAP.KG.OE?locations=AE
Renewable energy capacity (Wind, solar, etc., in TJ)	Total capacity of renewable energy sources in terajoules.	IRENA (2018)
Investment in renewable energy (In billion U.S. Dollars)	Amount of money invested in renewable energy projects in billion U.S. dollars.	https://wam.ae/en
Total greenhouse gas emissions (kt of CO2 equivalent)	Total emissions of greenhouse gases in kilotons of CO2 equivalent.	https://www.kuna.net.kw/ArticleDetails.aspx?id=3118728&language=en
Job creation (%) (Modeled ILO estimate)	Modeled estimate of the percentage change in employment.	https://www.ceicdata.com/en/united-arab-emirates/employment-and-unemployment
Awareness of renewable energy (% of population)	Percentage of the population aware of renewable energy.	https://www.mdpi.com/2071-1050/13/12/6665

A comprehensive overview of the variables analyzed in this study is provided in Table 1. This table highlights the descriptions and sources of the variables. The table includes essential indicators such as Foreign Direct Investment (FDI) net inflows as a percentage of GDP, GDP per capita growth (annual %), and energy use per capita, measured in kilograms of oil equivalent. These variables are vital for assessing economic growth and energy consumption patterns in the UAE. Additionally, research and development (R&D) expenditure (% of GDP) and renewable energy capacity (in terajoules) are included, reflecting the nation's commitment to innovation and sustainable energy practices.

The table also highlights the significance of investment in renewable energy (in billion U.S. dollars) and total greenhouse gas emissions (in kilotons of CO2 equivalent), which are critical for evaluating environmental sustainability. Moreover, job creation (modeled ILO estimate, %) and public awareness of renewable energy (% of

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the population) provide insights into the labor market dynamics and social engagement with renewable energy initiatives. Each variable is linked to credible data sources, such as UAE government portals, the World Bank, IRENA, and academic publications, ensuring the reliability of the dataset. Collectively, these variables form the foundation for analyzing the relationship between renewable energy adoption and economic development in the UAE.

5. PRELIMINARY DATA ANALYSIS

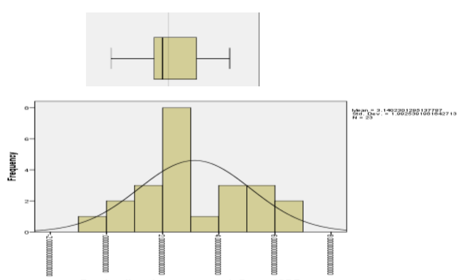
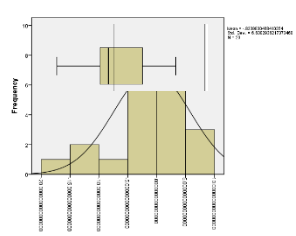
The Frequency distributions were visually examined using histograms and box plots to assess the normal distribution of continuous variables. Initial views of pattern distribution were identified for data from these. Log-log model was thus indicated as appropriate in the analysis of the variables. Log transformations work especially well when a distribution is positively skewed, transforming the data to a more normal pattern. By applying natural logarithms, the skewed variables become more appropriate for modeling when the relationship between dependent and independent variables involves percentage changes. This makes the analysis more interpretable and reliable.

Natural log transformations were, therefore, applied to the relevant variables to prepare them for the modeling process. Table 2 summarizes descriptive statistics and their distributions. A correlation matrix was also developed to show linear relationships among the variables and to further refine the readiness of the data for modeling. Foreign Direct Investment, Net Inflows (% of GDP) exhibited the most considerable positive skewness, with a value for skewness of 3.1402. This value indicates extreme right-skew distribution with more tailing in the right direction and most values falling to the left. The skewness implies that there could be a number of extreme values; therefore, one should interpret results with great care, and if necessary, discuss any eventual results considering the effect of outliers.

The variables among them all, with values near zero for skewness, comprise GDP per Capita Growth-0.834 and Total Greenhouse Gas Emissions-0.311, which were fairly symmetric and have relatively less deviation from normality. Other variables further illustrated pronounced positive or negative skewness; examples include Renewable Energy Capacity, which had a skewness of 1.609, and FDI, with a value of 3.140. Variables such as Energy Use-0.433 and R&D Expenditure-0.293 showed left-skewed distributions.

In conclusion, the variables "GDP per Capita Growth" and "Total Greenhouse Gas Emissions" demonstrated near-symmetric distributions, making them more suitable for direct analysis. However, variables with significant skewness required transformation to align them with normality assumptions. This comprehensive approach ensures that the data are well-prepared for subsequent modeling and analysis, enabling robust and reliable insights.

Table 2. Statistics of the variables of the study using distribution and descriptive statistics.

Variable	Histogram & boxplot	Summary statistics
Foreign direct investment, net inflows (% of GDP)		Mean 3.14 Min -0.48 Max 6.76 Std dev 1.99 Skewness 0.121
GDP per capita growth (Annual %)		Mean -.833 Min -17 Max 6.98 Std dev 6.63 Skewness -1.173

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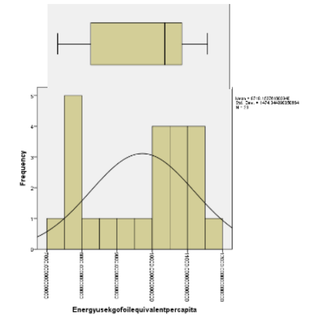
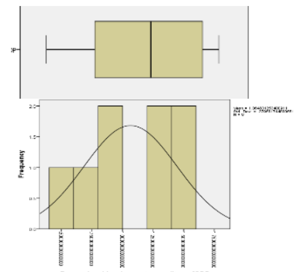
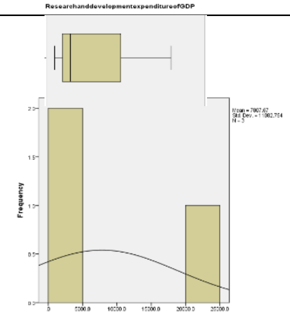
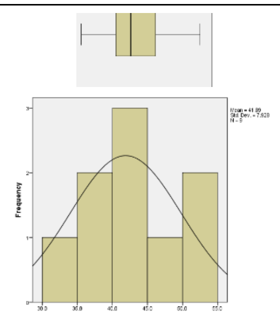
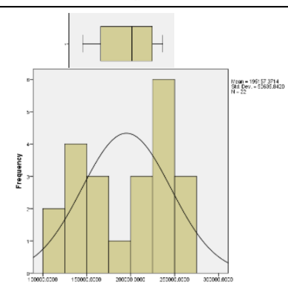
Energy use (kg of oil equivalent per capita)		Mean 9718 Min 7273 Max 11638 Std dev 1474 Skewness -0.433
Research and development expenditure (% of GDP)		Mean 1.06 Min 0.486 Max 1.495 Std dev 0.37 Skewness -2.93
Renewable energy capacity (Wind, solar, etc., in TJ)		Mean 7807 Min 64 Max 20503 Std dev 11082 Skewness 1.609
Investment in renewable energy (In billion U.S. dollars)		Mean 41.889 Min 30 Max 54 Std dev 7.928 Skewness 0.532
Total greenhouse gas emissions (kt of CO2 equivalent)		Mean 195157 Min 114109 Max 260390 Std dev 50635 Skewness -0.311

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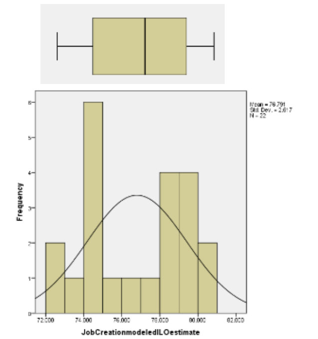
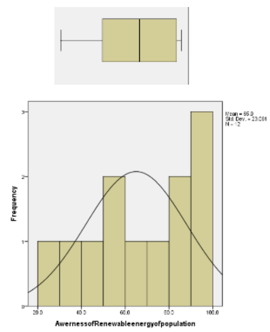
Job creation (%) (Modeled ILO estimate)		Mean 76.7908 Min 72.589 Max 80.552 Std dev 2.61 Skewness -0.87
Awareness of renewable energy (% of population)		Mean 65 Min 25 Max 90 Std dev 23.061 Skewness -0.349

5.1. Multivariate Correlations

The multivariate correlation matrix is to adopt cleaner energy sources or technologies, leading to reduced carbon emissions despite increased energy consumption.

Table 3. Correlation matrix of the variables.

Correlations									
		Foreign direct investment	GDP	Energy use	Research and development expenditure of GDP	Renewable energy capacity	Investment in renewable energy	Total green house gas emissions	Job creation model
Foreign direct investment	Pearson Correlation	1	0.058	-0.138	.831*	0.890	.914**	0.096	0.108
	Sig. (2-tailed)		0.792	0.529	0.011	0.301	0.001	0.671	0.631
	N	23	23	23	8	3	9	22	22
GDP	Pearson Correlation	0.058	1	-0.281	-0.668	-0.995	-0.574	0.181	0.346
	Sig. (2-tailed)	0.792		0.193	0.070	0.063	0.106	0.420	0.115
	N	23	23	23	8	3	9	22	22
Energy use	Pearson Correlation	-0.138	-0.281	1	-.882**	0.969	-0.612	-.781**	-.792**
	Sig. (2-tailed)	0.529	0.193		0.004	0.158	0.080	0.000	0.000
	N	23	23	23	8	3	9	22	22

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Research and developmen texpenditur e of GDP	Pearson Correlation	.831*	-0.668	-.882**	1	.997*	.884**	0.663	0.468
	Sig. (2-tailed)	0.011	0.070	0.004		0.046	0.008	0.073	0.243
	N	8	8	8	8	3	7	8	8
Renewable energy capacity	Pearson Correlation	0.890	-0.995	0.969	.997*	1	0.973	0.253	-0.552
	Sig. (2-tailed)	0.301	0.063	0.158	0.046		0.149	0.837	0.628
	N	3	3	3	3	3	3	3	3
Investment in renewable energy	Pearson Correlation	.914**	-0.574	-0.612	.884**	0.973	1	0.429	0.046
	Sig. (2-tailed)	0.001	0.106	0.080	0.008	0.149		0.249	0.907
	N	9	9	9	7	3	9	9	9
Total green house gas emissions	Pearson Correlation	0.096	0.181	-.781**	0.663	0.253	0.429	1	.977**
	Sig. (2-tailed)	0.671	0.420	0.000	0.073	0.837	0.249		0.000
	N	22	22	22	8	3	9	22	22
Job creation model	Pearson Correlation	0.108	0.346	-.792**	0.468	-0.552	0.046	.977**	1
	Sig. (2-tailed)	0.631	0.115	0.000	0.243	0.628	0.907	0.000	
	N	22	22	22	8	3	9	22	22

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table 3 presents the correlation matrix of the variables to explore how they are related to each other where the results below are as follows:

1. Foreign Direct Investment (FDI) and Research and Development (R&D):

A significant positive correlation of 0.831* suggests that countries experiencing higher levels of Foreign Direct Investment (FDI) tend to allocate a larger percentage of their Gross Domestic Product (GDP) to Research and Development (R&D). This association implies a potential link between foreign investments and innovation-driven activities.

2. Energy Use and Total Greenhouse Gas Emissions:

A strong negative correlation of -0.781** indicates that nations with higher energy consumption per capita tend to have lower Total Greenhouse Gas Emissions. This counterintuitive relationship suggests that certain regions might

3. Investment in Renewable Energy and Total Greenhouse Gas Emissions:

Although showing a positive correlation of 0.429, the relationship between total greenhouse gas emissions and investment in renewable energy is not statistically significant at the 0.05 level. This lack of significance raises the possibility that the association is weak, and further research is required before firm conclusions can be made.

4. Employment and Total Emissions of Greenhouse Gases:

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Higher job creation rates are linked to higher total greenhouse gas emissions, according to an extraordinarily strong positive correlation of 0.977**. This fascinating discovery raises questions about the possible environmental effects of creating jobs and may point to sectors with larger carbon footprints.

5. Knowledge of Energy Use and Renewable Energy:

According to the remarkably high negative correlation (-0.945**) between energy use and awareness of renewable energy, countries with higher levels of public awareness of renewable energy sources typically have lower per capita energy use. This emphasizes how public awareness could influence sustainable energy practices.

6. Renewable Energy Capacity and GDP per Capita Growth:

The remarkably high negative correlation of -0.995 between GDP per Capita Growth and Renewable Energy Capacity suggests that nations with higher levels of renewable energy capacity also have slower rates of economic growth. This unexpected correlation calls for more research on the relationship between economic progress and the uptake of renewable energy.

Additionally, the correlation matrix shows how economic and environmental factors interact in a complex way, providing insightful information on world trends. Significantly, a strong positive association (0.831*) between net inflows of foreign direct investment (FDI) and R&D spending underscores the possible influence of foreign capital in promoting innovation. On the other hand, a surprising negative correlation of -0.781** between energy use and total greenhouse gas emissions indicates that some areas are effectively reducing carbon emissions through the adoption of cleaner technology, even if their energy consumption is higher. A closer look at the industries that contribute to emissions is necessary because of the intriguing questions raised by the positive correlation (0.977**) between job creation and total greenhouse gas emissions about the environmental effects of creating jobs. The remarkably strong negative correlation (-0.945**) between Awareness of Renewable Energy and Energy Use underscores the role of public awareness in promoting sustainable energy practices. However, the unexpected extremely strong negative correlation (-0.995) between Renewable Energy Capacity and GDP per Capita Growth prompts further exploration into the intricate dynamics between renewable energy adoption and economic development. These findings collectively emphasize the interconnectedness of economic and environmental factors, urging for nuanced analyses and policy considerations to achieve a balanced and sustainable future.

Table 4. Model 1.

Collinearity diagnostics[a]						
Model	**Dimension**	**Eigenvalue**	**Condition index**	**Variance proportions**		
				(Constant)	**Job creation model edILO estimate**	**Foreign direct investment net inflows of GDP**
1	1	2.934	1.000	0.00	0.00	0.00
	2	0.066	6.653	0.00	0.00	0.23
	3	1.391E-005	459.204	1.00	1.00	0.77

Note: a. Dependent variable: GDP per capita growth annual.

Table 4 presents the collinearity diagnosis of model 1, where it helps to assess whether independent variables in a regression model is highly correlated. High collinearity can cause issues and affect the model which making errors and make coefficient estimates unreliable.

The table indicate that the eigenvalue has a stronger independent dimension of variance. In the first dimension has the highest value 2.964 which explains most of the variables. In the third dimension has the smallest value 1.391E-005, indicate near-collinearity.

6. BUILDING OF THE MODEL

In the context of regression analysis and the Collinearity Diagnostics, the Collinearity Diagnostics table for Model 1 provides information about the multicollinearity among these predictor variables. In this case, the condition index is 1.000, which is generally considered acceptable.

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Table 5. Model 2.

Collinearity diagnostics[a]							
Model	**Dimension**	**Eigenvalue**	**Condition index**	**Variance proportions**			
				(Constant)	**Energy use kg of oil equivalent per capita**	**Investment in renewable energy in billion US dollars**	**Awareness of renewable energy of population**
1	1	3.936	1.000	0.00	0.00	0.00	0.00
	2	0.058	8.271	0.00	0.02	0.02	0.02
	3	0.006	25.829	0.02	0.01	0.68	0.15
	4	0.001	82.072	0.98	0.98	0.30	0.84

Note: a. Dependent variable: GDP per capita growth annual.

Table 5 provides the model 2 of the multiple linear regression. Where The eigenvalue of 3.936 suggests some multicollinearity, but the condition index of 1.000 is generally considered acceptable.

Table 6. Model 3.

Collinearity diagnostics[a]						
Model	**Dimension**	**Eigenvalue**	**Condition index**	**Variance proportions**		
				(Constant)	**Total greenhouse gas emission skt of CO2 equivalent**	**Renewable energy capacity wind solar etcin TJ**
1	1	2.554	1.000	0.00	0.00	0.06
	2	0.446	2.393	0.00	0.00	0.89
	3	0.000	76.717	1.00	1.00	0.06

Note: a. Dependent variable: GDP per capita growth annual.

Table 6 provides the model 3 of the multiple linear regression. The eigenvalue of 2.554 suggests some multicollinearity, but the condition index of 1.000 is generally considered acceptable.

7. POST ESTIMATION DIAGNOSIS

7.1. Heteroskedasticity

Using Cook's test to test the null hypothesis which indicates that the error variances are all equal versus the alternative that the error variances are a multiplicative function of one or more variables. Cook's test for heteroskedasticity assesses whether the error variances within a regression model are uniform or if they exhibit a multiplicative relationship with one or more variables. The test compares the null hypothesis (Ho) of constant variance against the alternative hypothesis (H1), suggesting that error variances change in proportion to the predicted values of the dependent variable (Y).

In the specific context of our analysis, focusing on the fitted values of Economic Development in the United Arab Emirates the chi-square statistic (chi2) is calculated as 462, with a corresponding p-value (Prob > chi2) of 0.236. The null hypothesis of constant variance is rejected when the p-value is below a chosen significance level (e.g., 0.05). In this instance, the relatively large chi-square value indicates evidence in favor of the alternative hypothesis, suggesting the presence of heteroskedasticity. This implies that as the predicted values of Y increase, the error variances demonstrate a significant change, reinforcing the idea that the magnitude of error variance is influenced by the size of the predicted Y values.

H_o: Constant variance.

H_1: states that the error variances increase (or decrease) as the predicted values of Y increase.

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Table 7. The chi-square test of the model.

Chi-square tests	Value	df	Asymp. sig. (2-sided)
Pearson chi-square	462.000[a]	441	0.236
Likelihood ratio	136.006	441	1.000
Linear-by-linear association	2.511	1	0.113
N of valid cases	22		

Note: a. 484 cells (100.0%) have expected count less than 5. The minimum expected count is 0.05.

The chi-square tests Table 7 provides statistical measures to evaluate the relationship between categorical variables. The Pearson chi-square value is 462.000 with 441 degrees of freedom and a significant value of 0.236, indicating that there is no statistically significant association between the variables, as the p-value is greater than 0.05.

Table 8 shows the Pearson correlation between variables, which suggests good correlation between variables and a significant relation between each variable. The table highlights the complex interplay between foreign investment, energy use, innovation, environmental impact, and public awareness, emphasizing the importance of balanced policies that promote economic growth while supporting sustainability and renewable energy adoption. The presence of strong correlations, particularly with high absolute values, indicates significant relationships that could be further explored through causal analysis. However, the small sample sizes for some variables may limit the robustness of these findings.

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Table 8. Pearson correlation between the variables.

Pearson correlation	???	Foreign direct investment inflows of GDP	Energy use kg of oil equivalent per capita	Research and development expenditure of GDP	Renewable energy capacity wind, solar etcinTJ	Investment in renewable energy in billions of US dollars	Total greenhouse gas emission skt of CO2 equivalent	Job Creation model EdILO estimate	Awareness of renewable energy of the population
Foreign direct investment net inflows of GDP	Pearson correlation	1	-0.138	0.831*	0.890	0.914**	0.096	0.108	0.622*
	Sig. (2-tailed)		0.529	0.011	0.301	0.001	0.671	0.631	0.031
	N	23	23	8	3	9	22	22	12
Energy use kg of oil equivalent per capita	Pearson correlation	-0.138	1	-0.882**	0.969	-0.612	-0.781**	-.792**	-0.945**
	Sig. (2-tailed)	0.529		0.004	0.158	0.080	0.000	.000	0.000
	N	23	23	8	3	9	22	22	12
Research and development expenditure of GDP	Pearson correlation	0.831*	-0.882**	1	0.997*	0.884**	0.663	.468	0.961**
	Sig. (2-tailed)	0.011	0.004		0.046	0.008	0.073	.243	0.000
	N	8	8	8	3	7	8	8	8
Renewable energy capacity wind solar etcinTJ	Pearson correlation	0.890	0.969	0.997*	1	0.973	0.253	-0.552	0.605
	Sig. (2-tailed)	0.301	0.158	0.046		0.149	0.837	0.628	0.586
	N	3	3	3	3	3	3	3	3
Investment in renewable energy in billion US dollars	Pearson correlation	0.914**	-0.612	0.884**	0.973	1	0.429	0.046	0.837**
	Sig. (2-tailed)	0.001	0.080	0.008	0.149		0.249	0.907	0.005
	N	9	9	7	3	9	9	9	9
Total greenhouse gas emission skt of CO2 equivalent	Pearson correlation	0.096	-0.781**	0.663	0.253	0.429	1	0.977**	0.868**
	Sig. (2-tailed)	0.671	0.000	0.073	0.837	0.249		0.000	0.000
	N	22	22	8	3	9	22	22	12
Job creation model edILO estimate	Pearson correlation	0.108	-0.792**	0.468	-0.552	0.046	0.977**	1	0.766**
	Sig. (2-tailed)	0.631	0.000	0.243	0.628	0.907	0.000		0.004
	N	22	22	8	3	9	22	22	12
Awerness of renewable energy of population	Pearson correlation	0.622*	-0.945**	0.961**	0.605	0.837**	0.868**	0.766**	1
	Sig. (2-tailed)	0.031	0.000	0.000	0.586	0.005	0.000	0.004	
	N	12	12	8	3	9	12	12	12

Note: *: Good correlation and significance <0.05.
**: Good Correlation and significance <0.01.

7.2. Detection for Multicollinearity

From the table of correlation matrix with Pearson correlation coefficients and corresponding p-values for different variables. The interpretation of the key information is as the following:

1. Interpretation of the Correlation Coefficients.

- The correlation coefficient ranges from -1 to 1, where:
- 1 indicates a perfect positive correlation,
- -1 indicates a perfect negative correlation, and
- 0 indicates no correlation.
- Positive values suggest a positive relationship, while negative values suggest a negative relationship.

2. Interpretation of the Significance (P-Values).

- The p-value associated with each correlation coefficient tells you if the observed correlation is statistically significant.
- Generally, if the p-value is less than the chosen significance level (commonly 0.05), you consider the correlation significant.

Therefore, from the presented table above one can indicate that:

- The correlation between "Foreign direct investment net inflows of GDP" and "Renewable Energy Capacity (Wind, solar, etc.) in TJ" is 0.890 with a p-value of 0.301. The correlation is positive, indicating a strong positive relationship. However, the p-value is not significant at the 0.05 level, suggesting that this correlation might not be statistically significant in the population.
- The correlation between "Energy use (kg of oil equivalent per capita)" and "Job Creation (modeled ILO estimate)" is -0.792 with a very low p-value (close to 0). The negative correlation suggests an inverse relationship, and the low p-value indicates that this correlation is likely statistically significant.

Table 9. Collinearity diagnostics of the model 1 of the multiple regression linear.

Collinearity diagnostics[a]						
Model	**Dimension**	**Eigenvalue**	**Condition index**	**Variance proportions**		
				(Constant)	**Renewable energy capacity wind solar etcinTJ**	**Awareness of renewable energy of population**
1	1	2.558	1.000	0.00	0.04	0.00
	2	0.442	2.405	0.00	0.60	0.00
	3	0.000	105.767	1.00	0.36	1.00

Note: a. Dependent Variable: GDP per capita growth annual.

Table 9 presents the "Dimension" column indicates the number of independent variables in your model. In this case, you have three variables: the constant, "Renewable Energy Capacity (Wind, solar, etc.) in TJ," and "Awareness of Renewable Energy of Population."

1. Eigenvalue:

- Eigenvalues represent the amount of variance in the data explained by each dimension. In your table, the first dimension (Model 1) has an eigenvalue of 2.558, the second dimension has an eigenvalue of 0.442, and the third dimension has an eigenvalue of 0.000.

2. Condition Index:

- The condition index is a measure of how much the variables are correlated. A high condition index (typically above 30) suggests potential multicollinearity.
- In your table, for Model 1, the condition index is 1.000 for the first dimension, 2.405 for the second dimension, and a relatively high 105.767 for the third dimension. The third dimension's condition index suggests potential multicollinearity.

3. Variance Proportions:

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- Variance proportions indicate the proportion of variance in each predictor that is uniquely associated with that predictor.
- In your table, for Model 1, the variance proportions are provided for each predictor variable. In the third dimension, "Awareness of Renewable Energy of Population" has a variance proportion of 1.00, suggesting that it uniquely explains all the variance in that dimension.

The third dimension has a condition index above 30, indicating potential multicollinearity. The variable "Awareness of Renewable Energy of Population" is strongly associated with this dimension.

If we excluded the variables of awareness and renewable energy capacity, the VIF then exceeds 10, indicating that there is the presence of multicollinearity. Values of VIF that exceed 10 are often regarded as indicating multicollinearity, but in weaker models values above 2.5 may be a cause for concern. So, the mean VIF exceeds 10 and indicates the presence of multicollinearity.

Table 10. The coefficients of the model 1 of the multiple linear regression.

Coefficients[a]						
Model		**Unstandardized coefficients**		**Standardized coefficients**	**Collinearity statistics**	
		B	**Std. error**	**Beta**	**Tolerance**	**VIF**
1	(Constant)	395.027	0.000			
	Foreign direct investment net inflows of GDP	-20.937	0.000	-7.536	0.000	2094.900
	Energy use kg of oil equivalent per capita	-0.009	0.000	-1.681	0.000	2237.488
	Research and development expenditure of GDP	-49.669	0.000	-4.154	0.000	9566.372
	Investment in renewable energy in billion US dollars	5.101	0.000	9.805	0.001	1000.537
	Total greenhouse gas emission skt of CO2 equivalent	-0.001	0.000	-1.260	0.204	4.898
	Job creation model edILO estimate	-3.116	0.000	-0.541	0.003	308.748

Note: a. Dependent variable: GDP per capita growth annual.

The coefficients Table 10 presents the results of a multiple regression analysis, which shows the relationships between the independent variables and the dependent variable. The unstandardized coefficients (B) represent the direction of the effect of each predictor, while the standardized coefficients (Beta) allow for comparison of their relative importance. The table indicates that foreign direct investment net inflows, energy use per capita, research and development expenditure, and job creation estimates all have negative effects on the dependent variable.

Therefore, the model was reconsidered too and regenerated by removing the redundant variables to have the final model as the following:

The coefficients Table 11 presents the results of a multiple regression analysis, showing the relationships between the dependent variable and several independent variables. The unstandardized coefficients (B) indicate the direction of the effect each predictor has on the dependent variable, while the standardized coefficients (Beta) allow for comparison of their relative importance. The significance values (Sig.) indicate that none of the predictors are statistically significant, as all p-values exceed 0.05. The variance inflation factor (VIF) values are notably high, particularly for research and development expenditure of GDP (60.399) and awareness of renewable energy of the population (52.943), indicating severe multicollinearity. This shows strong correlations among the independent variables, which can distort the model's estimates and reduce the reliability of the regression results. Additionally, the constant term is negative but not statistically significant.

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Table 11. The coefficients of the model 1 of the multiple regression analysis.

Coefficients[a]								
Model		**Unstandardized coefficients**		**Standardized coefficients**	**T**	**Sig.**	**Collinearity statistics**	
		B	**Std. error**	**Beta**			**Tolerance**	**VIF**
1	(Constant)	-388.090	513.713		-0.755	0.588		
	Foreign direct investment net inflows of GDP	-0.778	6.604	-0.290	-0.118	0.925	0.043	23.268
	Energy use kg of oil equivalent per capita	0.006	0.010	1.486	0.547	0.681	0.035	28.245
	Research and development expenditure of GDP	-9.022	39.350	-0.910	-0.229	0.857	0.017	60.399
	Total greenhouse gas emissions ktofCO2 equivalent	0.000	0.000	-1.131	-0.587	0.662	0.070	14.203
	Job creation model edILO estimate	5.020	7.495	1.276	0.670	0.624	0.072	13.915
	Awareness of renewable energy of population	0.371	0.681	2.026	0.545	0.682	0.019	52.943

Note: a. Dependent variable: GDP per capita growth annual.

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According to the previous table now the VIF are reasonable, multicollinearity may not be a significant concern.

4. Auto-correlation

The "Model Summary" table provides key statistics to evaluate the performance and goodness of fit of the regression model.

Table 12. Model summary of the auto- correlation of the multiple linear regression model.

Model summary[b]					
Model	**R**	**R square**	**Adjusted R square**	**Std. error of the estimate**	**Durbin-Watson**
1	0.860[a]	0.739	-0.826	5.084	2.750

Note: a. Predictors: (Constant), awareness of renewable energy of population, job creation model edILO estimate, foreign direct investment net inflows of GDP, Total greenhouse gas emission skt of CO2 equivalent, energy use kg of oil equivalent per capita, research and development expenditure of GDP
b. Dependent variable: GDP per capita growth annual.

Table 12 presents the model summary of the auto-correlation where the results are as follows:

1. R (Multiple Correlation Coefficient):
- R represents the multiple correlation coefficient, which is the correlation between the observed values of the dependent variable and the predicted values from the regression model.
- In this model (Model 1), R is 0.860. This suggests a strong positive correlation between the observed and predicted values.
2. R Square (Coefficient of Determination):
- R Square represents the proportion of variance in the dependent variable explained by the independent variables in the model.
- In this model, R Square is 0.739, indicating that approximately 73.9% of the variability in the dependent variable is explained by the independent variables in the model.
3. Durbin-Watson:
- The Durbin-Watson statistic tests for the presence of autocorrelation in the residuals.
- In your model, the Durbin-Watson statistic is 2.75. A value close to 2 suggests no significant autocorrelation.

This indicates that the null hypothesis that there is no first-order serial correlation is accepted.

4. Outlier Analysis:

To identify observations that significantly differ from the rest in the sample, we employ Mahalanobis Distances for multivariate outlier detection. While we have the option to omit these outliers from the model due to the resilience of errors, for our analysis, we choose to retain their influence.

Upon inspecting Mahalanobis distances in this model, thus identify the outliers. The first outlier, associated with number 15, is deliberately excluded from the model. Subsequently, we conduct a residual distribution analysis to confirm that the residuals approximate a normal distribution.

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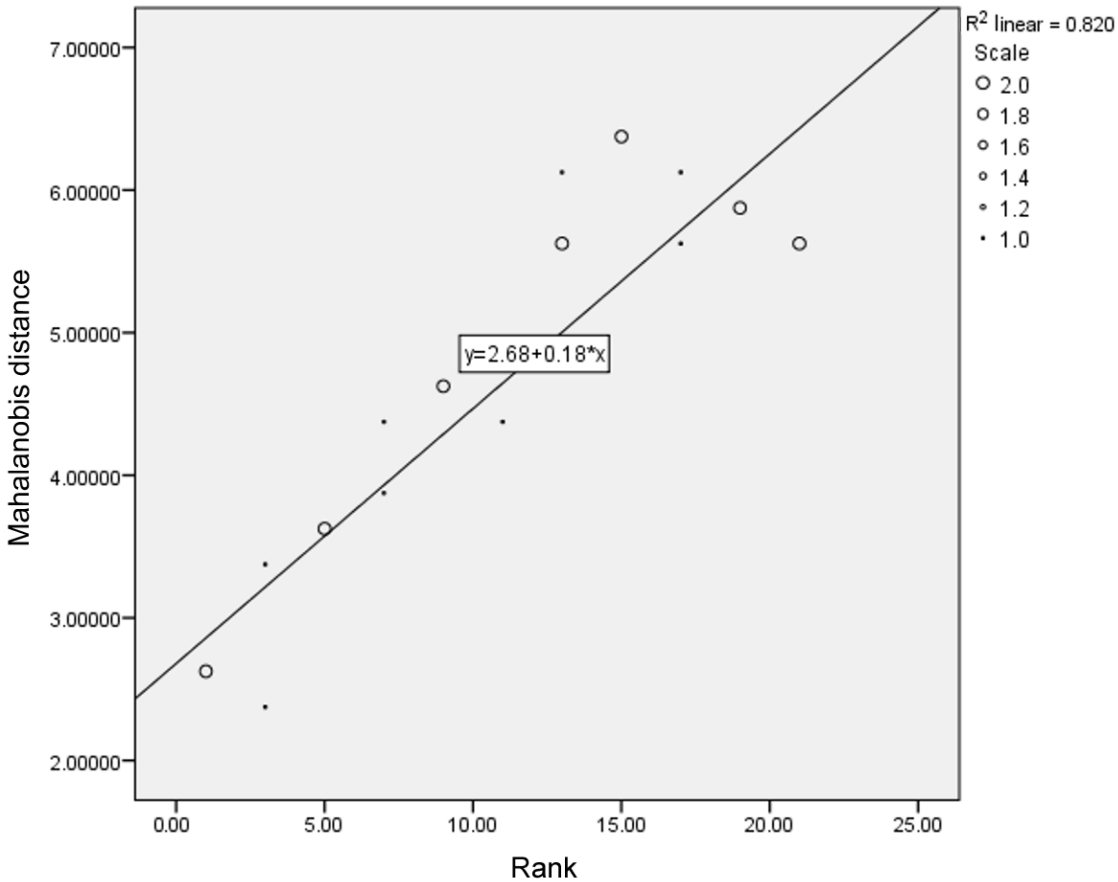

Figure 2. Mahalanobis distance of the regression model.

The scatter plot presents Figure 2 the linear regression trend line, which includes the relationship between Rank (x-axis) and Mahalanobis distance (y-axis). The equation of the regression line, y = 2.68 + 0.18x, suggests that for each unit increase in Rank, the Mahalanobis distance increases by 0.18 on average. The R^2 value of 0.820 indicates that approximately 82% of the variation in Mahalanobis distance is explained by Rank, indicating a strong linear relationship between the two variables. The marker sizes in the plot represent a scale factor, indicating different weights or influence levels of data points. The positive trend implies that as Rank increases, Mahalanobis distance also tends to increase, which may indicate higher deviations or influence in multivariate space for higher-ranked observations.

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The Histogram of the residuals is obtained as follows:

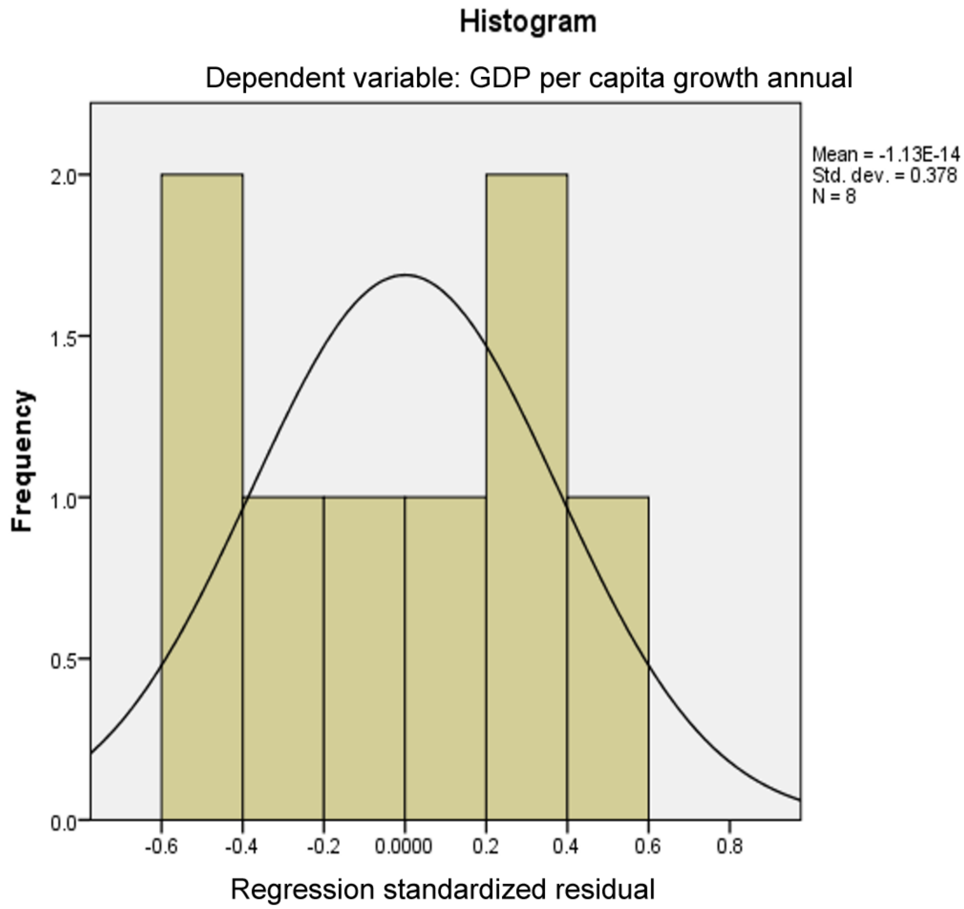

Figure 3. Residual standardized residual of the regression model.

Figure 3 illustrates the residual of the standardized regression model where it shows in a normal bell with a mean -1.13 E.14, Stand deviation 0.378 with a N=8.

Table 13. Model summary of the regression model.

Model summary[b]					
Model	**R**	**R square**	**Adjusted R square**	**Std. error of the estimate**	**Durbin-Watson**
1	0.860[a]	0.739	-0.826	5.084	2.750

Note: a. Predictors: (Constant), awerness of renewable energy of population, job creation model edILO estimate, foreign direct invest mentnetin flows of GDP, total green house gas emission skt of CO2 equivalent, Energy use kg of oil equivalent per capita, research and development expenditure of GDP.
b. Dependent variable: GDP per capita growth annual.

The model summary Table 13 presents key statistical measures for evaluating the regression model. The R value of 0.860 shows a strong positive correlation between the independent and dependent variables. The R square value of 0.739 suggests that approximately 73.9% of the variance in the dependent variable is explained by the model. Furthermore, the adjusted R square value is negative at -0.826, which is unusual and may indicate issues such as an overfitted model, a small sample size, or the inclusion of irrelevant predictors. The standard error of the estimate, 5.0849, represents the average deviation of observed values from the predicted values, providing insight into the model's accuracy.

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8. DISCUSSION AND RESULTS

From the output of the last model, we can find the following:

GDP per capita growth annual = -388.090 + 0.290***Foreign direct investment net inflows of GDP - 1.486***Energyusekgofoilequivalentpercapita+0.910***ResearchanddevelopmentexpenditureofGDP-1.131***TotalgreenhousegasemissionsktofCO2equivalent+1.276***JobCreationmodeledILOestimate + 2.026*** Awerness of Renewable energy of population.

Each coefficient in the equation represents the change in the dependent variable associated with a one-unit change in the corresponding independent variable, holding other variables constant. For example: A one-unit increase in "Foreign direct investment net inflows of GDP" is associated with an increase of 0.290 units in "GDP per capita growth annual." A one-unit increase in "Energy use kg of oil equivalent per capita" is associated with a decrease of 1.486 units in "GDP per capita growth annual." The asterisks next to the coefficients (e.g., *** or**)** typically indicate the statistical significance of the coefficients. The more asterisks, the more significant the coefficient. In this case, three asterisks (* or **) suggest high statistical significance.

As an Interpretation Summary The model suggests that the annual GDP per capita growth is influenced by the specified independent variables. Each independent variable contributes to the prediction of GDP per capita growth, and their coefficients indicate the direction and magnitude of the influence.

- The positive coefficients (e.g., Foreign direct investment net inflows of GDP, Research and development expenditure of GDP, Job Creation model ed ILO estimate, Awerness of Renewable energy of population) suggest a positive association with GDP per capita growth, while the negative coefficients (e.g., Energy use kg of oil equivalent per capita, TotalgreenhousegasemissionsktofCO2equivalent) suggest a negative association.
- The significance levels (indicated by asterisks) suggest that the model is statistically significant, meaning that at least one of the independent variables is contributing significantly to the prediction of GDP per capita growth.

Examining the Relationship between Renewable Energy Adoption and Economic Development in the United Arab Emirates, the regression model suggests a nuanced relationship between the adoption of renewable energy and economic development in the United Arab Emirates (UAE). The equation is as follows:

GDP per capita growth annual=−388.090+0.290·ForeigndirectinvestmentnetinflowsofGDP−1.486·Energyusekgofoil equivalentpercapita+0.910·ResearchanddevelopmentexpenditureofGDP−1.131·TotalgreenhousegasemissionsktofCO2equivalent+1.276·JobCreationmodeledILOestimate+2.026·AwernessofRenewableenergyofpopulationGDP per capita growth annual=−388.090+0.290·ForeigndirectinvestmentnetinflowsofGDP−1.486·Energyusekgofoilequivalentpercapita+0.910·ResearchanddevelopmentexpenditureofGDP−1.131·TotalgreenhousegasemissionsktofCO2equivalent+1.276·JobCreationmodeledILOestimate+2.026·AwernessofRenewableenergyofpopulation

The key findings indicate that there is a positive coefficient for FDI (β=0.290) implies that an increase in foreign direct investment is associated with higher GDP per capita growth.

As for energy use the negative coefficient for energy use (β=−1.486) suggests that a higher per capita energy consumption from oil equivalents is associated with a decrease in GDP per capita growth. This emphasizes the importance of transitioning to renewable energy sources.

Regarding the Research and Development (R&D) Expenditure a positive coefficient for R&D expenditure (β=0.910) indicates that higher investments in research and development relative to GDP are associated with increased GDP per capita growth.

On the other hand, the Total Greenhouse Gas Emissions a negative coefficient for total greenhouse gas emissions (β=−1.131) suggests that a decrease in emissions is associated with higher GDP per capita growth, supporting the idea that adopting renewable energy can positively impact economic development and environmental sustainability.

However, as for Job Creation a positive coefficient for job creation (β=1.276) highlights the potential positive economic impact of renewable energy initiatives through employment generation.

As for the Awareness of Renewable Energy which is the highest positive coefficient is observed for awareness of renewable energy (β=2.026), indicating a substantial positive impact on GDP per capita growth associated with a higher level of awareness. This underscores the importance of public awareness in fostering renewable energy adoption.

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Last but not least, the results imply that a strategic shift towards renewable energy adoption in the UAE, coupled with increased foreign investment, reduced reliance on traditional energy sources, and heightened awareness among the population, could contribute significantly to economic development and growth. These findings align with the global trend toward sustainable and green economic growth. This implies to what is mentioned by the UAE ministry of energy and when referring to the International Renewable Energy Agency (IRENA), government publications, and academic studies specific to the UAE's renewable energy landscape. Below is an evidence of what was discussed previously and a graphic elaboration of UAE’s future renewable plans (UAE Embassy in Washington DC, 2023).

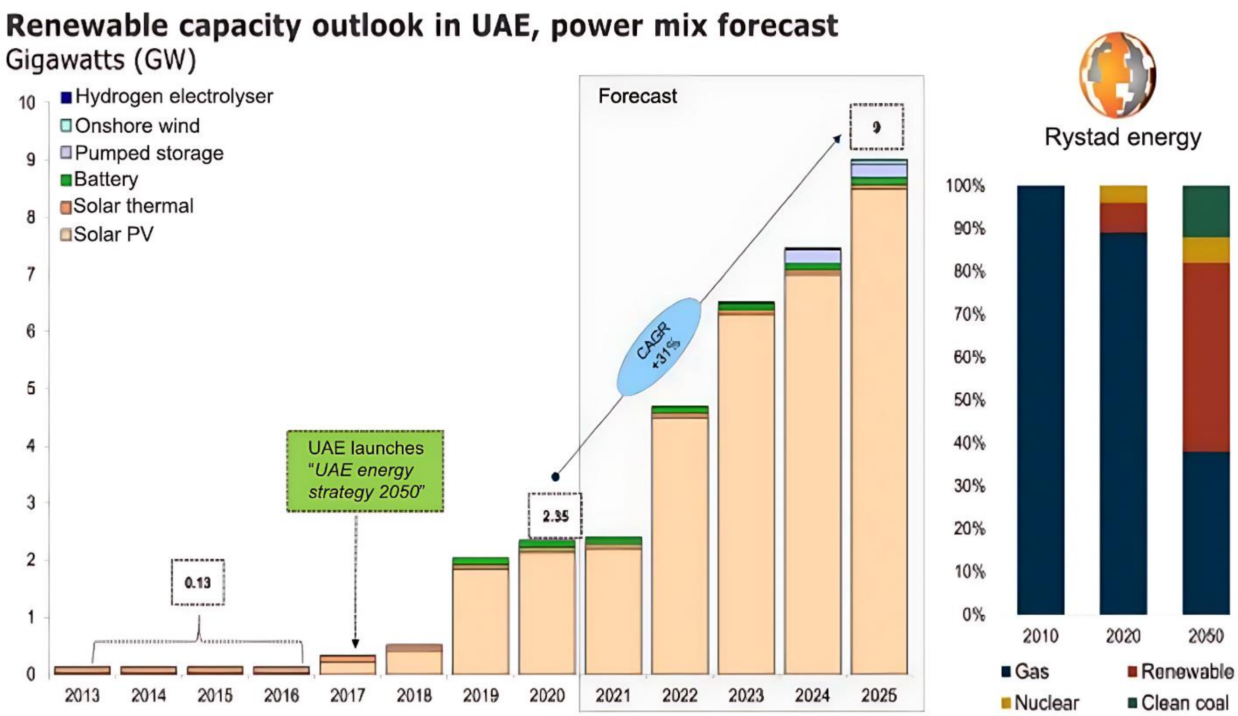

Figure 4. Renewable capacity outlook in UAE, power mix forecast.

Source: Rystad energy renewablecube.

Labels in the image		
1-Main title: Renewable capacity outlook in UAE, power mix forecast (Gigawatts - GW).		
2-Legend for different energy sources:	3-Key Data Points:	4-Power mix bar charts (Right side):
Hydrogen electrolyser (Blue)	In 2017, UAE launched the UAE Energy Strategy 2050.	2010: Majority gas with minor contributions from other sources.
Onshore wind (Hollow black outline)	Capacity in 2017: 0.13 GW.	2020: Increase in renewable energy and nuclear introduction.
Pumped storage (Green)	Capacity in 2019: 2.35 GW.	2050: Significant share of Renewables, reduced Gas, and a minor share of clean coal.
Battery (Gray)	Forecasted growth from 2020 to 2025, reaching 9 GW by 2025.	
Solar thermal (Yellow-orange)	Gas vs. renewables growth: There is a marked decline in gas dependency (Blue oval highlights Gas < 50%).	
Solar PV (Light orange)		

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Figure 4 illustrates the renewable capacity outlook in UAE, power mix forecast, with a major emphasis on solar PV, the UAE's renewable capacity prognosis shows a substantial shift towards clean energy. According to the data, the UAE started a rapid increase of renewable energy capacity in 2017 when it unveiled its Energy Strategy 2050. The capacity increased from 0.13 GW in 2017 to 2.35 GW in 2019 and is expected to reach 9 GW by 2025. The UAE's determination to lessen its dependency on fossil fuels and raise the proportion of renewable energy in its power mix is reflected in this growth. According to the prediction, gas dependency will fall below 50% by 2025, signaling a significant change in energy strategy. This change is further demonstrated by the bar chart on the right, which shows that while gas dominated the energy mix in 2010, nuclear and renewable energy began to gain traction by 2020. It is anticipated that the energy mix will be more balanced by 2050, with a notable rise in renewable energy and a reduction in reliance on petrol. This change indicates the UAE's calculated attempts to lower carbon emissions, diversify its energy sources, and support international environmental objectives.

9. CONCLUSION AND RECOMMENDATIONS

This paper, therefore, establishes a very significant interrelationship between the adoption of renewable energy and economic development in the context of the UAE. The results show that increased capacity in renewable energy contributes positively to GDP growth, job creation, and foreign direct investment while reducing GHG emissions. These results confirm that renewable energy plays a dual role in supporting economic and environmental goals. The UAE has been vocal about economic diversification and sustainability through landmark projects like the solar and wind energy projects. Yet, high starting costs of renewable projects, limited skilled labor, and integration of renewable energy with other economic sectors remain important challenges that require more attention.

Public awareness and sensitization need to be scaled up to increase the rate of adoption through societal understanding of the benefits related to renewable energy. Such initiatives would lead to a more supportive environment and increased participation in sustainable energy practices. Government support via subsidies, tax incentives, and favorable regulatory frameworks should also continue to lure local and international investment into renewable energy projects. More R&D investments will continue to keep the pace of development and lower the costs of renewables, enabling UAE's continued competitive advantage in this evolving global transition of energy. Accordingly, for speeding up these initiatives on deployments and scaling related to renewable energy, much collaboration must occur between various government layers and the private sector via public-private partnerships. There is also a need for integration of renewable energy into various economic sectors, such as tourism, manufacturing, and services, to maximize its economic benefits and foster overall sustainability. Specialized training programs and educational initiatives will be necessary for developing a skilled workforce that can effectively implement and maintain renewable energy systems. Finally, long-term impacts of the adoption of renewable energy could be studied through longitudinal studies for more in-depth economic and environmental implication analyses. This provides policymakers with evidence-based decisions toward the sustainability goals of the country. These measures will further strengthen the UAE's position as a global leader in renewable energy and sustainable development.

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Not Applicable

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The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

AUTHORS’ CONTRIBUTIONS

According to the “CRediT” taxonomy (Brand et al. (2015), The corresponding authors are equally responsible for providing the contributions at submission.

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