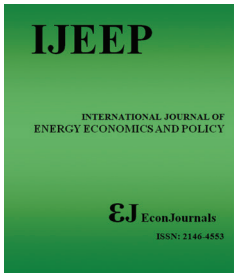

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Renewable Energy and Economic Growth in the United Arab Emirates: A Causal Analysis of CO_2 Emissions and Environmental Policy Trends

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ABSTRACT

United Arab Emirates rapid economic expansion, environmental degradation, particularly CO_2 emissions, has emerged as a pressing challenge. The study explores the dynamic relationship between the utilization of renewable energy sources, CO_2 emissions, environmental policy, and economic growth over the period 2000-2023. Applied to yearly time-series data using Granger causality tests and the Autoregressive Distributed Lag (ARDL) model, the research identifies both immediate and long-term variations in equilibrium among the variables. The stationary nature of the variables at the first difference or degree was validated by the Augmented Dickey-Fuller (ADF) test, satisfying ARDL prerequisites. Testing for ARDL boundaries showed considerable long-term cointegration, demonstrating how these variables change in tandem over time. GDP is positively impacted by using renewable energy in a statistically significant way over the long run (coefficient = 0.275) and short term (coefficient ≈ 0.112), according to the data. CO_2 emissions exert a negative influence on long-term economic growth (coefficient ≈ −0.190). Environmental policy contributes positively to growth, reinforcing the role of governance in green transitions. Granger causality analysis further confirms that renewable energy and environmental policy unidirectionally influence GDP, whereas GDP and CO_2 emissions share a bidirectional feedback loop. These results highlight the crucial role of sustainable energy strategies and regulatory frameworks in supporting long-term economic resilience. For policymakers, the study offers actionable insights into how green investments and emission controls can reinforce development goals. Future research should consider sector-level disaggregation and integrate high-frequency or regional comparative datasets to refine policy analysis and advance GCC-wide sustainability efforts.

Keywords: Renewable Energy, Economic Growth, CO_2 Emissions, Environmental Policy, ARDL Model, United Arab Emirates
JEL Classifications: Q42, O44, Q54, Q58

1. INTRODUCTION

The UAE has made impressive and swift moves forward economically. 'The UAE' is among the most vibrant of all the Gulf nations, having invested widely in infrastructure, real estate, finance, and tourism, besides hydrocarbons. Sustained economic growth, more people, and urban sprawl have made the country need more energy. Because greenhouse gas emissions and mainly carbon dioxide (CO_2) have increased a lot, putting the environment's sustainability at great risk (Hummieda et al., 2023; Akasha et al., 2023; Al Mamun et al., 2025). Now, the UAE is trying to ensure its economy keeps growing while minimizing the harm from

growth on the environment. Intentions to address climate change and damaged nature have inspired several nations to look for and use cleaner energy sources. Governments are making tremendous efforts to reduce carbon dioxide emissions by investing in climate-friendly energy sources, (Ebaidalla & Abusin 2022). Like multiple governments, the country is following international demands and its need for sustainable development by using renewable sources of energy. The world is witnessing a rapid shift towards sustainable energy. The world is witnessing a rapid shift towards sustainable energy (Chen, (2021)., with an increased reliance on renewable energy, based on the International Energy Agency's (IEA) most current estimates. Through its Energy Strategy 2050, the UAE has made it known that it hopes to extract half of its energy from clean sources and reduce carbon emissions by a great deal by 2050 (UAE Ministry of Energy and Infrastructure, 2023). They are in line with the nation's effort toward sustainability and aim to lower the environmental effects and increase the economy. Among its nearby nations, such as the UAE, which includes Saudi Arabia and Qatar, is at the forefront of the energy transition to greener sources. With Masdar City, solar farm projects, and investment in nuclear energy, the country wants to be a leader for sustainable development in the region. According to recent research, Kayani (2021) and Nassar (2025), the UAE is leading the way in integrating renewable energy sources into its energy mix.

By leading in policy making and investing a lot in environmental projects, the UAE is different from other Gulf Cooperation Council (GCC) members. Yet, although the UAE is dedicated to renewable energy, there are from studies about the real impacts and policy efficacy of its use there.

The issue of CO_2 emissions, growth, as well as the application of renewable energy has produced both positive and negative results. Numerous studies prove that energy from renewable sources brings economic growth to developing and emerging countries, as green investments can make energy more secure, give work to more people, and cut down on relying on resources from foreign powers (Inglesi-Lotz, 2016; Samour et al., 2022). A few academics think that because of infrastructure issues, high upfront costs, and transitional challenges, the benefits of renewable energy could only materialize in the long run (Dogan and Seker, 2016; Omri and Nguyen, 2014). Because the research shows different results, it is especially important to research unique situations like the UAE, which exports oil, is well-run, and is striving to reduce its carbon footprint.

The existing research overlooked how environmental policy helps link the development of the economy and its impact on the environment. Various empirical papers simply label environmental policies as either existent or absent, which makes it hard to understand their detailed and developing nature (Ferhi and Helali, 2024). As an example, carbon pricing, taxes on the environment, supporting green initiatives, and upholding environmental laws have been carried out quite differently across the world and over the years. In the UAE, environmental policy forms part of large planning efforts such as Net Zero by 2050, but so far, there isn't much evidence supporting the approach (Elmonshid et al., 2024). Besides, prior research often makes use of large-scale databases that make it harder to observe details in policies and institutions (Al-Mulali and Sab, 2012; Hossain, 2011). Due to what has been studied so far, it becomes obvious that an in-depth study should consider the distinctive UAE economic, political, and environmental environment. Recognizing the linkages between using CO_2 emissions and renewable energy sources, and environmental policies would help the UAE implement best practices in the area and the nation. To address the issue, advanced econometric methods have been applied to the data at hand. Pesaran and Shin (1995) created the ARDL model, which is most useful for looking at data series that are either I (0) or I (1). It makes it possible to predict relationships over both the short and long terms, which is useful for dynamic modeling of a national economy. To find out how different variables are related, Granger causality testing is used to check if one variable precedes another statistically in its rates of change.

Data on real GDP (Y), openness to trade (TRD), foreign direct investment (FDI), urban development (URB), emissions of CO_2, use of RE, and overall EC, and the government's environmental policy (EP) were gathered along with the study's annual observations from 2000 to 2023. It makes it possible to measure both instant and extended elasticities, highlighting how changes in the economy affect the environment.

The research makes three types of contributions. The study focuses on how renewable energy ties with the UAE's economy over the long and short terms, something that is not included in similar studies (Lahrech et al., 2024; Abid et al., 2024). The researchers test how CO_2 emissions, renewable energy, and GDP are related, which helps them learn about feedback systems and decide on better interventions. To better show the effects of environmental policy, the study treats it as a flexible approach, instead of simply treating it as black or white.

1.1. Research Objectives

1. To provide policy recommendations based on empirical evidence for enhancing sustainable development and low-carbon growth strategies in the UAE
2. To evaluate the effectiveness of environmental policies in shaping the nexus between energy consumption and economic development in the UAE
3. To determine the direction and Granger tests are used to determine the causal relationship between these variables.

2. LITERATURE REVIEW

To study in detail how renewable energy promotes both sustainable growth and protects the environment. It is increasingly crucial for both rich and emerging nations to comprehend the connections between emissions of carbon dioxide, renewable energy, and economic outcomes. Being known for exporting oil and gas while also actively supporting clean energy, the UAE makes for a special case in studying these topics. The content of this review explores and closely examines the latest studies and theories about renewable energy, growth, CO_2 emissions, and consequences for the environment, as well as ways to analyze the relationships using econometric methods.

2.1. Renewable Energy and Economic Growth

According to the International Renewable Energy Agency (IRENA, 2019), clean and safe energy constitutes the fundamental pillar of economic growth and socioeconomic development. Numerous studies now prove that using renewable energy can help developing and energy-reliant countries increase their economies. Apergis and Payne,)2010) found a bidirectional causal relationship between renewable energy consumption and economic growth in both the short and long run for thirteen Eurasian countries. As found by Bhattacharya et al. (2016), investing in growth is promoted by renewable energy by expanding the utilization of various energy sources. And using less fossil fuel. In accordance with Kayani (2021), the UAE's utilization of renewable energy helped grow the economy by creating new jobs and supplying more energy to people. In the same way, Samour et al. (2022) pointed out that financial development, FDI, and solid institutions encourage nations to adopt more renewable energy and support their economies in diversifying. Still, some challenges and results are not always positive. The authors pointed out that there are short-term problems like high infrastructure expenses, archaic grids, and limitations of current technology. According to Omri and Nguyen (2014), the gains from renewable energy depend greatly on how good a country's institutions and laws are. It is worth noting in the UAE's case, because even as it aims for 100% clean energy by 2050, it is still bound economically to hydrocarbons. In spite of the UAE's fast progress, it is still held back by issues with infrastructure and financial risks (Lahrech et al., 2024; Nassar, 2025). Besides, there is uncertainty about the relationship: Do growing economies support renewable energy, or can renewable energy help grow the economy (Sadorsky, 2009; Elmonshid et al., 2024)? As the situation is unclear, it is vital to examine each country's status using modern and advanced econometric techniques.

2.2. CO_2 Emissions and Environmental Consequences

The environmental influence of economic growth and the chances of applying CE with RE. In the early research from Al-Mulali and Sab (2012), Hossain (2011), (Jaradat and Al-Tamimi, 2022; and Abid., et al., 2023) it was found that using fossil fuel increases pollution and worsens the environment, mainly in fast-developing cities and industrial areas. Recently, Abid et al. (2024) investigated the GCC and found that energy intensity and the level of economic activity are still important reasons for CO_2 emissions. According to Ozturk and Acaravci (2013) in Turkey and UNEP (2022), switching to renewables can reduce emissions and not interfere with the country's progress. In the GCC, new technological systems have different effects on emissions than older ones because of their advances in innovation and strict policies, says Bousrih (2024). Because of government support for sustainable energy, the country's electricity efficiency is now better than that of the United Arab Emirates. Yet, emissions are still high due to the fact that cars, ships, planes, and most industries use a lot of fossil fuels (UAE Ministry of Energy and Infrastructure, 2023). Many feel that unless additional rules and carbon pricing are introduced, decreasing oil imports in these countries would not significantly reduce emissions (Farah et al., 2024; Wang et al., 2022). So, relying on renewable energy is helpful for nature, although its impact is determined by several other factors, including the way energy is used, laws in the area, and people's habits.

2.3. Environmental Policies and Their Effectiveness

Environmental policy is a key component of the national strategy that balances growth and sustainability; hence, it is a strategic necessity that requires coordinated frameworks and institutions capable of translating national objectives into tangible results (Li et al., 2021; Michailidis et al.,2025). Salim and Rafiq (2012) found that financial incentives combined with policy frameworks encourage green technology adoption. Omri and Nguyen (2014) warned that unclear or weak policies can reduce effectiveness. In the UAE, dynamic policies like the Net Zero 2050 Strategy, carbon pricing, and green bonds aim to drive sustainability (Abou Zahr, 2025; UAE Ministry of Climate Change and Environment, 2023). Yet, enforcement inconsistencies remain a challenge (Alsalman et al., 2021). Marzouk (2025) and the IEA (2023) noted that despite ambitious plans, coordination issues and unreliable data hinder progress. Recent research emphasizes evaluating environmental policy using multiple indicators. Elmonshid et al. (2024) showed through quantile regression that intensity-based metrics better reflect policy effectiveness in reducing emissions in GCC countries. The UAE also faces pressure from international commitments like the Paris Accord, while aiming to remain influential in global energy markets. As such, environmental policy is incorporated into the econometric model to assess its effects on economic growth, emissions, and energy use.

2.4. Econometric Approaches to the Energy-Growth-Environment Nexus

Empirical research on the environment, growth, and energy often relies on econometric models to explore interrelationships under varying conditions. Pesaran and Shin (1995) introduced the ARDL model, which is effective for analyzing time series with mixed levels of stationarity and is especially suitable for short time frames like the 12 years in the study. Researchers such as Bhattacharya et al. (2016) and Ozturk and Acaravci (2013) used ARDL to assess long- and short-term links between GDP and energy use, while others like Saqib et al. (2022) and Zakernezhad et al. (2024) examined institutional and financial influences, Enders (2008) points out that distributed delay autoregressive (ARDL) models represent a natural extension of dynamical models that combine the lagging values of dependent and independent variables, allowing for the separation of short-term and long-term effects within the same analytical framework. He explains that expressing the model in error-correction terms enables researchers to estimate the speed at which a system returns to equilibrium after a shock, making this type of model particularly suitable for studying economic relationships that gradually adapt over time, especially when data are limited or completely unstable.

The Granger causality test complements ARDL by identifying the direction of influence—whether economic growth precedes renewable energy expansion or vice versa—as demonstrated by Dogan and Seker (2016) and Shahbaz et al. (2013). These methods are especially valuable for data-limited, rapidly evolving economies like the UAE, where irregular and scarce data are common (Hummieda et al., 2023). Given the constraints of earlier models, Granger causality and ARDL are used in the study to deeply examine the UAE's energy-growth-emissions nexus, allowing for a clearer understanding of how environmental policies interact with economic dynamics.

3. METHODOLOGY

3.1. Research Design

The analysis studied how the UAE's economic progress, rise in CO_2 emissions, utilization of sustainable energy sources, and its environmental regulations relate to one another using time-series analysis and data. It concentrated on discovering how laws on renewable energy affected the economic situation of a country as it lowered its exports of fossil fuels. To analyze the data between 2000 and 2023, the study relied on the ARDL model for variables integrated to I(0) or I(1) and not I(2). The model depicted the way the UAE's energy and policy situation has progressed. In the ARDL framework, the ECT stood for how fast the system corrected past mistakes to its stable point. Besides, Granger causality tests were performed to check whether environmental policies and renewable energy had an impact on GDP. With the method, it became easier to explain the links between factors that led to better policymaking. The econometric model is specified as:

$$\Delta \ln Y_t = \alpha_0 + \sum \beta_i \Delta \ln Y_{t-i} + \sum \gamma_j \Delta \ln RE_{t-j} + \sum \delta_k \Delta \ln CO2_{t-k} + \sum \theta_l \Delta EP_{t-l} + \phi ECT_{t-1} + \varepsilon_t$$

Where:

- Δ denotes first differences,
- ln = natural logarithm,
- Y = real GDP,
- RE = renewable energy, CO_2 = emissions, EP = environmental policy,
- ECT = error correction term,
- ε_t = white noise error term.

3.2. Data Collection and Variable Construction

Since 2000, data for the research have been gathered yearly using World Bank, World Development Indicators databases, the UNEP, the UAE Ministry of Energy and Infrastructure, and the IEA. The selected variables match the studies about the energy-growth-environment relationship and match the context of the UAE's growth.

Key variables include:

- Real GDP (Y): Economic output proxy
- Renewable energy (RE): Primary energy from renewable sources
- CO_2 emissions (CO_2): Annual per capita emissions
- Total energy consumption (EC): Aggregate primary energy use
- Foreign direct investment (FDI): Net inflow as % of GDP
- Trade openness (TRD): Total trade as % of GDP
- Urbanization (URB): Urban population share
- Environmental policy (EP): Composite index capturing policy strength and continuity

3.3. Population and Sampling

The study was statistical and did not involve sampling from individual subjects. It used macroscopic data collected for the UAE over 1 year for analysis. As the dataset included 24 time points, bounds testing, stationarity checks, and causality analysis were performed, with all integration order conditions fulfilled. The inclusion of key macroeconomic and energy-environment indicators ensured that the data remained internally consistent and reliable.

3.4. Data Analysis Technique

The study used a type of econometrics to assess how the variables changed both in the near and far future. Before employing the ARDL method, to guarantee that no variables were combined at I(2), the ADF test was performed. By determining if the computed F-statistic is below the crucial levels, the presence of long-term associations was examined, and if the stationarity conditions were satisfied. If cointegration was confirmed, ARDL was used to estimate the relations both in the near and far future, and the ECT displayed the rate at which the system stabilized after a shock. In addition, tests for Granger causality were applied to check which variable drove the growth of the economy among the three.

3.5. Model Robustness and Diagnostic Tests

The model was tested in many ways to check its accuracy. To check for serial correlation, Godfrey-Breusch was chosen, and White, ARCH, and ARMA tests were applied for heteroskedasticity. The Jarque-Bera test was employed to show whether the residuals fit a normal distribution. CUSUM and CUSUMSQ tests examined whether the model kept the same pattern as data gathered over time. Where multicollinearity was suspected, the Variance Inflation Factor (VIF) was checked. All the data relating to the findings was shown in separate tables to maintain transparency and encourage others to repeat the experiment.

4. RESULTS

The study was based on annual data for the years 2000-2023 to determine how much renewable energy is consumed, what happens

Table 1: ADF test results for variable stationarity

Variable	ADF statistic (level)	Critical value (5%)	Stationary at level?	ADF statistic (1st diff.)	Stationary at 1st diff.?
Real GDP (lY)	−2.43	−3.00	No	−4.75*	Yes
Renewable energy (RE)	−1.98	−3.00	No	−5.12*	Yes
CO_2 emissions (CO_2)	−2.27	−3.00	No	−4.85*	Yes
Environmental policy (EP)	N/A	N/A	Yes (I (0))	N/A	N/A
Total energy consumption (EC)	−2.54	−3.00	No	−4.64*	Yes
Trade openness (TRD)	−3.25*	−3.00	Yes	−6.01*	Yes
Foreign direct investment (FDI)	−2.11	−3.00	No	−4.98*	Yes
Urbanization (URB)	−2.73	−3.00	No	−5.03*	Yes

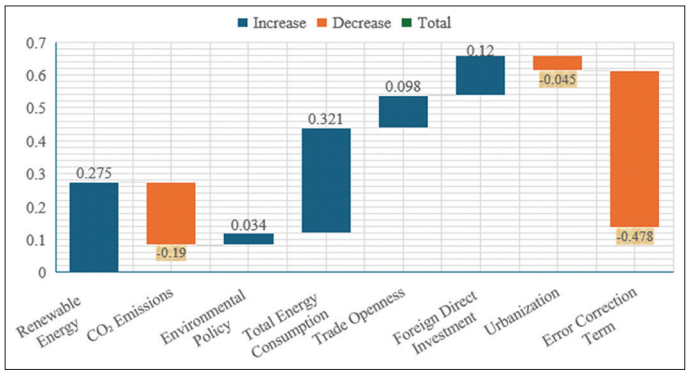
*indicates significance at 5% level

to the economy, how carbon emissions change, and what influence environmental policies have in the UAE. Unit root testing is done first, followed by collecting evidence for cointegration, estimating ARDL coefficients of both immediate and long-term impacts, as well as carrying out Granger causality analysis.

4.1. Stationarity Test Results

As demonstrated by the Augmented Dickey-Fuller (ADF) test in Table 1, was used to assess stationarity. (Gujarati,2002; Harris and Sollis, 2003). emphasize that a unit-root test, such as the ADF, is a fundamental step when dealing with time series; and they explain, that this test determines whether time series contain a unit root and helps to determine whether it is necessary to take the first difference to make the variables constant I(1) or if they are constant at the I(0) level, thus enhancing the reliability of the estimates. Most variables—Real GDP (Y), CO_2 Emissions (CO_2), Renewable Energy (RE), Urbanization (URB), Foreign Direct Investment (FDI), and Total Energy Consumption (EC) were non-fixed at the level, as their ADF values exceeded −3.00. Trade Openness (TRD) was fixed at the level with an ADF statistic of −3.25. After first differencing, all non-stationary variables became stationary, confirming they were integrated at order one I(1). The environmental policy index remained stationary at level I(0). These results confirmed that the ARDL model was appropriate, as it required variables to be either I(0) or I(1), ensuring estimation reliability.

Figure 1: Long-run ARDL coefficients of economic and environmental variables affecting UAE GDP



4.2. ARDL Bounds Test for Cointegration

The ARDL limits test's result, which sees whether the important variables have a link of long-term equilibrium, such as CO_2 emissions, renewable energy, and actual GDP, and so forth, are displayed in Table 2. The calculated F-statistic value of 6.42 is larger than the top critical bound value of 4.85 at 5% significance. If the findings indicate that the F-statistic surpasses the upper limit, the variables are connected by long-term cointegration. There are ups and downs, and the value of these factors becomes synchronized in the long term and helps restore balance gradually. To measure both the near and far future changes in the UAE's energy-growth-environment framework, the ARDL model should be used.

4.3. Long-run and Short-run ARDL Estimates

The ARDL model's short- and long-term effects are listed in Table 3. Coefficients over a long period confirm that the use of renewables (RE) helps raise the real GDP (0.275) in the UAE. In a similar way, total energy consumption (EC) also results in stronger, positive long-term growth. When the study looks at the long-term relationship, CO_2 emissions (CO_2) negatively affect GDP, which could indicate that pollution can hurt economic growth over the years. Strong policies in the area promote green growth, as seen by the extremely strong and obviously appealing

Table 2: ARDL bounds test results for long-run cointegration

Test model variables	F-statistic	Critical value I (0)	Critical value I (1)	Conclusion
Y, RE, CO_2, EP, EC, TRD, FDI, URB	6.42	3.79	4.85	Long-run cointegration

Table 3: ARDL long- and short-run estimates

Variable	Long-run coefficient	Standard error	t-statistic	Short-run coefficient	Standard error	t-statistic
Renewable energy (RE)	0.275**	0.093	2.95	0.112*	0.056	2.00
CO_2 emissions (CO_2)	−0.190*	0.087	−2.18	−0.075	0.051	−1.47
Environmental policy (EP)	0.034**	0.013	2.61	0.010	0.007	1.43
Total energy consumption (EC)	0.321**	0.099	3.24	0.145*	0.073	1.98
Trade openness (TRD)	0.098	0.065	1.51	0.041	0.029	1.41
Foreign direct investment (FDI)	0.120*	0.061	1.97	0.053	0.031	1.71
Urbanization (URB)	−0.045	0.054	−0.83	−0.018	0.014	−1.29
Error correction term (ECT)	−0.478**	0.121	−3.95	N/A	N/A	N/A

** and * indicate significance at 1% and 5% levels, respectively

Table 4: Granger causality test results among key variables

Null hypothesis	F-statistic	P-value	Interpretation
Renewable energy does not granger cause GDP	5.21	0.010*	Renewable energy→GDP
GDP does not Granger-cause Renewable Energy	2.11	0.142	No causality
CO_2 emissions do not Granger-cause GDP	4.34	0.022*	CO_2 emissions→GDP
GDP does not Granger-cause CO_2 Emissions	3.95	0.032*	GDP→CO_2 emissions
Environmental policy does not Granger cause GDP	3.82	0.034*	Environmental policy→GDP
GDP does not Granger-cause environmental policy	1.10	0.354	No causality

*indicates significance at 5% level

link between GDP and environmental policy. Higher GDP is correlated with foreign direct investment and trade liberalization; the impacts are not as great as those of imports, exports, or investment. The effect of urbanization is not very meaningful. The ECT of −0.478 reveals that about 47.8% of the past unbalance is removed each year, and the finding is substantiated by its significant result.

Figure 1 presents a waterfall chart showing the incremental impacts of various factors. Renewable Energy (+0.275), Environmental Policy (+0.034), Total Energy Consumption (+0.321), Trade Openness (+0.098), and Foreign Direct Investment (+0.12) contributed to increases. CO_2 Emissions (−0.19), Urbanization (−0.045), and a significant Error Correction Term (−0.478) led to decreases. The net change results from the cumulative effect of these contributors.

4.4. Granger Causality Test

The findings of Granger causality tests for the connections between environmental policy, GDP, CO_2 emissions, and renewable energy in the United Arab Emirates between 2000 and 2023 are displayed in Table 4. There is proof that more renewable energy used leads to higher GDP ($F = 5.21$, $P = 0.010$), but not the other way around. Likewise, environmental policy increases GDP ($F = 3.82$, $P = 0.034$), meaning that stronger environmental policies tend to strengthen the economy. Growth causes emissions to rise, and emissions reduce growth ($P = 0.022$ and $P = 0.032$, respectively); CO_2 emissions and GDP are influenced by each other. But there is no direct link seen between GDP and renewable energy or environmental policy. They confirm that better environmental policies and clean energy make it easier for economies to prosper and avoid damage to the planet, and point out a cycle where growth leads to more harm to the environment.

5. DISCUSSION

The study examined how CO_2 emissions, economic development, environmental constraints, and the UAE's utilization of renewable energy changed between 2000 and 2023. According to results from the ARDL bounds test, the selected variables exhibit a long-term, significant, and stable economic-environmental link. It shows that, to steer toward sustainable growth and handle emissions, the UAE depends heavily on policies for renewables and the environment. Long-term ARDL analysis indicated that renewable energy helps GDP, and its effect is significant in all timeframes. It can be argued that clean energy initiatives make the energy system more secure, flexible, and innovative, which helps the economy. As confirmed by other scholars (Bhattacharya et al., 2016; Inglesi-Lotz, 2016; Sadorsky, 2009), these findings demonstrate the commitment of the UAE to renewable energy through practical initiatives like Masdar City and Mohammed bin Rashid Al Maktoum Solar Park. Renewables provide poor nations a less damaging means of boosting their economy, claim Abid et al. (2024).

Over the long term, increasing CO_2 emissions negatively affected GDP, stressing that the economy is paying the price for worsening the environment and pollution due to heavy use of fossil fuels. As Al-Mulali and Sab (2012) and Hossain (2011) also found, emissions lead to a drop in productivity and bring about unnecessary costs that affect the economy's efficiency. It has been confirmed by Granger analysis that CO_2 and GDP influence each other, so that as the GDP climbs, emissions also increase, and emissions then impact the economy with negative effects on health and the environment. It proves the need for placing emission mitigation at the forefront of development planning.

Studies indicate that similar policies have been important in raising GDP, which shows that the UAE's environmental efforts guided investments into green energy. Ferhi and Helali state in their paper (2024) that environmental policies that are robust support the conservation of nature and help boost economic growth by using more environment-friendly technologies. This agrees with the study by Salim and Rafiq (2012), which found that better environmental governance boosts the efficiency of industry and encourages new energy innovations.

The direction in which these linkages operate was demonstrated by Granger's test of causality findings. The research concludes that using GDP growth was spurred by renewable energy, but GDP did not encourage more renewable usage. Also, environmental policy was found to predetermine and shape the performance of GDP. The result proves that good governance and solid institutions encourage sustainable development (Elmonshid et al., 2024). The ARDL model included trade liberalization and foreign direct investment's effect on GDP, these variables were not statistically significant. Putting more importance on green additions and strong domestic standards may help us most from a global integration (Nassar, 2025; Sun, 2024). Although urbanization is found to have little impact on GDP here, it may still lead to higher infrastructure costs, more energy use, and more damage to the environment in indirect ways. The UAE's city development may not need much energy because its economic progress has separated cities from resource-consuming industries.

The findings support earlier studies that prove renewable energy can support sustainable development for economies that are still developing or resource-based. Bhattacharya et al. (2016) and Inglesi-Lotz (2016) reveal that countries that use renewable energy resources have safer supplies, cost-stable markets, and more work opportunities. Dogan and Seker (2016) further state that for these benefits to materialize, infrastructure must be equipped, laws supportive and the society should accept them. All of which has seen progress in the UAE in recent times.

The analysis makes clear that the study should invest more in renewables and improve emissions by imposing regulations, setting standards, and giving subsidies for green technology. Leading policy should start by including energy-saving efforts, enhancing new ideas in technology, and drawing attention to the environment. Development plans should recognize how emissions impact economic activities so as not to cause the economy to develop unsustainably. The rewards of environmental policy are now clear, it is essential to keep evaluating and improving it with shifts in the global setting and economic changes. For environmental policy to keep giving economic benefits, its targets

and management should always be updated and strongly supported. Marzouk (2025) points out that a combination of policies and clear regulatory checks is necessary for policies to be well-coordinated and more effective. It appears from the data that strong results from clean energy investments can be achieved through solid policy support from the government. With the UAE developing new energy sources and becoming a strong player in clean technology, smart grids, hydrogen energy, and energy storage technologies now offer chances for collaboration. All of this is consistent with the Carbon emissions to be decreased under UAE's 2050 Energy Strategy and Vision 2021 by just 70%, and have 50% of energy come from renewable sources.

6. CONCLUSION

Using both ARDL and Granger causality models, the researchers examined the consequences of using renewable energy in the UAE on CO_2 emissions, regulations, and economic development between 2000 and 2023. It was shown through analysis that these factors influence the country's sustainable development together. Renewable energy uses led to a noticeable and positive boost in GDP, which proved that spending on clean energy strongly supports economic growth. Long-term growth was shown to be slowed by CO_2 emissions, demonstrating the detrimental impact of fossil fuel use on the ecosystem. Every time improved environmental policies were implemented, the economy benefited. The outcomes show the effectiveness of the Energy Strategy 2050 and the appropriateness of the UAE's renewable energy policy. The link between CO_2 levels and GDP proves that if growth is not controlled, the damage to our environment will just continue. It proves why macroeconomic strategies must include actions that curb emissions.

Based on the findings, some recommendations are to increase regulation, give more support to green energy, and include environmental protections in trade deals. To eliminate the connection between pollution and growth and safeguard the stability of the Earth for future generations, the study requires certain regulations. Researchers could improve their studies by using more frequent data, separating sectors, and looking at a wider collection of policy outcomes. The progress of the United Arab Emirates may be compared to that of other Gulf Cooperation Council members. Examining how the connection between energy and growth is affected by the usage of contemporary technologies and new financial instruments may lead to fruitful research directions. All in all, the study proves that connecting investments in renewables with solid environmental policies supports both economic growth and care for nature in the UAE.

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