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Examining the Impact of Environmental Taxation, Economic Growth, and Political Instability on Sustainability

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Abstract
Sustainable development is the most challenging issue facing the whole world. It includes multiple dimensions like economic, social, and environmental. The current study explores the determinants of sustainability in developing countries by incorporating the role of environmental taxes, economic growth, renewable energy, and political stability. The study used 21 developing countries from 1994 to 2023 to find the impact of these macroeconomic variables on greenhouse gas emissions. The generalized method of moments and penal least squares with fixed effects model have been used to find robust empirical evidence. The empirical findings indicate that environmental taxes have a significant positive impact on environmental sustainability, while renewable energy, political stability, and economic growth have a significant negative impact on environmental sustainability. The study also demonstrates the moderating role of environmental taxes on renewable energy and political stability. It indicates that environmental taxes have no statistical support to build a statement about the moderating role. The study suggests that policy makers to take immediate action to revise taxation policies by incorporating the current challenges faced by the environment. Renewable energy sources should be promoted to make them accessible. If possible, taxes on accessories of renewable energy setups should immediately be removed.

Keywords: Environment Taxes, Renewable Energy, Sustainable Growth, Greenhouse Gas Emissions, Developing Countries, Political Stability

1. Introduction
The environmental situation is a fundamental element of the development process, as it exerts a direct influence on the core factors of production—land, labour, and capital. The availability and quality of natural resources (land), including fertile soil, clean water, and a stable climate, are critical for sectors such as agriculture, forestry, mining, and tourism, which serve as economic backbones in many regions (Barbier 2010; Ali & Audi, 2016; Carlo, 2019; Martin, 2025). The environmental situation of an economy also helps in the promotion of health, productivity, and mobility of the labour workforce; for

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instance, poor air and water quality, exposure to climate-related hazards, and extreme temperatures can significantly reduce workforce efficiency and boost public health issues, which ultimately become a cause of an increase in living costs. Environmental risks together with resource shortages create obstacles to capital formation because they affect both investment choices and insurance premiums and infrastructure durability (William & Adam, 2018; Ali et al., 2021; Qasir & Agha, 2025). The natural capital that supports economic production gets damaged through ecosystem degradation, which leads to economic growth limitations that last for extended periods. The relationship between ecological integrity and economic development requires that environmental sustainability function as the main strength that supports resilient economic systems instead of being treated as a restriction.

Sustainable development has three core pillars, i.e., Economic, Social, and Environmental sustainability. Economic sustainability is defined as increasing economic growth without disturbing its surroundings. Social sustainability means the good governance, Rule of Law, and equal opportunity without any discrimination, whilst Environmental sustainability, the core focus of the current study, is defined as protection of the ecosystem, climate change mitigation, and biodiversity conservation. The environmental Kuznets Curve very well-established growth-environment association (Marc & Ali, 2016; Emodi, 2019; Almeida et al., 2024; Ahmed & Hu, 2025). It indicates that without taking timely, adequate mitigation measures, growth and environmental sustainability can't move in the same direction. Sweden was the first country to take mitigation measures to protect its environment. It is a pioneer country among the world's economies that implemented a carbon tax in 1990. Its early taken step makes it possible to stand at first position in the Environmental Performance Index 2024, organized by Yale University. By following it, Norway and Hungary have also taken early steps to introduce and imply carbon tax in 1991 (Pavlevski et al. 2025). Moving toward sustainability, Pakistan has also introduced a petroleum levy of Rs. 2/litre in the Finance Act 2025.

One of the major causes of environmental damage is excessive and unsustainable use of power sources. It is the fundamental fact that energy is the major element for every industrial activity. But the problem is that approximately every industry still uses traditional ways to get power, like through the burning of fossil fuels, crude oil. Renewable energy sources such as solar, wind, hydro, and biomass have a double dividend effect (Ibrahim & Simian, 2023; Chowdhury & Hassan, 2025; Marc et al., 2025). It is not only environmentally friendly but also a cost-effective source of energy. It has been evidenced through the findings of numerous studies that this economic source

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of energy acquisition has a significant positive impact on environmental sustainability in various developed economies, like in United States, Canada, and the European Union. (Wiredu et al. 2025; Putri et al. 2024; Calin & Horodnic, 2023; Wang & Chen, 2021). The research results demonstrate that we must develop sustainable economic systems that include environmental expenses as essential. The historical data show that between 1990 and 2008, worldwide CO_2 emissions increased from 22.5 billion tons to 31.5 billion tons, which created severe dangers for the health of our planet. NASA reports that without major policy changes, Earth will experience a temperature increase of 3°C by 2030, which will create disastrous conditions for all living organisms. Economies keep extracting and consuming coal, crude oil, and natural gas to satisfy their growing energy requirements, which makes fossil fuel dependence the main reason for this crisis.

Tax has an ancient history and has a well-defined enforcement ability of governance policy. So, this attribute of taxation gives the opportunity to the governing body to implement appropriate taxes on activities that produce harmful emissions. It attributes a double dividend to the economy, one in the shape of environmental protection, and the second is in monetary terms. Almost all developed countries use environmental taxes as a tool to protect the environment. No doubt taxes increase inflations but their marginal utility is higher than inflation (Jaelani & Nazara, 2022; Lee & Zhuang, 2025). The carbon pricing model has a strong association with multiple factors, such as green energy consumption practices (Oloko, 2022; Chowdhury et al., 2024). A recent study on urbanisation and its side effect is conducted, which indicates that urbanisation is a cause of increased greenhouse gas emissions due to deforestation in Pakistan (Tanveer et al. 2025). The current study addressed the current global environmental challenges, and its aims to identify the key determinants of environmental sustainability among environmental taxes, political instability, renewable energy consumptions and economic growth, as the climate crisis has intensified, making it essential to solve this complicated problem.

2. Literature Review

Environmental resources function as economic assets, yet their degradation through deforestation, pollution, biodiversity loss, and soil erosion creates a major worldwide environmental crisis. The Paris Agreement, held in 2015 (Mamun et al. 2025), established a critical benchmark to limit the excessive increase in temperature. The agreement will reach its goals if the annual reduction rate achieves 42 percent. However, the current scenario indicates a significant shortfall in meeting this threshold. The earth's surface temperature is projected to rise by 2.6°C to 3.1°C by the end of the 21st century, posing

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serious risks to the planet's ecological balance and the habitability of many regions. Carbon dioxide (CO_2) remains the primary driver of such an increase in temperature. Its atmospheric concentration has risen sharply from 365 parts per million (ppm) in the early 2000s to over 465 ppm in 2024 (Wahyudi et al. 2025).

Numerous existing studies demonstrate the influential role of environmental taxes, renewable energy, political stability, and economic growth in achieving environmental sustainability. Ali et al. (2023) investigate the impact of economic growth, energy consumption, and urbanisation growth on carbon emission on Kingdom of Saudi Arabia from 1980 to 2020. Results indicate that economic growth, energy consumption, and urbanisation have significant positive effects on carbon emissions, while trade openness has no significant effect. Ashiq et al. (2023) explore the impact of technological innovations on carbon dioxide emissions in 5 South Asian countries from 1980 to 2019. Results indicate that technological innovations have a significant negative impact on carbon emissions.

Sulehri et al. (2024) examine the impact of economic growth and innovations on greenhouse gas emissions in 18 different countries, which account for approximately 64% of global greenhouse gas emissions from 2000 to 2022. The findings show that the moderating role of the regulatory framework among green innovations and greenhouse gas emissions is statistically significant with negative effects. While economic growth's impact is positive but no statistical evidence available. Ali et al. (2025) examine the impact of renewable energy consumption and green finance on ecological footprints in fifty-four developed and developing countries from 1995 to 2021. In developing countries association of ecological footprints with green finance and renewable energy consumption is negative, which is statistically significant. In the developed country analysis, the bounding of ecological footprints with green finance is positive and significant, while with renewable energy consumption is statistically significantly negative.

Abdulqader et al. (2025) explore the impact of carbon taxation and the emission trade license system on the reduction of carbon emissions by using data from 30 developing economies from 1990 to 2020. Findings show that carbon taxation or a trade licence system significantly leads to environmental improvement. Empirical analysis indicate 8.91% reduction in emissions takes place due to effective carbon taxation and trade license. Audi et al. (2025) investigate the impact of globalization, economic growth, and energy consumption on carbon emissions in worldwide economies from 1970 to 2023. Findings show that economic growth have significant positive effect on carbon emissions. All globalization indices have a significant positive effect on carbon

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emissions. Antohi et al. (2025) investigate the interplay between green taxation and greenhouse gas emissions in 27 states of the European Union from 2010 to 2022. Results show that all environment taxes except taxes on the labour force have significant positive effects on greenhouse gas emissions.

Abid et al. (2025) investigate the role of economic growth, environmental technological advancement, financial development, and urbanisation on environmental sustainability in Saudi Arabia from 1990 to 2023. Findings show that economic growth is positively linked with carbon emissions in the short run, while minimal integration exists in the long run. Bashir et al. (2025) investigate the impact of energy structure, renewable energy investment, and urbanisation on carbon emissions in the top ten polluting economies from 1995 to 2022. Findings show that energy structure from fossil fuels and urbanisation have significant positive effects on carbon emissions. However, renewable energy investments have significant negative effects on carbon emissions. Bala et at. (2025) explore the moderating role of foreign direct investment between environmental taxes and green energy in Nigeria from 2003 to 2022. Findings show that foreign direct investment strengthens the relationship of environment taxes and green energy consumption. However, it has significant positive effects on carbon emissions. Foreign direct investment has a significant negative impact on carbon emissions.

The inconsistent impact of Carbon Taxes and Carbon emissions on economic growth was investigated by Dang et al. (2025) using data from 55 developing countries from 2012-2022. The results show that CO_2 emission is positively associated with higher quantiles of growth, while environmental taxes have a negative effect on growth in countries with higher quantile levels. Du et al. (2025) analyse the impact of trade globalization, financial globalism, and information and communication technology on environmental emission factors. Findings show that financial globalization, pollution taxation policies, and governance quality have a significant positive effect on environmental sustainability. Elhassan (2025) explores the impact of green technology innovation, green financing, and economic growth on environmental sustainability in G-7 countries from 1990 to 2022. Findings show that green financing and advancement in green technology hurt carbon emissions, while gross domestic product and energy consumption have a significant positive impact on carbon emissions. Hussain et al. (2025) explicate the nexus between green finance and green economic growth in G-20 countries from 1995 to 2021. The results indicate that green finance have significant positive impact on green economic growth, whilst the other have a significant negative impact on green economic growth.

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Mustafa et al. (2025) examine the moderating role of environmental taxes on renewable energy and greenhouse gas emissions in 81 different countries from 2010 to 2020. Findings indicate that environmental taxes have the potential to moderate the relationship between renewable energy consumption and environmental sustainability. Murad et al. (2025) explore how green taxation and sustainable energy transition influenced low-carbon development in G-7 nations from 1994 to 2020. Findings show that environmental taxes have a significant positive impact on environmental sustainability. Gross domestic productions have significant negative impact on environmental sustainability. Nguyen et al. (2025) investigate the impact of foreign direct investment, trade openness, financial development, gross capital formation, and renewable energy consumption on greenhouse gas emissions in Vietnam from 1990 to 2021. Findings indicate economic growth has significant positive effects on carbon emissions. Nawaz et al. (2025) explore the impact of economic growth and renewable energy practices on CO_2 emissions from 1990 to 2020 in Japan. Findings indicate that gross domestic product is positively associated with carbon emissions, and renewable energy have negative effect on carbon emissions.

Ozmen et al. (2025) examine the impact of economic growth and environmental taxes on carbon dioxide emissions in European States from 1995 to 2020. Findings show that transport taxes have a significant positive impact on carbon emissions, while taxes on energy have a significant negative effect. Obwori et al. (2025) investigate the impact of environmental taxes on CO_2 emissions in Romania during 1990-2021. Findings indicate that environmental taxes have a significant negative impact on carbon emissions. Rahman et al. (2025) examine the impact of economic and population growth, renewable energy, nuclear energy, and energy through fossil fuels on greenhouse gas emissions in South Asian countries (Pakistan, India, Bangladesh, Nepal, and Sri Lanka) from 1972 to 2021. Findings indicate that economic, population growth, and energy from fossil fuels have significant positive effects on greenhouse gas emissions.

The environmental effects of highway development projects in Tehran City are examined by Shirinkalam et at. (2025) with a particular emphasis on air and noise pollution. The results show that development causes socioeconomic problems, raises health care issues, and disturbs ecosystems. Salim et al. (2025) investigate the impact of trade openness, technology advancement, and economic growth on environmental sustainability by using data from the Gulf Cooperation Council countries from 1990-2022. Findings show that advancement in technology and trade openness have a significant negative impact on carbon emissions. Topuz et al. (2025) examine the impact

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of export diversification, gross domestic product, green innovation, and environmental taxes on CO_2 emissions in 21 European states from 1995-2020. Results show that export diversification have significant positive effect on CO2 emissions. Green Innovations have also significant negative impact on carbon emissions. Environmental taxes and economic growth have a positive influence on carbon emissions. Wahyudi et al. (2025) investigate the impact of carbon taxes on carbon emissions in G-20 countries from 2016-2020. Results indicate carbon taxes have significant negative effects on emissions. Widianingsih (2025) examines the impact of carbon taxes, renewable energy consumption, and economic growth on CO_2 emissions by using the data of 47 countries around the world from 2010 to 2020. Findings show that carbon taxes have no ability to reduce carbon emissions in these economies. However, renewable energy has significant positive effects on the reduction of carbon emissions.

Wiredu et al. (2025) evaluate the interaction pattern of Carbon emissions with economic development, green finance, urbanisation, life expectancy, and renewable energy resources by using data from G-7 countries from 1990 to 2020. Findings indicate that economic growth, renewable energy consumption, and green finance have a significant negative effect on carbon emissions. Wang et al. (2025) explore the impact of carbon taxes in China's wind power industry. Findings show that public green tax incentives and penalties have an insignificant effect on corporations' R&D policies. Wei et al. (2025) examine the impact of green economy and environmental taxes on CO_2 emissions in 25 different countries from 2000 to 2021. Findings show that steps toward the conversion of a greener economy and imposing environmental taxes leads significant positive effect on environmental sustainability. Xu et al. (2025) inspect the impact of carbon taxes on green technological progress in 30 Chinese provinces from 2005 to 2021. Findings show that carbon taxes have a positive effect on carbon emissions. Green technological progress without carbon taxation has no fruitful effect on carbon emissions. Xuan et al. (2025) explore the role of electricity consumption, green energy consumption, foreign direct investment, and economic growth in environmental sustainability in Brunei from 1990 to 2023. The results show that electricity generation through fossil fuels, foreign direct investment, and economic growth have significant positive effects on carbon emissions. Renewable energy has a significant negative effect on carbon emissions.

Yilmaz et al. (2025) investigate the impact of the government's environmental protection expenditures, economic growth, urbanisation, and trade openness on greenhouse gas emissions in 117 countries from 2000 to 2023. Results indicate that environmental protection expenditures, Trade

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openness, and urbanization have significant negative effects, while economic growth has significant positive effects on emissions. A long-term association between CO_2 emissions, environmental taxes, and nuclear energy in Japan between 1994 and 2022 has been investigated by Yasir et al. (2025). Empirical results show that environmental taxes have significant negative effects on carbon emissions. Zhang et al. (2025) investigate the performance of China's environmental protection law 2018 by evaluating the Environment, Social, and Governance score of Chinese listed companies from 2014 to 2021. The findings show that environment protection tax law 2018 has a time lag effect on carbon emissions. Firms with a mandatory obligation of ESG reporting have a greater effect than those not required. The firms that have political connections have a strong impact of this law on their ESG score. Zhang et al. (2025) examine the impact of trade openness, environmental tax, financial depth, and renewable energy consumption on the rate of natural resource extraction in China and the United States from 2000-2022. Finding shows that the rate of natural resources extraction is directly proportional to trade openness and a financially strong economy. Environmental taxes have a significant negative impact on emissions. However, renewable energy consumption has no statistical evidence in promoting environmental sustainability in both economies. The study used a unique unified model in which it examined three important macroeconomic indicators – environmental taxes, political stability, and renewable energy- to examine their impact on environmental sustainability. Furthermore, it also examines the moderating role of environmental taxes on renewable energy consumption and environmental sustainability, which is the main contribution of the current study. Although numerous existing studies have evidence of the significant impact of these macroeconomic variables on environmental sustainability in developed economies (Putri et al. 2024; Pavlevski et al. 2025), no evidence is available in existing literature regarding developing countries. With the help of the current study, this gap has been filled by applying this unified model to developing countries.

3. Theoretical Framework

One of the most relevant theoretical perspectives in this context is the Ecological Modernization Hypothesis (Mol 2014). The ecological modernization hypothesis posits that environmental reform and economic development are not mutually exclusive. Economic growth and environmental preservation can be achieved at the same time through the use of market-based instruments and technological innovation, together with institutional transformation. Environmental taxes function as a strategic instrument that enables the internalization of environmental externalities through their

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financial incentives that promote the transition from polluting practices to cleaner technologies and renewable energy solutions (Solarin & Leong, 2022; Moscato et al., 2025; Shao et al., 2025; Chowdhury & Hassan, 2025). Sustainable development serves as one of the main theoretical frameworks that guide the present research according to its original definition by the Brundtland Report (World Commission on Environment and Development 1987). The report defines sustainable development as a process that enables present needs to be met while preserving the future needs of coming generations. The Brundtland definition captures the intertemporal trade-offs that are inherent in environmental and economic policy decisions and aligns closely with the current study's focus on environmental taxation as a mechanism for achieving sustainability (Stewart, 2020; Wiredu et al., 2025; Putri et al., 2024; Pavlevski et al., 2025; Chowdhury et al., 2024). The Double Dividend Hypothesis presents an economic explanation for environmental taxation that expands the current discussion. The hypothesis states that environmental taxes create two separate economic benefits for the government, according to Bernard et al. (2021). The first dividend comes from environmental advantages, which result from market failure corrections based on Pigouvian economic principles through emission reductions and better environmental outcomes. The second dividend represents possible economic advantages that stem from better fiscal efficiency, job creation, and higher economic productivity resulting from specific tax policy design and implementation (Putri et al. 2024; Qasir & Agha, 2025). Environmental taxes should be part of all economic and fiscal policy systems because they provide two distinct benefits to the public.

Based on the theoretical discussion, the mathematical model of our study becomes:

$$GHG_{it} = f\,(ENT, RNE, POS, GNI, POP, ELE, FDI, TRO) \ldots (1)$$

where:

GHG = Greenhouse gas emissions

ENT =Environmental tax

RNE = Annual renewable energy production as % of total energy production (in petajoules).

POS =Annual political stability score

GNI =Gross national income growth rate

POP =Annual population in millions

TRO = Export volume

FDI = Financial Development Index constructed by the International Monetary Fund

ELE = Electricity produced by fossil fuels as % of total energy production

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The econometric model has been given here:

$$GHG_{it} = \alpha_0 + \beta_1 ENT_{it} + \beta_2 RNE_{it} + \beta_3 (ENT_{it} * RNE_{it}) + \beta_4 POS_{it} + \beta_5 POP_{it} + \beta_6 GNI_{it} + \beta_7 ELE_{it} + \beta_8 FDI_{it} + \beta_9 TRO_{it} + \mu_{it} \ldots\ldots (2)$$

μ_{it} is the white noise error term, which captures unobserved factors affecting carbon emissions. α_0 is the constant term indicating the effect of the dependent variable when all other independent variables become zero, while β_n slopes of the independent variables used in the model, which tells the % change in GHG due to 1% change in the respective independent variable.

4. Results and Discussions

The empirical study used Table 1 to present descriptive statistics, which showed how the studied variables distributed their values throughout the entire set of sample measurements. The statistics show that greenhouse gas emissions vary between the various selected economies according to their emissions levels. The distribution shows that some countries maintain low emission levels while other nations create much more serious environmental damage. The sampled countries demonstrate different industrial structures and energy usage patterns, together with their unique approaches to environmental management, which results in this pattern of variation. Environmental taxes show multiple levels of variation throughout the different observation points. The descriptive results show that some governments use minimal environmental taxation systems, which contrasts with the taxation systems used by other governments to fight environmental problems. Countries in the data set show different environmental policy systems, together with different regulatory systems and different institutional capabilities, which create this institutional difference. The sample shows moderate usage of renewable energy sources. The descriptive results show that some economies have reached advanced renewable energy adoption in their energy systems, while other economies still depend on traditional energy sources. Different technological development levels, together with energy policy priorities and renewable resource access, create the observed dispersion among countries.

The sample data shows different levels of political stability, which leads to different quality of governance and institutional performance. The data distribution shows that certain nations maintain stable political systems while other nations experience difficulties with their institutions and governance systems. The implementation of policies, the planning of economies, and the management of environmental resources experience impacts from the existing political situation differences between countries. The sample economies exhibit substantial population characteristic differences according to their economic profiles. The dataset contains both small and large populated

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countries according to the descriptive statistics analysis. The different demographic characteristics in the panel study will impact how economic activities take place, how energy needs will develop, and how environmental results will emerge. The gross national income growth demonstrates how economic performance differs between the chosen countries. The descriptive evidence shows that some economies maintain steady economic growth at a moderate speed, while other economies go through periods of fast growth or economic downturns. The study period reveals economic development patterns through different economic development trends that occurred during the study period. The selected economies experience foreign direct investment as external capital enters their markets. The results show that countries differ in their foreign investment levels because some countries attract more international capital than other countries do. The differences across countries result from how investment policies, institutional quality, and economic conditions operate. The sample shows substantial differences in trade openness between its various countries. The statistics show that some countries operate at high levels of international trade while other countries conduct their trade activities at low levels. The panel study states that different countries have different trade policies, which impact how they trade with others, how their economies function, and how they participate in global trade. Electricity consumption shows distinct differences between the studied countries because their economic growth, industrial production, and energy needs vary from one another. The descriptive statistics show that some economies consume more electricity because their industrial activities and economic growth move to higher levels, while other economies consume less electricity.

Table 1: ***Descriptive Statistics***

	GHG	ENT	RNE	POS	POP	GNI	FDI	TRO	ELC
Mean	219.56	1285.4	45.785	-0.3240	75.801	2.9216	0.1999	85.912	46.056
Median	60.504	187.11	44.259	-0.2586	32.164	2.4146	0.1448	86.300	43.140
Maximum	3426.3	27466.	100.00	1.0858	612.43	60.914	0.6622	607.20	99.954
Minimum	1.6180	0.0032	0.3000	-2.7291	0.5959	-58.20	0.0339	12.100	0.0000
Std. Dev.	538.49	3199.0	32.224	0.6026	125.97	5.3986	0.1336	42.269	33.533
Obs.	630	630	630	630	630	630	630	630	630

The correlation matrix results presented in Table 2 demonstrate how the analyzed variables show their relationships with each other. The correlation matrix provides an initial understanding of how dependent variable relationships function with explanatory variables and how independent

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variables connect. The results help researchers establish possible connections between environmental conditions, economic conditions, and institutional conditions that occur in the studied population. The research results show that greenhouse gas emissions have a direct relationship with environmental taxes, renewable energy use, political stability, and both population size and foreign direct investment. Countries with higher emissions levels receive higher environmental tax revenue, which results in greater foreign investment. The association may reflect the fact that economies with larger industrial and economic activities generate higher emissions while simultaneously adopting environmental fiscal measures to manage environmental pressures. The positive link with population shows that demographic growth leads to more environmental damage because people consume more energy and drive economic development. The results show that greenhouse gas emissions decrease when gross national income increases, trade openness rises, and electricity usage declines. The negative association suggests that economic development, together with increased trade activities, leads to improved production methods and better environmental management practices. The negative relationship with electricity consumption may reflect different energy efficiency levels between countries, or it may show how some nations transition to cleaner energy technologies. The data shows that political stability exists as a positive factor for environmental taxes because countries with better institutional stability tend to adopt environmental fiscal measures. Environmental regulations receive better development and enforcement support from stable political systems because they lead to the establishment of taxation systems that reduce environmental damage. The data show that political stability negatively affects both renewable energy use and population numbers because different governance systems affect both energy policy decisions and population growth.

The correlation results show that renewable energy consumption decreases when foreign direct investment increases and trade openness increases, and electricity consumption rises, but it increases with gross national income growth. The evidence indicates that countries with better economic conditions can better finance renewable energy projects, but economies that receive more foreign investment will continue to depend on conventional energy systems. Environmental taxes and foreign direct investment show a positive relationship with population because larger economies with larger populations receive more foreign direct investment, and they tend to implement wider environmental tax policies. Population growth creates governance difficulties, which affect energy demand patterns, according to the research, because it shows a negative relationship with

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political stability and electricity use in particular areas. Foreign direct investment demonstrates positive relationships with environmental taxes, political stability, population, trade openness, and electricity consumption. The research shows that countries that have higher economic openness, together with strong institutional frameworks and large market sizes, will attract more foreign investments. The findings show that foreign direct investment negatively affects both renewable energy consumption and gross national income growth because foreign investments prefer traditional industries, which require resources at high levels. Trade openness demonstrates positive connections to environmental taxes, political stability, foreign direct investment, and electricity use. The research shows that countries that participate in global markets will develop stronger economic ties, and their energy needs will increase. The evidence shows that trade openness reduces renewable energy consumption and gross national income growth, which indicates that trade-oriented economies have different structural characteristics. Electricity consumption establishes a positive relationship with political stability. Foreign direct investment. Trade openness shows the connection between energy demand and economic growth. The study shows that electricity consumption creates negative effects on greenhouse gas emissions, environmental taxes, and renewable energy consumption, and population and gross national income growth, which shows how energy consumption affects economic development and environmental results throughout different areas.

Table 2: ***Results of Correlation Matrix***

Variables	GHG	ENT	RNE	POS	POP	GNI_	FDI	TRO	ELC
GHG	1.0000								
ENT	0.7819*	1.0000							
RNE	0.1386*	-0.0108	1.0000						
POS	0.0356	0.0611	-0.1893*	1.0000					
POP	0.9027*	0.7865*	0.0864**	-0.1543*	1.0000				
GNI_	-0.0133	-0.0161	0.1086*	-0.1278*	0.0476	1.0000			
FDI	0.6277*	0.7297*	-0.3974*	0.1663*	0.6563*	-0.0992**	1.0000		

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TRO	-0.0238	0.0920**	-0.2140*	0.1221*	0.0118	-0.0717***	0.1258* 1.0000
ELC	-0.1478*	-0.0236	-0.8655*	0.0867**	-0.1081**	-0.0619	0.3058* 0.1945* 1.0000

*,**,*** indicate the significance level @ 1%, 5%, 10%, respectively.

The analysis of variable stationarity through unit root testing results is shown in Table 3, which displays the test outcomes. Panel data analysis requires stationarity testing because non-stationary data results in spurious regression output, which produces erroneous results. The research uses multiple panel unit root tests to confirm that the empirical estimation results are accurate and trustworthy. The study applies standard panel unit root tests to evaluate whether the variables maintain their stability throughout time or need changes for the upcoming econometric analysis. The research uses various tests, which enhance the strength of results by delivering dependable outcomes that demonstrate the dataset integration characteristics (Zhang et al. 2025; Ahmed et al. 2024). The results shown in Table 3 demonstrate that the variables exhibit different integration patterns. The statistical properties of some variables remain constant over time at their level form because they are stationary. The first difference is necessary for the permanent stationarity achievement of several variables at their level form. The panel dataset contains both level-stationary and first-difference stationary variables as demonstrated by this data pattern. All unit root tests applied throughout the study found evidence that confirmed the mixed stationarity pattern present in all examined variables. According to the results obtained through multiple tests, particular variables attain stationarity at the level form because their time series properties lack ongoing stochastic trends. The first difference of multiple variables makes them non-stationary at the level, while their stationary state emerges through this transformation. The transformation process establishes stationarity by eliminating potential trends while it maintains the series mean and variance throughout time, which fulfills the requirements for reliable econometric estimation. The mixed stationarity of variables directly influences the empirical modeling methodology that researchers will use to study their relationships. Conventional estimation methods, which demand all variables to achieve the same level of stationarity, become invalid when researchers work with variables integrated at different orders. The application of mixed integration orders requires econometric techniques that will deliver accurate and precise estimation results. The unit root test results establish the statistical foundation that will guide the

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selection of panel estimation methods that will be used in the next analysis phase.

Table 3: ***Results of Unit Root Test***

Variables	At Level			
	LLC	**IPS**	**ADF**	**PP**
GHG	-3.75459*	-3.24104*	91.9789*	76.4493*
ENT	0.82712	4.03356	17.3675	14.1025
RNE	-3.21448*	-1.57258***	59.2235**	56.0940***
POS	-0.81952	-0.57542	43.979	44.4832
POP	-0.62271	4.94332	39.3882	100.249*
GNI	-18.6403*	-17.7282*	279.660*	339.547*
FDI	0.37102	0.02916	54.1087***	45.3973
TRO	1.62939	4.49439	31.7293	32.2109
ELE	-0.95476	-0.52953	54.8473***	58.0795***
First Difference				
GHG	-18.2285*	-18.3828*	356.401*	468.552*
ENT	-20.1484*	-18.9935*	353.139*	453.162*
RNE	-23.0675*	-22.1820*	424.100*	469.420*
POS	-21.7966*	-20.5602*	389.762*	423.497*
POP	-1.46632***	-5.03198*	121.183*	111.613*
GNI	-22.2852*	-27.4711*	512.982*	515.210*
FDI	-18.9840*	-20.0091*	374.866*	447.728*
TRO	-17.3905*	-17.9757*	361.912*	406.309*
ELE	-26.0732*	-23.8800*	408.474*	447.264*

*,**,*** indicate the significance level @ 1%, 5%, 10%, respectively.

The Breusch-Pagan Lagrange Multiplier test results are displayed in Table 4, which tests the validity of the panel estimation method. This test determines whether panel effects exist in the dataset, while it also evaluates the validity of the pooled ordinary least squares model for conducting empirical research. The test enables researchers to detect cross-sectional and time-specific patterns that exist in panel data, which helps them decide whether to include individual heterogeneity in their econometric models. The findings show that cross-sectional effects reach a level of statistical significance, which indicates that unobserved heterogeneity exists among the countries that make up the sample group. The economic structures, institutional environments, and environmental conditions of the selected economies create cross-sectional units that display different variable behavior. The results confirm the existence of time-related effects because the panel dataset demonstrates different variations that occur during different time intervals. The time-specific differences may arise due to global economic fluctuations, changes in

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environmental policies, technological developments, or other macroeconomic dynamics that influence the variables over time. The existence of temporal variation demonstrates that the dataset includes time-related heterogeneity, which a pooled estimation framework cannot effectively capture.

Table 4: ***Results of Bruesch-Pagan Test***

	Cross-section	Time	Both
Breusch-Pagan	2945.964*	3.8313**	2949.795*
P-value	(0.0000)	(0.0503)	(0.0000)

*,**,*** indicate the significance level @ 1%, 5%, 10%, respectively.

The Hausman test results shown in Table 5 identify the better model between fixed effects and random effects methods, which are used for panel data analysis. This test is widely applied in empirical research to evaluate whether the individual effects are correlated with the explanatory variables. Previous studies have demonstrated that this test serves a critical function in choosing the correct panel estimation method (Bashir et al. 2025; Ozmen et al. 2025; Nguyen et al. 2025; Xuan et al. 2025). The Hausman test operates on two opposing hypotheses, which it uses as its foundation. The null hypothesis assumes that the random effects model is appropriate for panel data estimation, implying that individual-specific effects are not correlated with the explanatory variables. The alternative hypothesis establishes the fixed effects model's suitability because individual effects display a statistical connection with independent variables. The model selection process depends on the chi-square statistic because it determines which model to choose through its statistical significance. The fixed effects model should be used when the chi-square statistic reaches statistical significance at the established level because the null hypothesis must be rejected. The random effects model becomes the better choice when the chi-square statistic fails to demonstrate statistical significance.

Table 5: ***Results of Hausman Tests***

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	477.0314	9	0.0000

*,**,*** indicate the significance level @ 1%, 5%, 10%, respectively.

Table 1 displays the ultimate research results that were obtained through static and dynamic estimation methods. The analysis employs the fixed effects model as the static estimation approach and the generalized method of moments as the dynamic estimation technique. The two methods enable researchers to study greenhouse gas emission determinants more thoroughly because they reveal present-day effects and show how relationships evolve throughout time. The results show that environmental taxes create a

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substantial reduction in greenhouse gas emissions through both static and dynamic estimation methods. The finding demonstrates that environmental fiscal instruments function as essential tools that help decrease environmental degradation because they discourage pollution-intensive activities while promoting cleaner production practices. The study demonstrates how environmental taxation provides economic incentives through policy mechanisms that lead to better sustainability results in environmental protection and improved ecological health across the studied economies, which Putri et al. (2025) confirmed. The two estimation methods show that renewable energy consumption correlates positively and significantly with greenhouse gas emissions. The result demonstrates that increased renewable energy usage leads to higher emissions within the studied sample. The initial stages of energy transformation create a situation where renewable energy systems start to replace traditional energy sources at their most fundamental level. The process of renewable energy development in developing economies operates together with fossil fuel dependency, which results in increased energy consumption and emissions during the period of transition. The relationship exists between political stability and greenhouse gas emissions according to both fixed effects and dynamic estimation methods in this study. Institutional stability in countries leads to greater economic activity and industrial growth, which results in higher emissions, according to the study. Political stability enhances governance and policy execution processes, yet it brings about economic advancement, which leads to greater industrial expansion that results in environmental destruction.

The fixed effects estimation shows that environmental taxes negatively interact with renewable energy consumption through their moderating effect. The result shows that environmental taxes reduce the strength of the connection between renewable energy usage and greenhouse gas emissions. Environmental fiscal policies that become stronger will decrease all environmental damage that comes from developing energy systems while enabling cleaner energy transitions to occur. The research found that gross national income increases greenhouse gas emissions in both estimation methods. Static estimation fails to show statistical significance for this relationship, but dynamic estimation establishes its significance. People will create environmental pressure through economic growth because higher income levels drive greater production and consumption and energy needs. The pattern seen in electricity generation from fossil fuels shows a direct relationship with emissions, which becomes statistically significant through dynamic estimation. The evidence shows that electricity generation from fossil fuels continues to be the main factor that causes environmental damage

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through dynamic effects, according to the study by Humbatova et al. (2025). Population growth has a positive effect on greenhouse gas emissions, which researchers found to be statistically significant through both estimation methods. Demographic growth leads to increased energy requirements and higher industrial production, and increased transportation activities, which all result in more emissions. Larger populations increase environmental resource usage and energy system demand, which creates bigger environmental problems for society. The financial development index demonstrates strong negative effects on greenhouse gas emissions through both estimation methods. The finding shows that more developed financial systems will encourage businesses to invest in green technologies, energy-efficient infrastructure, and sustainable production methods. Financial development will enhance environmental conditions through its function, which enables access to green financing and sustainable investment opportunities. Trade openness shows a direct link to greenhouse gas emissions through dynamic estimation, while the fixed effects model shows no statistical impact from trade openness. The result shows that greater market access will lead to higher industrial output and increased trade activities, which will have environmental effects. Static estimation shows no statistical significance for trade openness and emissions, which indicates that the emissions patterns will depend on the dynamic economic changes and structural shifts that occur in the economy. The environmental consequences of trade integration have received recognition from Barkat et al. (2025) through their research work.

Table 6: ***Final Outcomes***

Variable	**Static Estimation Fixed Effect Model**		**Dynamic Estimation GMM**	
	Coefficient	**t-stat**	**Coefficient**	**t-stat**
GHG(-)	-	-	0.6788*	128.8536
ENT	-0.01253*	0.004108	-0.0085*	-9.659135
RNE	0.41278*	0.242429	0.2509*	2.317059
POS	12.3990*	5.525818	4.3228*	2.993694
GNI	0.64166	0.439101	0.2195*	2.577731
POP	0.83403*	0.200426	0.4298*	2.822363
FDI	-98.5612**	58.49008	-52.789*	-8.509945
TRO	-0.000130	0.064618	-0.0220	-0.137413
ELC	0.104944	0.181423	0.2482*	3.604489
MOD	-0.0000	0.000052	-	-
C	172.8824*	24.99439	-	-

*,**,*** indicate the significance level @ 1%, 5%, 10%, respectively.

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This study examines how greenhouse gas emissions interact with fundamental social, economic, and governance-based macroeconomic elements through their relationship with environmental taxes, renewable energy use, and political stability. The analysis uses static and dynamic relationships between macroeconomic variables to assess their environmental impact through their direct environmental effects. The static estimation uses ordinary least squares with fixed effects to estimate model parameters while controlling for unobserved differences between individual cross-sectional units. The study uses the generalized method of moments to examine dynamic relationships because this method handles two issues. The empirical findings reveal consistent results across both static and dynamic estimations regarding the role of environmental taxes. Environmental taxes, which produce disruptive effects on greenhouse gas emissions, represent an important element that scientist use to study the environmental impacts of their research work. The research shows that environmental taxation functions as an essential policy tool that enables nations to reach their sustainable environmental targets, which confirms the findings from Putri et al. (2025) and Zhang et al. (2025). The results show that renewable energy usage creates unpredictable results that scientists did not anticipate. Scientists found that renewable energy usage shows a direct link with increased greenhouse gas emissions. The finding contradicts the common belief which states that renewable energy helps protect the environment because Zhang et al. (2025) found identical results. The explanation for this situation stems from the fact that developing countries continue to depend on traditional energy sources while they try to adopt renewable energy technologies. The process of expanding renewable energy resources will take place together with rising energy consumption and ongoing fossil fuel use, which will result in increased emissions during the transitional period. The existing literature shows that renewable energy usage creates environmental benefits through more than half of its studies, which confirm these findings (Sumaira, 2020; Altaf & Shahzad, 2021; Gupta & Kumar, 2022; Mehdi et al., 2025; Bashir et al., 2025; Xuan et al., 2025; Ali et al., 2025; Wahyudi et al., 2025; Obwori et al., 2025; Batool et al., 2025; Wiredu et al., 2025; Longston et al., 2025).

The research investigates how environmental taxes function as a moderating factor that affects the relationship between renewable energy use and greenhouse gas emissions. The research findings show that environmental taxes do not show any statistical significance as a moderating factor. The research shows that environmental taxes do not change how renewable energy consumption affects greenhouse gas emissions in the chosen countries. The study shows that environmental taxes do not have a

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major moderating effect because it matches what earlier studies found about the weak moderating capacity of environmental taxation in similar research frameworks (Mustafa et al. 2025; Arshad et al., 2025). The research demonstrates that political stability creates a direct connection that leads to increased greenhouse gas emissions. The research shows that countries with stable political conditions create more greenhouse gas emissions than countries with unstable political conditions. The reason for this phenomenon exists because stable political systems enable economic development, which leads to industrial progress and infrastructure development, resulting in higher energy requirements and environmental damage. The research shows that people in stable political systems will choose to grow the economy instead of protecting the environment. The observation matches the results that Audi et al. (2025) reported. The research shows that economic growth creates positive environmental effects through its two main pathways. The research shows that rising economic activity and industrial development result in increased energy consumption, which causes environmental pollution. The process of economic growth leads to higher resource consumption, more transportation activities, and increased industrial production, which causes a rise in emissions. The results show that developing economies will lead to serious environmental damage because they do not have proper environmental regulations and sustainable environmental technologies at their disposal. These findings match the empirical evidence from earlier studies (Methmini et al. 2025; Anus et al., 2025; Sulehri et al. 2024; Audi et al. 2025; Dang et al. 2025; Elhassan 2025; Humbatova et al. 2025; Saglam et al. 2025; Ali et al., 2025).

5. Conclusions and Policy Implications

The research aimed to assess how environmental taxes, renewable energy usage, political stability, and economic development affect environmental sustainability in developing nations. The study focused on identifying the factors that determine greenhouse gas emissions because these emissions serve as a critical measurement of environmental sustainability. The researchers used panel data from 21 developing countries, which included data from 1994 to 2023. The study used static and dynamic estimation methods to obtain reliable and strong empirical results. The researchers used static analysis through a fixed effects model, while dynamic estimation was conducted through the generalized method of moments to handle endogeneity and display greenhouse gas emissions dynamic patterns. The study used environmental taxes and renewable energy production, political stability, and various control variables, which included population and gross national income growth, financial development, trade openness, and electricity

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generation through fossil fuels, to create a complete picture of the elements that affect environmental sustainability in developing nations. The empirical findings reveal several important relationships among the variables under investigation. The results show that environmental taxes have a statistically significant negative effect on greenhouse gas emissions in both the static and dynamic estimations. The environmental taxation system helps to achieve better environmental sustainability results because it reduces pollution through taxes while promoting eco-friendly practices among businesses. The findings support the view that environmental taxes function as effective emission reduction tools that drive sustainable development. The study found that renewable energy consumption results in higher greenhouse gas emissions based on the research findings. The current renewable energy transition in developing countries has reached a phase where renewable energy expansion occurs together with ongoing fossil fuel energy dependence. Political stability leads to higher greenhouse gas emissions because politically stable economies experience increased industrial activity and economic growth, which creates environmental damage when environmental protections remain weak. The traditional development pattern shows that economic growth leads to higher emissions because economic development causes people to use more energy, which harms the environment.

The study results indicate that there are multiple policy recommendations that can be derived from the research findings. The developing nations need to develop their environmental tax systems by establishing comprehensive environmental tax regulations, which should function as part of their environmental and fiscal tax systems. The design of environmental taxes needs to create a financial disincentive against carbon-heavy operations while simultaneously producing government revenue, which will fund sustainable development projects. The current renewable energy transition needs to accelerate through government investments in renewable energy infrastructure, technological progress, and regulatory systems that enable this development. The elimination of taxes and import duties on renewable energy equipment creates a barrier that customers need to overcome to access and adopt clean energy technologies. The existing economic development methods need to change because they presently support unsustainable industrial growth, which leads to environmental damage, through their promotion of environmentally friendly industrial growth and eco-friendly production methods, and their implementation of more rigorous environmental standards. The political stability of the country requires institutional capacity development and environmental governance system development to enable sustainable development through effective

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political systems, because political stability creates environmental problems when it does not have institutional capacity and environmental governance systems. The combination of fiscal reforms, energy transition policies, and environmental regulations will enable developing countries to achieve long-term economic development while they protect their environmental resources. The research study made a valuable contribution to science, but it contains one essential flaw, which arises from the unavailability of research data about developing nations. The research barrier eliminates access for developing nations, which results in the exclusion of most economies from the obtained suggestions. The environmental tax system operates as an intricate system that limits research activities because of its multiple components. The study recommends environmental taxation as a method to safeguard the environment because taxes raise production expenses, but it creates a negative impact on consumer spending power, which diminishes life quality. The current research study creates several possibilities for future investigation because researchers can examine the environmental tax impacts that affect different sectors individually to establish new policies that will benefit those areas. The role of fossil fuel taxes in promoting environmental sustainability needs to be evaluated through separate assessments of these taxes.

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