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The Role of Financial Development and Capital Formation in Promoting Renewable Energy in Bangladesh

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Abstract

Bangladesh, rich in various resources, stands at a pivotal point where the sustainable use of renewable energy can be significantly increased. This study focuses on analyzing the impact of financial development (FD), foreign direct investment (FDI), economic growth, carbon dioxide emissions, and capital formation on renewable energy consumption in Bangladesh. Using time series data from 1991 to 2020 and employing the ARDL bounds testing approach to cointegration, the study provides a comprehensive analysis of these factors. The results reveal a long-term positive relationship between financial development and capital formation with renewable energy consumption, while FDI and economic growth do not significantly influence renewable energy use in the long run. Conversely, carbon dioxide emissions negatively impact renewable energy consumption in both the short and long term. The short-term analysis further indicates a negative relationship between capital formation, FDI, and renewable energy consumption, but financial development shows a positive and significant impact. These findings emphasize the need to enhance our understanding of the role of capital formation and financial development in promoting renewable energy, not just in Bangladesh but also in other developing and developed nations. To curb environmental damage and increase the use of renewable energy, eliminating fossil fuel subsidies and introducing a carbon tax on non-renewable energy use is crucial. Furthermore, Bangladeshi policymakers should advocate for green financing and allocate more funds to clean renewable energy projects, laying the groundwork for a robust renewable energy economy.

Keywords: *Financial development, Environmental degradation, Renewable energy, ARDL, Bangladesh*

1. Introduction

Energy use is seen as a key factor in a country's economic development and progress. The Sustainable Development Goals (SDG) progress report 2020 identified energy as an enabler of sustainable development, which is to ensure universal access to energy (United Nations, 2020). The report does, though, also draw attention to the problem of global energy security. The International Institute of Sustainable Development's evaluation study on the energy transition stresses the problems with energy security brought on by a reliance on fossil fuel-based energy sources and the ensuing demand for renewable energy solutions (IISD, 2019).

The importance of renewable energy as a significant tool for policy is being acknowledged as the globe experiences an energy transition. A suitable financial structure is required for this policy realignment focused on renewable energy. In order to achieve SDG 7's goals, UNDP estimates that yearly investments in renewable energy projects must range from $442 to 650 billion dollars, while increasing energy efficiency will cost $560 billion and achieving inclusive electrification will cost $52 billion (UNDP, 2021). However, the global energy transformation is being significantly hampered by the existence of an annual funding shortfall. The risk involved with financing renewable project is one of the main causes of the occurrence of this gap. Interventions in the form of public finance through local financial institutions and external financing are necessary for minimizing this risk (UNDP, 2019).

Investment in renewable energy projects remains behind expectations, despite the fact that the costs of its research and deployment are falling. The report of International Renewable Energy Agency's 2016 (IRENA), Renewable Energy Investment Assessment Report demonstrates that risks connected to renewable energy projects disrupt renewable energy finance. Political and legislative risks, transmission loss risk, currency exposure risk, refinancing risk, and liquidity risk are a few examples of these dangers. The availability of these hazards is limiting private sector investments in the production of renewable energy. Policymakers must step in to mitigate these risks and reaffirm investor confidence. United States Agency for International Development's (USAID) Scaling Up Renewable Energy (SURE) program worked with 61 institutions in Bangladesh to address clean energy concerns, produced four white papers that assisted the development and implementation of renewable energy projects, and taught 153 individuals in the field. To improve development outcomes, USAID and SURE created trainings and tools to assist regulators, power utilities, and policymakers in being more inventive, strategic, and successful. SURE collaborated with regulators and the Bangladesh Ministry of Power, Energy and Mineral Resources to establish the conditions necessary for the success of renewable energy. Governments in Bangladesh were able to encourage the integration of variable renewable energy and stimulate private investment thanks to the adoption of laws and regulations. Bangladesh's shift to clean energy was accelerated by USAID under the SURE program. With SURE's assistance, the government of Bangladesh is better able to cut greenhouse gas emissions and benefit from renewable energy's social and economic advantages, USAID, 2022.

The ratio of the gross inland consumption of energy from renewable sources to the total (primary) gross inland energy consumption determined for a calendar year is known as the renewable energy consumption. It is calculated as the total of the gross domestic renewable energy consumption, IEA, 2013. Energy obtained from natural resources that are renewed more quickly than they are used up is referred to as renewable energy. Such sources that are constantly replenished include the sun and the wind, for instance. There are numerous renewable energy sources all around us. On the other hand, non-renewable fossil fuels like coal, oil, and gas require hundreds of millions of years to create. When fossil fuels are used to create energy, they emit dangerous greenhouse gases like carbon dioxide. There are few common sources of renewable energy such as: solar energy, Geothermal energy, wind energy, hydropower, ocean energy, bioenergy (biomass), United Nations. The most common renewable energy sources in Bangladesh at the moment are hydroelectric power, biogas, solar, and wind energy.

The only power plant in the nation that produces 230 MW of electrical energy is the Karnaphuli Hydro Power Station. One prospective energy sector for the nation is renewable energy. Bangladesh is among the top 20 economies in terms of GDP growth, which necessitates rising energy consumption, according to the World Bank. The country needs to use more energy while reducing CO_2 emissions in order to meet the SDGs (sustainable development goals) of 2030 and graduate as an advanced nation by 2041. The nation is also the most susceptible to climate change. In this situation, renewable energy may play a crucial role in both sustaining economic growth and preserving the environment. The GDP, non-renewable energy, and CO_2 emission all have statistically significant positive relationships, according to the Bangladesh Institute of Governance and Management (BIGM). Renewable energy, however, has a bad relationship. It has been determined through the application of several econometric estimating techniques that a 1% increase in the use of non-renewable energy will, on average, result in CO_2 emissions rising by more than 0.75%. The Ministry of Power, Energy and Mineral Resources released the policy strategies in 2008, which marked the beginning of Bangladesh's relatively new renewable energy policy. The nation has made slow but consistent improvement up to 2022. Natural issues like limited available land and low solar and wind potential are to blame for the delayed pace. Obstacles include lengthy land acquisition processes, hefty equipment costs, the potential for cancellation, and delays in project clearance. The use of renewable energy also has a high initial cost and a slow rate of utilization. Therefore, the need to encourage the government to use renewable energy sources. Furthermore, in order to assure efficient energy production and exploitation, the government must first invest more in modern equipment. To ensure environmental sustainability, everyone should adapt to alternate energy consumption practices, which could act as a catalyst for exploring uncharted waters. As a result, further research into energy parameters can establish the standard for the sustainability of energy consumption that necessitates international investment, Sharmin, 2022.

Bangladesh still has a considerable amount of opportunity to cut CO2 emissions by employing renewable energy instead of non-renewable energy. Figure.1 demonstrates that over the past 30 years, Bangladesh has not been able to raise the proportion of renewable energy in total energy. Bangladesh still lacks the proportion of renewable energy it had in the 1990s. Because this number demonstrates unequivocally that the consumption of renewable energy falls sharply. This condition may be influenced by a number of Bangladesh's internal and external issues. Due to Bangladesh's heavy reliance on non-renewable energy sources, the environment is being harmed and investments in renewable energy are being put off. In this circumstance, REC is essential for protecting the environment and achieving long-term economic growth. In this sense, this study looks at how economic growth, foreign direct investment, carbon dioxide emissions, capital formation based on renewable energy projects, and financial development all affect the consumption of renewable energy in emerging nations like Bangladesh between 1991 and 2020. The majority of earlier research avoided the variable of capital formation in favor of focusing on the effects of financial development, carbon dioxide emissions, economic growth, and foreign direct investment on the consumption of renewable energy. Thus, this study will use an ARDL technique to investigate how foreign direct investment, financial development, economic growth, and carbon dioxide emissions affect the use of renewable energy in Bangladesh.

The ARDL bound testing approach to cointegration will be used to study the long- and short-run interactions among economic growth, FDI, financial development, carbon dioxide emission, capital formation, and use of renewable energy during the period from 1991 to 2020.

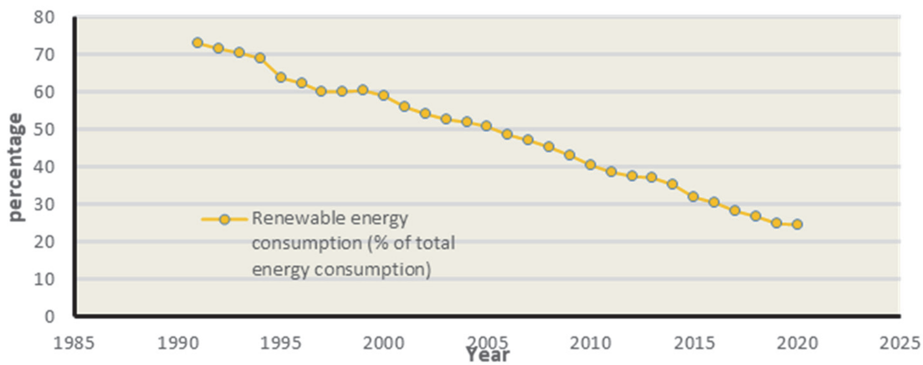

Figure 1: Renewable energy consumption (% of total final energy consumption) over the period from 1991 to 2020. (World Development Indicator, 2022).

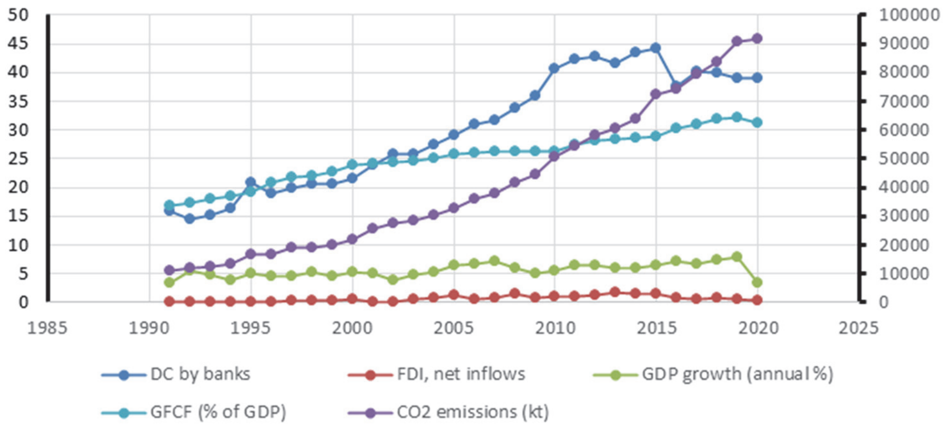

Figure 2: Trend of five indicators of renewable energy

The current study attempts to add to the corpus of literature in a number of ways. According to the best understanding of this study, this study will first act as a revolutionary investigation of how the study's variables affect the use of renewable energy. In order to investigate the impact of these variables on the consumption of renewable energy within the context of environmental rules and constraints on emerging economies like Bangladesh, we have introduced the important variables for a wider perspective. This relationship among the fields of energy, economy and environment has not been considered in previous studies. The addition of new variables will probably aid in reducing the bias caused by the omitted variable. And policymakers can create energy policies to enhance energy security and environmental quality by looking into the relationship between a few specific variables and the consumption of renewable energy.

The ARDL bound testing approach to cointegration is used in this study to analyze the existence of the short-run and long-run equilibrium relationship. This approach helps to avoid the presence of serial correlation, heteroscedasticity, specification error, abnormality, and helps to forecast the stable relationship in the future through the CUSUM and CUSUM square test.

By utilizing cutting-edge time series data methodologies, the current study provides a complete assessment of the dynamic association between CO2 emissions, GDP, capital formation, foreign direct investment, financial development, and renewable energy consumption for developing economies. It's generally accepted that rising economic expansion results in rising energy consumption. On the one hand, emerging nations are under strain to increase their renewable energy consumption if they do not have sufficient capital for renewable energy projects. On the other hand, the nation is under intense international pressure to cut their CO2 emissions. In this regard, the current study aims to close the existing research gap by utilizing alternative empirical methodologies. For example, it will attempt to demonstrate the different relationship between capital formation and the demand for renewable energy as well as how to increase renewable energy consumption by lowering carbon dioxide with the aid of a discussion of renewable energy policy that is likely to be helpful to the policymakers of the study country.

Previous studies did not investigate the generation of capital which is based on renewable energy project. Such empirical modeling, which mainly deals with the issue of bias caused by omitted variables, is frequently referred to as the "conventional approach." But this study uses the variable of capital formation which is based on renewable energy project. According to capital formation, Bangladesh will be able to develop new green jobs because the building of different infrastructure based on renewable energy project will be improved in order to meet rising energy demands, which reduces unemployment and shifts to renewable energy sources. because the consumption of non-renewable energy sources is very costly and unhealthy for both people and environment. And, thus the country will be able to use less costly consumption sources and the consumption of renewable energy will increase than before.

However, the nation has made a commitment to renewable energy in response to international pressure and a desire to address environmental challenges. The results of the current study are therefore likely to provide useful insights into the state of the economy and the favorable climate that fosters demand for and a preference for renewable energy sources.

2. Research Gap

This succinct assessment of the literature reveals that research have generally pinpointed different factors that influence the production and consumption of renewable energy. There is a policy gap in the scholarly literature about risk mitigation for renewable energy project funding, unfortunately. Even though studies have examined the connections between financial development, foreign direct investment, economic growth, and the use of renewable energy sources, questions about how these factors relate to risk management still exist. And none of those studies specifically looked into the effects of capital formation based on the use of renewable energy. This study addresses this research gap by recommending capital formation based on renewable energy project by isolating the long-run and short-run effects on renewable energy consumption and this study also investigate the environmental degradation impact on renewable energy consumption. This study addresses this research gap by recommending capital formation based on renewable energy project by isolating the long-run and short-run effects on renewable energy consumption and this study also investigate the impact of environmental degradation on renewable energy consumption. In a few research, it was discovered that there is a weak negative correlation between carbon dioxide emissions and the demand for renewable energy. But by utilizing the ARDL framework to demonstrate the short- and long-term effects of carbon dioxide emissions on the use of renewable energy in Bangladesh, this study has filled the knowledge vacuum.

3. Objective of the Study

Bangladesh is a resource-rich but impoverished developing nation. However, these assets are being wasted. In this nation, the consumption of non-renewable energy sources like fossil fuels and natural gas is rising daily, which contributes to environmental damage like the release of greenhouse gases. The environment is not well-served by carbon dioxide emissions. The growth of the financial sector, the creation of capital based on renewable energy projects, and foreign direct investment all contribute to an increase in the use of renewable energy. To increase the use of renewable energy in Bangladesh, the government must take immediate action. This includes granting domestic credit to the private sector which is a component of financial development, raising public awareness, developing methods to reduce carbon dioxide emissions, and raising capital to fund renewable energy projects. The ARDL bound testing approach to cointegration will be used to study the long- and short-run interactions among economic growth, FDI, financial development, carbon dioxide emission, capital formation, and use of renewable energy during the period from 1991 to 2020.

In particular, the study will use an ARDL technique to investigate how foreign direct investment, financial development, economic growth, and carbon dioxide emissions affect the use of renewable energy in Bangladesh.

4. Relevant Literature Review

4.1 Financial development and Renewable energy consumption

Successful financial development encourages renewable energy initiatives, which in turn lowers the need for fuel energy and promotes the economy to consume renewable resources. Effective financial development will also be able to fund energy-related research and development that can aid in the production of renewable energy. According to the findings of some earlier studies, financial development has a favorable effect on renewable energy in this regard which is consistent with this hypothesis of the research study. For instance, it was noted that usage of renewable energy rises together with financial development, Riti et al., 2017. Wu & Broadstock in 2015 provided evidence of the beneficial effects of financial development on the use of renewable energy. Zeren & Mustafa, 2014 also demonstrated how financial development and energy use are mutually beneficial. They discovered a two-way causal relationship between the use of renewable energy and financial progress, Mulali and Sab. The usage of renewable energy increases as a result of financial development, according to additional information from Japan Rafindadi and Ozturk, 2016. According to a different study, the consumption of renewable energy and financial development are both causally related, Anton, & Nucu, 2020. A recent study examined the impact of financial transparency on investments in renewable energy. According to the empirical findings, financial openness has a long-term beneficial impact for renewable energy, Koengkan et al., 2020. The authors also came to the conclusion that financial development encourages investments in renewable energy, which increases demand for renewable energy, Kim & Park, 2016, Lin et al., 2016. The findings of earlier studies, however, demonstrated that financial progress does not promote the use of fossil fuels. This suggests that the demand for renewable energy would rise if the direction of financial development changed to investment in renewable energy, such as Jalil, 2011, Tamazian, 2010, Claessens, 2007, Farhani, 2017, Chang, 2015, Vadlamannati, 2009. The second line of research from earlier studies contends that financial development encourages the use of fossil fuels. This suggests that investment in renewable energy has been overlooked in favor of fossil fuels due to low investment costs and financial sector expansion, which has decreased demand for renewable energy as indicated by studies of Riti, 2017, Omri, 2014, Sadrosky, 2010, Shahbaz, 2012, Coban, 2013, Sadorsky, 2011, Islam et al., 2013, Aslan et al., 2014, Zhang et. Al., 2011, Komal, 2015, Rashid, 2016. The relationship between the growth of the financial markets and energy use has long been recognized in the literature on energy economics. A large increase in productivity can be stimulated by an economic system's efficient, sufficient, and sustainable energy use, according to the empirical findings of Sardorsky, 2010, 2011, 2011. In their empirical contributions, Shahbaz et al., 2013 added to the body of knowledge about the development of financial markets. They showed that as financial markets develop, it becomes possible to obtain loans for the purchase of machinery and other forms of productive equipment. This will increase productivity, which will increase demand for energy. Leading studies by Rafindadi and Yusuf, Al-mulali, et al., Al-Mulali, Al-mulali and Ozturk, Wolde-Rufael and Menyah, Wolde-Rufael, Asafu-Adjaye, Mahadevan, and Asafu Adjaye, Rafindadi, 2016, Lin, Shiu and Lam, Yuan et al. and Adom et al., Rafindadi, Rafindadi and Usman also established similar research outcomes. Dumrul (2018) conducted research on the connection between Turkey's financial development and energy use, finding a favorable correlation between the two. According to Saud et al. (2018), financial development encourages energy usage for the next 11 countries. This section focuses on research that evaluated the relationship between economic growth and the use of renewable energy. Brunnschweiler, 2010, one of the first studies to look at this phenomenon, using a sample of 119 non-OECD countries between 1980 and 2006 and found a strong and positive correlation between both variables. Time series stability was confirmed using the panel unit test, and a heterogeneous dynamic panel was built using the ARDL analytical methodology to test panel data. The findings show that a significant factor in lowering the utilization of renewable energy is financial expansion. Financial development reduces renewable energy consumption which is investigated by the Khan et al., 2020.

4.2 Carbon dioxide emission and Renewable energy consumption

The study's hypothesis is that by lowering carbon dioxide emissions, renewable energy consumption will rise, supporting the author's Paramati et al., 2016 findings. Several authors such as Rafique, 2021; Menegaki, 2011; Salim, 2012, Sbia et al., 2014, found that carbon dioxide emission carry significantly negative impact on the demand for renewable energy. Irandoust, 2016 looked into the Nordic nations' links between carbon dioxide emissions and renewable energy sources. According to the results of a vector autoregressive model, the direction of causality from the use of renewable energy to carbon emissions is unidirectional in Denmark and Finland but bidirectional in Sweden and Norway. The panel data for the years 1998 to 2018 are used by Assi et al. in 2021. Time series stability was confirmed using the panel unit test, and a heterogeneous dynamic panel was built using the ARDL analytical methodology to test panel data. They showed that environmental pollution has a negative correlation with renewable energy consumption. Turkey is one of the most energy-intensive nations with one of the fastest rates of growth in greenhouse gas emissions among emerging economies between 1985 and 2016, according to the World Bank, 2021. Turkey still has a lot of room to cut CO2 emissions by consuming renewable energy instead of non-renewable energy. Sustainability in energy is related to less CO2 emissions, a cleaner environment, and an effective energy system, claim Bhattacharya et al., 2016. According to Lu (2017), CO2 emissions put significant pressure on the use of renewable energy, which causes countries to transition to renewable energy sources. The demand for renewable energy may be hampered by CO2 emissions. Clean energy is provided by renewable energy sources, which can lower CO2 emissions, Omri and Nguyen, 2014.

4.3 Capital formation and Renewable energy consumption

The hypothesis of the study is that capital formation increases renewable energy consumption. Rafindadi & Mika'Ilu,2019, Paramati et al., 2017 look at how domestic and foreign capital has affected the development of sustainable energy in the EU, G20, and OECD countries between 1993 to 2012. They discover that both local and foreign capitals support the use of clean energy in the sample countries utilizing the panel ARDL and Westerlund cointegration tests.

Finally, we can point out that not many research from the earlier body of knowledge have addressed the connection between capital formation and renewable energy. However, none of the previous studies used capital formation to look into the effects on overall or renewable energy consumption. As a result, the current analysis takes into account how capital formation from renewable energy projects influences the growth of consumption of renewable energy. Additionally, earlier studies mainly used a classical econometric approach like capital. The impact of this variable on the consumption of renewable energy is however estimated in the current study. We anticipate that our estimations will yield trustworthy results with potential policy consequences that are useful and positive.

4.4 Foreign direct investment and Renewable energy consumption

The hypothesis of the study is that Foreign direct investment increases renewable energy consumption. Lin et al., 2016 found that foreign direct investment decreases renewable energy consumption in China. While taking into account economic development as a control variable in the energy demand function, Mielnik and Goldemberg's study from 2002 studied the relationship between foreign direct investment and energy consumption. Twenty emerging economies were included in the sample for a brief period beginning in 1987 and ending in 1998. The empirical findings demonstrated a correlation between a rise in foreign direct investment and a decrease in energy intensity. However, Antweiler et al., 2001 produced contradicting findings that suggested foreign direct investment affects the host country's domestic production but had no impact on the energy intensity. Cole, 2006 asserted that the influence of FDI on energy consumption varies among nations because to differences in economic environments, economic structures, stages of development, and energy prices. These conclusions are less extreme and more sensible than Cole's earlier claims. Hubler, 2009 examined, using a framework of general equilibrium, the effects of foreign direct investment and the trading of energy-saving technologies on energy consumption. He made it clear that foreign direct investment may be used as a motivator to adopt energy-saving technology and reduce energy use. Using data from G-20 nations, Lee, 2013 examined how foreign direct investment and production growth affected energy consumption and clean energy demand. The author discovered that the series are cointegrated and that adoption of renewable energy is boosted by FDI. Using data from G-20 countries, Lee, 2013 has investigated the complex relationship between foreign direct investment, energy consumption, clean energy use, CO_2 emissions, and economic growth. According to the empirical analysis, foreign direct investment increases economic growth while lowering energy intensity through the use of energy-efficient machinery. FDI, respectively, on clean energy consumption and showed that FDI and stock market expansion both play a big part in increasing the usage of renewable energy. Similar to this, the evolution of the financial system provides governments and businesses with less expensive funding options for initiatives that promote the use of renewable energy sources. Doytch and Narayan, 2016 looked at the effect of FDI on the consumption of renewable energy for a panel of 74 nations. Their findings suggest that foreign direct investment increases demand for renewable energy, which lowers non-renewable energy use in the industrial sector. According to Marton and Hagert, 2017, who used the fixed effect model, foreign direct investment decreases renewable energy consumption in the short term but raises the share of renewable energy consumption in the long term. The effect of foreign direct investment on the production of renewable energy was recently evaluated by Kilicarslan, 2019 for a panel of six different countries, namely Brazil, Russia, India, China, South Africa, and Turkey. They used the Pedroni panel cointegration approach and the panel ARDL approach to find the long-term relationship between the variables. Their empirical findings indicated that foreign direct investment has a detrimental impact on the utilization of renewable energy. Using the GMM approach, Yahya and Rafiq, 2019 discovered that greenfield and brownfield investments have a favorable impact on the consumption of renewable energy. The impact of trade openness and foreign direct investment on the usage of clean energy from 1985 to 2017 was studied by Yilanci et al. in 2019. Their findings indicated that while foreign direct investment had a strong beneficial influence on clean energy consumption in Russia, China, and South Africa. They also discovered a one-way causal link between China's usage of clean energy and foreign direct investment. In Bangladesh from 1980 to 2015, Khandker et al., 2018 used the Granger causality test and Johansen's cointegration. Foreign direct investment and renewable energy consumption are long-run cointegrated, according to the Johansen cointegration test, and the Granger causality test demonstrates that there is a bidirectional causal relationship between the two variables of concern. There was no short-term causation discovered using the Vector Error Correction Model (VECM) between the variables. A negative correlation between FDI and energy intensity was discovered by Mielnik and Goldemberg in 2002.

4.5 Economic growth and Renewable energy consumption

The hypothesis of the study is that Economic growth increases renewable energy consumption. Gozgor et al., 2020 found that the usage of renewable energy increases through the higher economic growth in the OECD countries. One study employing the ARDL method found that although there is a negligible short-term association between renewable energy and economic growth in Nigeria, there is a negative long-term relationship, Maji, 2015. Through a structural VAR method, Tiwari, 2011 discovered the dynamic link between renewable energy and GDP. According to the generalized variance decomposition study, a boost in renewable energy has a significant impact on real GDP. Fuinhas and Marques, 2012 investigate the possibility of a feedback relationship between these two factors (growth and energy consumption) in the southern European Union over the years 1965 to 2009. An ARDL boundary testing method's empirical findings point to a bidirectional causal relationship between the two variables in pairs for both long- and short-run causality. The research conducted in the USA by Soytas et al., 2007 has confirmed the notion that there is no relationship between energy use and income. It is impossible to observe the long-term Granger causal relationships between income and energy use. Over the entire panel, it is impossible to determine the direction of causality between renewable energy and real GDP, Irandoust, 2016. The panel data for the years 1998 to 2018 are used by Assi et al. in 2021. Time series stability was confirmed using the panel unit test, and a heterogeneous dynamic panel was built using the ARDL analytical methodology to test panel data. They found that the relationship between GDP per capita and renewable energy consumption is negative. Economic growth and the use of renewable energy are causally related in both directions, as demonstrated by Lin et al. in 2014. Sadorsky observed in a 2009 study that the adoption of renewable energy in developing nations was promoted by economic growth. Other research, however, has shown that economic expansion boosts industrial activity, which raises the demand for fossil fuels while lowering renewable energy use. For instance, Shahbaz, 2017 discovered that higher economic growth causes a rise in the demand for fossil fuels. Abdouli, 2017 discovered a causal link in both directions between the use of fossil fuels and economic expansion. Yoo's study from 2006 found that there is a causal link between the use of fossil fuels and economic growth in both directions. Ocal, 2013 found an inverse relationship between the use of renewable energy and economic expansion. According to Menegaki (2011), there is no correlation between the use of renewable energy and GDP. According to Yildirim, 2012, there is only a one-way causal relationship between the consumption of energy obtained from biomass waste and real GDP, but there is no causal association between real GDP and other renewable energy types (geothermal energy consumption, hydro-electric energy consumption, etc.). According to Bowden, 2010, there is a unidirectional causal relationship connecting GDP and the utilization of renewable energy. According to research by Balcilar et al., 2018, Eren et al., 2019, Mukhtarov et al., 2020, Simionescu et al., 2020, and Samour et al., 2022, economic expansion has a favorable impact on the consumption of renewable energy. Lv et al. investigated how income affected energy intensity in 224 Chinese towns. Using annual data from 2005 to 2016, the study used geographic panel data methodologies for empirical analysis. According to the empirical results, income has a favorable effect on energy intensity. The findings of a unidirectional link between energy and economic growth were disputed by Kraft and Kraft's 1978 study, which used a different data set and various study periods.

According to empirical studies, the demand for renewable energy will rise as new industries relying on renewable energy which will lead to economic expansion. However, if industrial activities promote economic growth, the use of renewable energy will decline in favor of fossil fuels.

5. Methodological Framework

We implement the ARDL bound test cointegration strategy from the literature reviews that were based on the Autoregressive Distributed Lag approach since it has many benefits and it cannot break the periodicity or flexibility. It is dynamic and has an error correction model (ECM) that is derivable from the ARDL bounds testing using just a straightforward linear transformation.

This study will examine how consumption of renewable energy is impacted by financial development, economic growth, carbon dioxide emissions, foreign direct investment, and capital formation based on renewable energy projects. This study will use five independent variables and one dependent variable.

5.1 Definition of variables:

Renewable energy consumption (REC): This study will use Renewable Energy Consumption (% of total final energy consumption) as variable from World bank data. Renewable energy consumption is the share of renewable energy in overall final energy consumption.

Economic growth (EG): This study will use GDP growth (annual %) as variable from World bank data. The annual average rate of change of the gross domestic product (GDP) at market price based on constant local currency, for a given national economy, during a specified period of time.

Domestic credit to private sectors (DCB): This study will use Domestic credit to private sectors by banks (% of GDP) as variable from World bank data. It refers to financial resources provided to the private sector by other depository corporations (deposit taking corporations except central banks)

Foreign direct investment (FDI): This study will use Foreign direct investment (% of GDP) as variable from World bank data. Foreign direct investment is the net inflows of investment meant to acquire a prolonged managerial interest (up to 10% or more of voting stock) in an enterprise operating in an economy other than the investor.

Carbon dioxide emission (CO2): This study will use Carbon dioxide emissions (metric tons per capita) as variable from World bank data. It is used as a measure for environmental degradation.

Gross Fixed capital formation (GFCF): This study will use Gorss fixed capital formation (% of GDP) as variable from World bank data. It is the variable of the capital of the country over the period. It provides a financial support such as the building of different infrastructure based on renewable energy project.

5.2 Estimation strategy:

Unit root test: These series splits have univariate integration qualities that can be used to validate the degree; this work used tests for unit root stationarity. The ideal test to establish the presence of a unit root is the augmented Dickey-Fuller (ADF). In this study, the ADF test was applied. At certain level of confidence, the hypothesis that there is a unit root is strongly rejected the more negative it is.

Lag length selection: By adding all of our variables in non-difference data, a vector auto regression (VAR) model is estimated, which is the method used most frequently to determine the ideal lag duration. This VAR model should be estimated for a significant number of lags before being reduced by re-estimating the model for each subsequent lag until zero lags are reached. The study examines the values of the Schwar information criterion (SIC) and the Akaike information criterion (AIC) for that model. The model with the ideal lag length is the one that minimizes the AIC and SIC.

Cointegration analysis: The Pesaran et al. ARDL method tests will be used in this study to measure co-integration. Because the ARDL bounds test approach has numerous significant advantages over other tests that have been demonstrated by Monte Carlo evidence, it is preferred over other typical co-integration tests. The estimations exhibit favorable small example features and the ARDL technique effectively adjusts for any explanatory variable endogeneity. Another notable benefit of ARDL techniques is that they can eliminate unit root pre-testing issues because the test can be applied whether the series are I(0), I(1) or a combination of both. The short-run and long-run relationships can be estimated simultaneously in this way. In this case, applying the ARDL technique to cointegration will produce accurate and reliable predictions. The Autoregressive Distributed Lag (ARDL) technique to cointegration, in contrast to the Johansen and Juselius(1990) cointegration procedure, aids in locating the cointegrating vector (s). That is, a single long-term relationship equation can be written for each of the underlying variables. The ARDL model of the cointegrating vector is reparameterized into ECM if only one cointegrating vector (i.e., the underlying equation) is found. The reparameterized result provides the long-run relationship of the variables in a single model as well as short-run dynamics (i.e., regular ARDL). The ARDL is a dynamic single model equation and has the same form as the ECM, making re-parameterization possible. However, the approach developed by Johansen and Juselius (1990) can be used when there are several cointegrating vectors.

Diagnostic tests: Stability and diagnostic tests are also carried out to confirm the model's fitness; the diagnostic test looks at the serial correlation, functional form, normality, and heteroscedasticity related to the chosen model.

Heteroscedasticity testing: There are various types of methods to determine the heteroscedasticity of our data. This study will use Breusch-Pagan test as a method for heteroscedasticity testing. A more complete theoretical procedure explanation of Breusch-Pagan test can be seen here. This test uses two hypothetical assumptions:

- H_0 (Null Hypothesis): Homoscedasticity is present (the residuals are distributed with equal variance)
- H_1 (Alternative Hypothesis): Heteroscedasticity is present (the residuals are not distributed with equal variance)

If the p-value of the test results is smaller than alpha (significance level) then we can reject H_0 and conclude that the data is heteroscedastic. We will use 0.05 as the significance level parameter.

Serial Correlation test: The Breusch–Godfrey serial correlation LM test is a test for autocorrelation in the errors in a regression model. It makes use of the residuals from the model being considered in a regression analysis, and a test statistic is derived from these. The null hypothesis is that there is no serial correlation of any order up to p.

Normality test: The normality tests are used to identify whether a data set is well-modeled by a normal distribution or to figure out how likely a related random variable is to be normally distributed. The aim of this test was to test whether the residuals are normally distributed or not. The hypotheses testing for the normality are as follow:

Null hypothesis (H_0): the residuals are normally distributed

Alternative hypothesis (H_1): the residuals are not normally distributed

Ramsey Reset test: Ramsey Regression Equation Specification Error Test (RESET) test (Ramsey, 1969) is a general specification test for the linear regression model. More specifically, it tests whether non-linear combinations of the fitted values help explain the response variable. The intuition behind the test is that if non-linear combinations of the explanatory variables have any power in explaining the response variable, the model is mis-specified. The hypotheses testing for the RESET Test are as follow:

Null hypothesis (H_0): Model is not mis-specified.

Alternative hypothesis (H_1): Model is mis-specified.

6. Research Design

This study uses annualized secondary time series data for the 30 years period from 1991 to 2020 from the World Bank dataset of global development indicators. Based on past study and data availability, the variables and years analyzed were chosen. In this study, we have used five independent variables and one dependent variable.

For data analysis in this study, E-views software has been used.

The purpose of this research is to look into the influence of economic growth, foreign direct investment, and financial sector expansion on REC in Bangladesh. The general form of Renewable energy consumption model is created as following:

$REC_t = f(EG_{t,} FDI_{t,} DCB_{t,} GFCF_t, CO_2)$ (1)

The following is the tested model for economic growth, financial sector development, FDI, Capital formation and REC in Bangladesh:

$\ln REC_t = \beta_0 + \beta_1 \ln EG_t + \beta_2 \ln FDI_t + \beta_3 \ln DCB_t + \beta_4 \ln GFCF_t + \beta_5 \ln CO2_t + \varepsilon_t$ (2)

In Equation (2), the REC is the percentage of the renewable energy consumption from the total nonrenewable energy consumption; the EG is the Bnagladesh's GDP growth (annual %); DCB is the credits provided by the banks to the private sector as a percentage of the GDP; FDI is the foreign direct investment; GFCF is the gross fixed capital formation as a percentage of GDP; CO_2 is the carbon dioxide emissions which is used as environmental degradation. The natural log was used to convert all of the tested series.

6.1 Estimation strategy:

Unit root test: The ideal test to establish the presence of a unit root is the augmented Dickey-Fuller (ADF). In this study, the ADF test will be applied. For example, ADF test consists of estimating the following regression:

$\Delta Y_t = \beta_1 + \beta_2 + \delta Y_{t-1} + \alpha_i \sum_{i=1}^{m} \Delta Y_{t-I} + \varepsilon_t$ (3)

Lag length selection: The study examines the values of the Schwar information criterion (SIC) and the Akaike information criterion (AIC) for that model. The model with the ideal lag length is the one that minimizes the AIC and SIC.

Cointegration analysis: The conditional ARDL model is specified in the following manner to carry out the bound test for co-integration:

$\Delta lnREC_t = \alpha_0 + \sum_{i=1}^{p} \beta_{1i} \Delta lnREC_{t-i} + \sum_{i=1}^{q} \beta_{2i} \Delta lnEG_{t-i} + \sum_{i=1}^{q} \beta_{3i} \Delta lnFDI_{t-i} + \sum_{i=1}^{q} \beta_{4i} \Delta lnDCB_{t-i} + \sum_{i=1}^{q} \beta_{5i} \Delta lnGFCF_{t-i} + \sum_{i=1}^{q} \beta_{6i} \Delta lnCO2_{t-i} + \gamma_1 lnREC_{t-1} + \gamma_2 lnEG_{t-1} + \gamma_3 lnFDI_{t-1} + \gamma_4 lnDCB_{t-1} + \gamma_5 lnGFCF_{t-1} + \gamma_6 lnCO2_{t-1} + \varepsilon_t$ (4)

In equation (3), p denotes the lag length for dependent variables, q denotes lag length for independent variables, Δ indicates the first difference of those variables. The coefficient values of β_1 to β_6 represent short-run dynamics while γ_1 to γ_6 represent long-run effect. ε_t is the white noise error term. The hypothesis that the coefficients of the lag level variables are zero is to be tested.

The null of non-existence of the long-run relationship is defined by;

Ho: $\gamma_1 = \gamma_2 = \gamma_3 = \gamma_4 = \gamma_5 = \gamma_6 = 0$ (i.e. the long run relationship does not exist)

H1: $\gamma_1 \neq \gamma_2 \neq \gamma_3 \neq \gamma_4 \neq \gamma_5 \neq \gamma_6 \neq 0$ (i.e. the long run relationship exists)

A comparison is made between the computed F-statistics value and two sets of critical values provided by Pesaran et al (2001). One set considers all variables to be I (0), while the other set considers them to be I (1). Regardless of whether the variable is I(0) or I (1), the null hypothesis of no cointegration would be rejected if the estimated F State exceeds the upper critical value. The null hypothesis of no cointegration cannot be ruled out if it is below the lower number. The test is inconclusive if it falls inside the crucial value band. The researchers may need to perform unit root tests on variables entered into the model at this stage of the estimating procedure (Pesaran and Pesaran 1997).

In the second stage, the researchers use the chosen ARDL model to estimate the long-term association using AIC or SIC. There is an error correction representation when there is a long-term link between the variables. Therefore, in the third stage, the following error correction model (ECM) is estimated:

$\Delta lnREC_i = \alpha_0 + \sum_{i=1}^{p} \delta_{1i} \Delta lnREC_{t-i} + \sum_{i=1}^{q} \delta_{2i} \Delta lnEG_{t-i} + \sum_{i=1}^{q} \delta_{3i} \Delta lnFDI_{t-i} + \sum_{i=1}^{q} \delta_{4i} \Delta lnDCB_{t-i} + \sum_{i=1}^{q} \delta_{5i} \Delta lnGFCF_{t-i} + \sum_{i=1}^{q} \delta_{6i} \Delta lnCO2_{t-i} + \Theta ECM_{t-1} + e_t$ (5)

In equation (4), the coefficient values from δ_1 to δ_6 indicates the short-run dynamics of the variables, while the coefficient of Error Correction Mechanism ϴ refers the correction in disequilibrium. That means, the outcome of the error correction model shows how quickly long-run equilibrium is restored following a short-run shock.

Wald test: The Wald test (Wald Chi-Squared Test) is a parametric statistical measure to confirm whether a set of independent variables are collectively 'significant' for a model or not. This test computes a test statistic which tests for the joint significance of the coefficients. It is used to ascertain whether the joint impact of the independent variables actually have a significant influence on the dependent variable. That means, it is used to determine the statistical significance of the short-run causality on the coefficients of the differenced explanatory variables. If the probability value is less than 5% or 0.05, it implies that the variables are jointly statistically significant at 5% level.

Null hypothesis: There is no causality between the set of independent variables.

Alternative hypothesis: There is a causality between the set of independent variables.

We are more likely to reject the null hypothesis of non-causality as the test statistic gets larger.

Diagnostic tests: Stability and diagnostic tests are also carried out to confirm the model's fitness; the diagnostic test looks at the serial correlation, functional form, normality, and heteroscedasticity related to the chosen model.

Stability tests: Pesaran & Pesaran (1997) advise adopting the stability test developed by Brown et al in 1975. This method is sometimes referred to as cumulative (CUSUM) and cumulative sum of squares (CUSUMSQ). Recursively updated data for CUSUM and CUSUMSQ are shown against the breaking points. The null hypothesis that all coefficients in the provided regression are stable cannot be rejected if the plots of CUSUM and CUSUMSQ statistics remain within the critical boundaries of 5% level of significance.

6.2 Methodology structure:

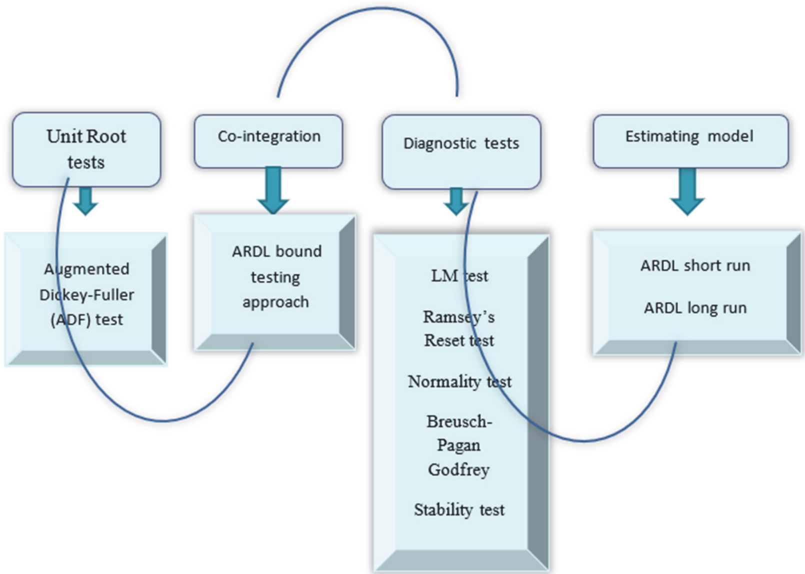

Figure 2: The structure of methodology

7. Results Analysis and Discussion

Table 2 presents descriptive information of 30 observations for the time series variables used in this study. It demonstrates that the majority of the variables have changed significantly over time. Gross Domestic Product (GDP), for instance, goes from a low of 1.24 to a high of 2.06. Gross Fixed Capital Formation (GFCF), which ranges from 2.83 to 3.47, is similar. The study's observations supported the moderate degree of variability among the variables. For instance, the LNREC has a mean of 3.83 and a standard deviation of 0.33. The mean and median values for carbon dioxide emissions are the greatest. The variable with the biggest standard deviation is foreign direct investment. The analysis is completed by applying the logarithmic transformation to all variables.

Table 2: Descriptive Statistics

Variables	LNREC	LNGDP	LNFDI	LNDCB	LNCO2	LNGFCF
Mean	3.83	1.69	-1.19	3.34	10.44	3.21
Median	3.91	1.68	-0.54	3.39	10.44	3.26
Maximum	4.29	2.06	0.55	3.78	11.42	3.47
Minimum	3.19	1.23	-5.40	2.67	9.29	2.82
Std. Dev.	0.33	0.21	1.71	0.36	0.66	0.18
Observations	30	30	30	30	30	30

Unit Root Test: Finding the proper order of integration for each of the variables is necessary for the assumption of a fair co-integrating connection between the time series variables. This study looked into the variable's order of integration first. Table 3 reports the outcomes of the unit root test under the null hypotheses of non-stationarity and stationarity. Table 3 demonstrates that the variables utilized in this study have not been integrated in the same sequence. Certain variables are integrated at I(0) whereas others are integrated at I(1). Gross Domestic Product (GDP) and Gross Fixed Capital Formation (GFCF) are confirmed to be stationary at level I(0) by the ADF test, and the other variables also become stationary after the first difference I(1) when just intercept is assumed in the test equations.

No variable is integrated at I(2), which leads to the Autoregressive Distributed Lag Model (ARDL) bounds testing approach (Pesaran et al. 2001) being used to represent the long-run equilibrium relationship between the variables, is one of the significant findings presented in Table [3].

Table 3: ADF tests results

Variable	Intercept				
	Level		First difference		Remarks
	t-stat	p-value	t-stat	p-value	I (d)
LNREC	2.203	0.999	-3.960	0.005	I (1)
LNGDP	-3.318	0.023			I (0)
LNFDI	-2.724	0.082	-4.736	0.000	I (1)
LNDCB	-1.378	0.578	-6.216	0.000	I (1)
LNCO2	-1.360	0.587	-6.702	0.000	I (1)
LNGFCF	-3.011	0.044			I (0)

Lag selection for vector error correction model: Finding the ideal lag for the VEC model comes after running the unit root test. To choose the best lag for the cointegration test in the research analysis, Vector Autoregression (VAR) lag order selection criteria are employed.

Table 4: Lag order selection criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	100.5038	NA	4.72e-11	-6.750271	-6.464799	-6.663000
1	273.5847	259.6214*	2.81e-15*	-16.54176	-14.54346*	-15.93086*
2	311.6725	40.80839	3.60e-15	-16.69090*	-12.97975	-15.55636

LR: Likelihood ratio; FPE: Final prediction error; AIC: Akaike information criterion; SC: Schwarz criterion; HQ: Hannane Quinn criterion. Optimal lag length. *indicates lag order selected by the criterion.

Table 4 shows the lag order selection criterion of VAR. The rule-of-thumb is to select the criterion with the lowest value which is the AIC at -16.69090 this is because the lower the value, the better the model. In here, between the AIC and Schwartz, the former's criterion of -16.69090 is lower than that of Schwartz at -14.54346. Therefore, we can conclude based on this output that the lag selection must be based on the AIC and also conclude that the optimal lag length for the model is 2. Lag 2 was determined to be the most appropriate lag for additional empirical analysis in that analysis. The greater explanatory qualities of AIC led to the selection of the lag order of the variable in this study. It is crucial to understand that choosing the wrong lag length has an impact on the cointegration outcomes. In light of this, the study moves forward with the ARDL Bound testing strategy to cointegration, which demonstrates the long-term link, after choosing lag length 2 in the study.

Cointegration test: Our variables are an amalgam of I(0) and I(1), according to the findings of the unit root test, with an I(1) dependent variable. This supports the use of the ARDL bound cointegration approach, together with other applicable explanatory variables, to analyze the long-run relationship between renewable energy consumption (REC) and financial development (FD). The results of the ARDL bound cointegration test are shown in Table 5. The combined significance of the one-period lagged level variables in Equation (3) is determined by the results, and the F-statistic evaluates this significance. The resultant value is 8.55, which is higher than the upper bound critical value (4.68) at the 1% level of significance. We therefore reject the null hypothesis that there is no cointegration between the dependent and explanatory variables and come to the conclusion that the variables have a stable long-run relationship. As a result, this investigation supports the model's long-run cointegration according to the choice criteria. This finding suggests that divergence from the short-run equilibrium is only a temporal phenomenon since the long-run equilibrium is stable.

Table 5: ARDL Bound testing result for long-run co-integration

		Lag: AIC	**F-statistics**	**Result**
Model F_{LNREC}(LNREC/LNGDP, LNFDI,LNDCB,LNCO2,LNGFCF)		ARDL(1,0,1,2,1,1)	8.55	Cointegration
Critical value	**K**	**1%**	**5%**	**10%**
I(0) Lower bound	5	3.41	2.62	2.26
I(1) Upper bound	5	4.68	3.79	3.35

Note: AIC = Akaike information criterion. All the variables are in the natural log form and rejection of null hypothesis of no cointegration at the 1% level.

It becomes customary to report the normalized cointegrating coefficients of exogenous variables as produced from the level equation object of the ARDL model framework once it has been demonstrated that there is a long-run association between the consumption of renewable energy and the pertinent predictors. Table 6 presents the outcomes.

Table 6: Long-run estimate of the ARDL model

Dependent Variable: LNREC				
Variable	Coefficient	Std. error	t-statistic	Prob.
LNGDP	-0.050819	0.059209	-0.858299	0.4034
LNFDI	0.004988	0.016509	0.302115	0.7665
LNDCB	0.819763***	0.163134	5.025083	0.0001
LNCO2	-1.261286***	0.149691	-8.425905	0.0000
LNGFCF	0.928250***	0.288769	3.214507	0.0054

***denotes significance at the 1% level.

According to Table 6, the domestic credit provided by banks to the private sector (DCB), carbon dioxide emissions (CO2), and capital creation (GFCF) are all individually statistically significant, although GDP and FDI are not. All variables, however, appear to follow theoretical predictions, based on the signs of the predicted coefficients. For instance, it is theoretically significant that fixed capital formation (GFCF), domestic bank credit to the private sector (DCB), and foreign direct investment (FDI) all have a positive impact on the consumption of renewable energy, whereas the growth rate of GDP and carbon dioxide emissions (CO2) have a negative impact on renewable energy consumption.

The results of the model suggest that a 1% increase in domestic credit extended to the private sector, which represents financial development increases the consumption of renewable energy by 0.82 percent. In Bangladesh, domestic credit given by banks to the private sector is a key indicator of financial development and has a considerable positive impact on the country's usage of renewable energy. This result may be explained by the fact that Bangladesh's private sector has continued to promote or encourage the development and use of renewable energy sources so that the country can achieve its environmental goals in the long run. The findings of this study, which show that financial development has a favorable impact on the consumption of renewable energy, are strikingly identical to those of prior case studies (see Rafindadi & Mika'Ilu,2019 ; Lin et al., 2016; Ji and Zhang, 2019; Eren et al., 2019; Anton and Nucu, 2019; Raza et al., 2020; Qamruzzaman and Jianguo, 2020, Alsagr & Hemmen, 2021, Rafindadi & Ozturk, 2017, Islam et al. 2013, Shahbaz et al. 2013 and Mudakkar et al. 2013 for Pakistan, Malaysia and China, respectively, Samour et. Al., 2022. This result, however, contradicts findings made by Saibu and Omoju, 2016 and Ankrah and Lin, 2020, who claimed that the use of renewable energy was undermined by financial development in their specific research papers.

If carbon dioxide emissions increase by 1%, it would result in a long-term reduction of 1.26% in the consumption of renewable energy. It is statistically significant that higher carbon dioxide emissions, which signify environmental degradation, result in reduced utilization of renewable energy. The desire for renewable energy consumption decreases as carbon dioxide emissions rise since they will pollute the environment and bring several issues for renewable energy sources. Therefore, a high level of carbon emissions puts pressure on clean environmental legislation and encourages the use of alternative renewable energies that are more efficient and emit no carbon. This finding is consistent with those of numerous research, including Menegaki, 2011and Salim and Rafiq, 2012, Rafique et al., 2021, Sbia et al., 2014, Paramati et al., 2016. According to Lu (2017), CO2 emissions put significant pressure on the use of renewable energy and the demand for renewable energy may be hampered by CO2 emissions. Clean energy is provided by renewable energy sources, which can lower CO2 emissions, Omri and Nguyen, 2014.

Infrastructure construction is an example of fixed capital formation, which is the nation's capital based on renewable energy projects. This variable has a statistically significant positive impact on renewable energy projects. A 1% increase in capital formation, it leads to increase the usage of renewable energy by 0.93 percent. Actually, it gives the nation financial assistance so that it can focus on funding the construction of renewable energy projects. And as a result, capital development in Bangladesh will increase the usage of renewable energy and lowers the unemployment level, which is favorable to the environment. And this result is consistent with author Rafindadi & Mika'Ilu, 2019.

But it can also be seen from the table 6, if 1% increase in economic growth, it would decrease the renewable energy consumption in the long run and this result is insignificant. And a 1% increase in foreign direct investment would increase the renewable energy consumption and it is statistically insignificant. These variables have no impact on Bangladesh's degree of renewable energy use. In Bangladesh, for example, the consumption of renewable energy is negatively and negligibly impacted by the growth GDP (GDPG), which is used to evaluate the influence of income. Bangladesh's economic development may not have been environmentally benign, which is one cause. Investment by the government, businesses, and families in the development and use of renewable energy has not been sufficient to maintain growth in the long run.

Finally, In Bangladesh, the use of renewable energy is positively impacted by foreign direct investment (FDI), albeit this effect is not statistically significant in the long run. Therefore, a rise in foreign direct investment has little impact on the country's use of renewable energy.

Table 7: Findings of ARDL in the short-run

ECM Regression				
Variable	**Coefficient**	**Std. error**	**t-statistic**	**Prob.**
Constant	3.778431	0.461528	8.186793	0.0000
Δ LNFDI	-0.004551	0.002906	-1.566382	0.1368
Δ LNDCB	0.094891**	0.044177	2.147951	0.0474
Δ LNDCB (-1)	-0.087694***	0.029340	-2.988873	0.0087
Δ LNCO2	-0.597680***	0.070712	-8.452312	0.0000
Δ LNGFCF	-0.100244	0.110047	-0.910918	0.3759
ECT (-1)	-0.331679***	0.040432	-8.203454	0.0000

& * indicates the significance level at the 5% and 1% respectively.

Table 7 displays the ECT-ARDL [see equation 4] model's short-run coefficients for the model specification and the ECT (-1), error correction model coefficient. According to the model's parameters, the lagged one-period ECT's negative and statistically significant coefficients show that any short-run disequilibrium is corrected annually at a speed of 33% towards long-run equilibrium. The importance of the lag error term supports the long-term relationship between the variables that we have already established.

The results show that domestic credit provided to the private sector by banks raises REC in the short run favorably and significantly. The results confirm that, in both the short and long periods, domestic credit for financial development is positively and significantly correlated with REC at a 1% level of significance. A 0.09 percent increase in the REC coincides with a 1% increase in financial development in Bangladesh. These results demonstrate that domestic credit employed for financial development has a significant influence on Bangladesh's rate of REC. These findings concur with those of certain studies such as Wang and Zhang, 2021, Anton and Nucu, 2020. But the author Rafindadi & Mika'Ilu,2019 does not support the positive impact of financial development on the demand of renewable energy in the short run.

The higher carbon dioxide emission lowers the demand of renewable energy consumption in both the short run and the long run which is consistent with the studies of Toumi and Toumi, 2019, Lu, 2017, Omri and Nguyen, 2014.

But the influence of foreign direct investment and capital formation is negative and statistically insignificant in the short run. In a related breakthrough, it was discovered that capital reduces renewable energy usage, but this finding was deemed to be insignificant in the short run and it supports the similar result of Rafindadi & Mika'Ilu,2019.

Wald test: Now, we would like to estimate whether there is any short run causality or not between the set of independent variables. For doing this test, this study has used the Wald test (Wald Chi-Squared Test) which is a parametric statistical measure to confirm whether a set of independent variables are collectively ‘significant’ for a model or not. This study has used this test to examine the joint impact of the financial development (independent variables) on the renewable energy consumption (dependent variable) or there is any causal relationship between the two which is represented in Table 8.

Table 8: Short run causality between financial development and renewable energy consumption

Wald test			
Test Statistic	**Value**	**df**	**Probability**
F-statistic	1.388664	(2, 16)	0.2779
Chi-square	2.777327	2	0.2494

Table 8 shows that there is no short run causal relationship between financial development and renewable energy consumption as chi-square value is more than 5% or probability value, $p>0.05$.

Diagnostic tests: Since the various test statistics have p-values greater than 0.05, our results are resistant to various diagnostic tests like the Breusch-Godfrey serial correlation LM test, Breusch-Pagan-Godfrey heteroskedasticity test, Jaque-Bera normality test, and the Ramsey RESET test for the model specification error (see Table 9). In the case of the numerous diagnostic tests, for instance, the probability value is higher than 0.05, indicating that the test data are statistically meaningless at the 5% level. Therefore, we were unable to reject the null hypotheses of homoskedasticity, normally distributed residuals, and an error-free model as well as residuals that are not serially correlated and have constant variance.

For serial correlation LM test, H_0: There is no serial correlation.
For heteroscedasticity test, H_0: Homoscedasticity is present.
For normality test, H_0: The residuals are normally distributed.
For specification error test, H_0: Model is not mis-specified.

Table 9: Diagnostic tests

Diagnostic tests			
Test type	**Test-statistic**	**Value obtained**	**Prob.**
Serial Correlation LM Test (Breusch-Godfrey)	F-statistic	0.218974	0.8060
Heteroskedasticity Test (Breusch-Pagan-Godfrey)	F-statistic	0.451635	0.9074
Normality Test (Jaque-Bera)	JB-statistic	0.548101	0.760294
Specification Error Test (Ramsey RESET)	F-statistic	1.417729	0.2523

Stability test: As shown in Figure: 1, we further tested the stability of the model using the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMQ). Brown et al., 1975 supported the usage of these two tests by establishing that they give a reliable basis for testing and identifying the positions of any observable gradual changes that may develop within the estimated parameters. The null hypothesis, which suggests that the parameters are valid and consistent, will be accepted if the expected value of the recursive residual is zero in this regard. If this is not the case, the parameters are invalid and inconsistent. The empirical results show that, at a 5 percent level of significance, the plots of both tests are inside the critical region. This attests to the stability of both long-run and short-run characteristics. As a result, the computed ARDL model coefficients are dynamically stable over the time periods.

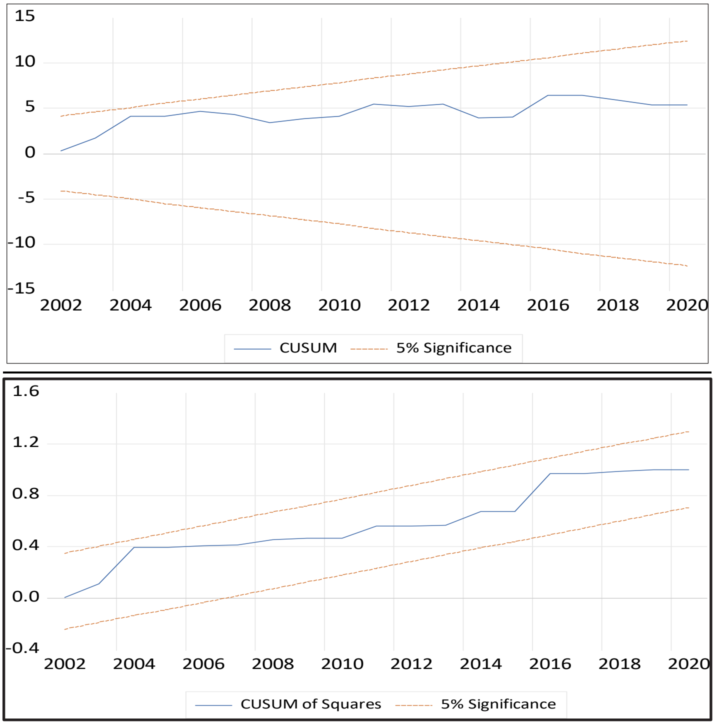

Figure 3: Model Stability Tests- CUSUM and CUSUMQ at 5% significance level.

8. Conclusion and Policy Implications

On the basis of the aforementioned, some policy recommendations are put out. Since it has been demonstrated that Bangladesh's development of renewable energy is positively influenced by a strong financial sector, financial sector policies that promote the growth of renewable energy should take the lead. Within the variables of the policy framework, financing initiatives must take into account the development of new renewable energy businesses and the expansion of existing renewable energy projects, as well as the search for additional operating capital through the conversion of liquid assets to readily available assets, among other things. The essential players' transparent collaboration and fruitful relationship are equally crucial to this policy project's success (Government, financial organizations, and energy investors). This partnership will foster a long-lasting environment that will enable a smooth transition to an environmentally friendly banking system. In order to effectively articulate policy regarding fiscal, ecological, and environmental concerns, the government must adopt a "clean attitude." Finance industry businesses may support the expansion of renewable energy by opening up finance channels through creative, business-friendly green packages, while reviving already-existing green loans and insurance. In addition, the

Central Bank of Bangladesh should expand its digital payments initiative to increase credit access, particularly for businesses and people interested in green products, given the limited credit facilities in Bangladesh. Therefore, the Central Bank of Bangladesh should think about offering a favorable interest rate to investors in renewable energy.

Second, Bangladesh needs a plenty of investment for renewable energy projects which will generate sufficient amount of capital. In order to meet their own energy needs, businesses may be encouraged by the Bangladeshi government to invest in small-scale renewable energy production projects as well as to increase their consumption of renewable energy. Therefore, governments in developing nations like Bangladesh should promote policies that strengthen the financial capability of companies to invest in renewable power plants rather than imposing haphazard and unattainable targets of minimizing fossil fuel consumption if they want to successfully implement the energy transition from non-renewable to renewable. Additionally, encourage collaboration with other nearby nations in the study of renewable energy sciences to spur curiosity, improve understanding, and lay a firmer groundwork for innovation. This will enable the advancement of investment in environmentally friendly renewable energy projects that will generate enough capital accumulation as a means of reducing adverse environmental effects. Therefore, businesses must choose capital-intensive technological solutions rather than labor-supplementing ones. They will be able to meet the demand for renewable energy sources thanks to this.

Third, The Bangladeshi government should make conscious efforts to significantly lower its reliance on fossil fuels. By eliminating subsidies for fossil fuels and gradually enacting an environmental or carbon tax on the use of non-renewable energy, one such solution could be put into action. In order to increase capacity for the use of clean and ecologically friendly energy technologies to minimize carbon dioxide emissions, it is crucial to work together with neighboring nations. The nation should have cutting-edge technology and in-depth knowledge in creating eco-friendly, low-carbon technologies. The governments of Bangladesh can start programs to raise public awareness of environmental issues, provide incentives and subsidies, and offer tax breaks and refunds for people who use renewable energy sources.

Fourth, Macroeconomic initiatives that are strong, stable, and dedicated are required to address the growth in GDP and FDI, both of which were found to have little bearing on Bangladesh's use of renewable energy. The government of Bangladesh can use a strong banking sector and anticipated development in economic conditions to attract more foreign investors into the economy with a focus on increasing the share of FDI in renewable energy in the nation.

Finally, the common factors of interested parties should be directed toward policies that not only increase the percentage of renewable electricity but also increase the proportion of renewable energy in total energy consumption. Furthermore, increasing the use of renewable energies would benefit sustainability by offering a number of financial advantages; the flexibility of the energy supply promotes economic growth and expands market prospects for capital accumulation. And as a result, it will expand the use of renewable energy while decreasing environmental damage.

9. Limitations and Future Research Direction

The study's shortcomings, which are described below, will provide for a variety of future research directions. First of all, the current study is only applicable to one developing nation; comparable studies can be expanded to additional nations, especially when employing more contemporary approaches like PNARDL. The current empirical model can be broken down and looked at by future scholars. By concentrating on the importance of corporate governance in the financial development-renewable energy usage nexus in developing countries, future studies can build on this. Furthermore, as the majority of developing countries are endowed with a variety of renewable energy sources, further research could determine, when data permits, the impact of capital accumulation on various renewable energy sources. To further enlighten present findings, more researchers may decide to include fossil fuel energy use in the study. A few variables that may have an impact on the usage of renewable energy are used in the study analysis. Other exogenous elements, such as monetary policy, environmental and economic regulations, R&D spending, and energy innovation techniques, can be used to further expand the current model. Future study can also concentrate on the link between complexity and renewable energy, using a worldwide sample, newly industrialized nations, oil-exporting nations, and net oil-importing nations. Additionally, academics can investigate how economic complexity and technical improvements interact to create new and more relevant policies for the demand for renewable and nonrenewable energy.

The impact of energy usage on the quality of the environment has dramatically increased over the previous few decades. The goal of reducing carbon emissions has received attention from both developed and developing nations, but more attention is needed to reach this goal. In this scenario, rising CO2 emissions have made the development of sustainable energy sources extremely vital. The government of Bangladesh has acknowledged the necessity of utilizing renewable energy sources through the diversification of their energy supplies to address climate change and promote environmental sustainability.

The connection between energy consumption, financial development, and foreign direct investment has been investigated in a number of empirical research. However, no research has been done in the case of Bangladesh on the effects of financial development, carbon dioxide emission, economic growth, foreign direct investment, and capital formation on renewable energy consumption (REC). For this purpose, this study was to examine the effects of financial development, foreign direct investment, economic growth, carbon dioxide emissions, and capital creation on the use of renewable energy using time series data covering the years 1991 to 2020. Bangladesh has a wealth of natural resources, and this study explains how to use these in conjunction with a few key variables to affect Bangladesh's energy consumption. It is in reference to this development serves as the driving force behind the study's motivation to examine any connections that may exist between the financial market development in Bangladesh and the country's capital formation prospects, which are based on renewable energy projects, as well as how these influences may affect Bangladesh's consumption of renewable energy. The study uses the ADF test to determine the stationarity of the variables, and then uses the ARDL bound testing technique to cointegration to explain the long-term relationships between those chosen variables as well as the short-term relationships with the help of error correction mechanism (ECM).

The study found a substantial and strong link between Bangladesh's use of renewable energy and financial development as assessed by domestic credit as a percentage of GDP. This shows that, both in the short and long terms, the growth of the financial sector supports the switch to the use of clean energy. This is because the financial system makes it simple for households, businesses, and people to obtain funds from financial institutions and therefore raise their capacity for consumption and production. These factors lead to an increase in the consumption of renewable energy. Carbon dioxide emissions (environmental degradation) have a negative, statistically significant effect on the consumption of renewable energy both in the short and long terms. In other words, if carbon dioxide emissions rise, renewable energy use will decline. This finding suggests that Bangladesh should promote a low-carbon lifestyle that includes adopting residential appliances powered by clean energy and reducing the use of non-renewable energy sources including fossil fuels, natural gas, and electricity. When environmental degradation happens, individuals are typically less inclined to use renewable energy sources. because it causes pollution and places a strain on natural resources. Through each of these actions, efficient and environmentally industry growth can be encouraged, and residents' good mobility and clean energy habits can be encouraged. Through each of these actions, eco-friendly industry growth can be encouraged, and residents' good mobility and clean energy habits can be encouraged. Natural resources are being depleted faster and more quickly in Bangladesh as a result of rising non-renewable energy usage and carbon dioxide emissions. Long-term growth in renewable energy consumption is positively impacted by capital formation based on renewable energy projects. However, the short-term use of renewable energy is statistically insignificant and does not rise by capital formation. It is difficult to expand capital formation in the short term because Bangladesh is a poor developing nation. In a developing nation like Bangladesh, capital generation is a long-term endeavor. Last but not least, other factors like GDP growth and foreign direct investment have little bearing on Bangladesh's degree of use of renewable energy.

References

Abdouli, M., & Hammami, S. (2017). Exploring links between FDI inflows, energy consumption, and economic growth: further evidence from MENA countries. *Journal of economic development*, *42*(1), 95.

Adom, P. K., Bekoe, W., & Akoena, S. K. K. (2012). Modelling aggregate domestic electricity demand in Ghana: An autoregressive distributed lag bounds cointegration approach. *Energy policy*, *42*, 530-537.

Adom, P. K., Bekoe, W., Amuakwa-Mensah, F., Mensah, J. T., & Botchway, E. (2012). Carbon dioxide emissions, economic growth, industrial structure, and technical efficiency: Empirical evidence from Ghana, Senegal, and Morocco on the causal dynamics. *Energy*, *47*(1), 314-325.

Ali, H. S., Yusop, Z. B., & Hook, L. S. (2015). Financial development and energy consumption nexus in Nigeria: An application of autoregressive distributed lag bound testing approach. *International Journal of Energy Economics and Policy*, *5*(3), 816-821.

Al-Mulali, U. (2014). Investigating the impact of nuclear energy consumption on GDP growth and CO2 emission: A panel data analysis. *Progress in Nuclear Energy*, *73*, 172-178.

Al-Mulali, U., & Ozturk, I. (2014). Are energy conservation policies effective without harming economic growth in the Gulf Cooperation Council countries?. *Renewable and Sustainable Energy Reviews*, *38*, 639-650.

Al-Mulali, U., & Sab, C. N. B. C. (2012). The impact of energy consumption and CO2 emission on the economic growth and financial development in the Sub Saharan African countries. *Energy*, *39*(1), 180-186.

Al-Mulali, U., Fereidouni, H. G., & Lee, J. Y. (2014). Electricity consumption from renewable and non-renewable sources and economic growth: Evidence from Latin American countries. *Renewable and Sustainable Energy Reviews*, *30*, 290-298.

Al-Mulali, U., Fereidouni, H. G., Lee, J. Y., & Sab, C. N. B. C. (2013). Examining the bi-directional long run relationship between renewable energy consumption and GDP growth. *Renewable and sustainable energy reviews*, *22*, 209-222.

Alsagr, N., & van Hemmen, S. (2021). The impact of financial development and geopolitical risk on renewable energy consumption: evidence from emerging markets. *Environmental Science and Pollution Research*, *28*(20), 25906-25919.

Ankrah, I., & Lin, B. (2020). Renewable energy development in Ghana: Beyond potentials and commitment. *Energy*, *198*, 117356.

Anton, S. G., & Nucu, A. E. A. (2020). The effect of financial development on renewable energy consumption. A panel data approach. *Renewable Energy*, *147*, 330-338.

Anton, S.G., & Nucu, A.E.A. (2019). The effect of financial development on renewable energy consumption: A panel data approach. *Renew. Energy 147*, 330-338.

Antweiler, W., Copeland, B. R., & Taylor, M. S. (2001). Is free trade good for the environment? *American economic review*, *91*(4), 877-908.

Apergis, N., & Payne, J. E. (2010a). Renewable energy consumption and economic growth: evidence from a panel of OECD countries. *Energy policy*, *38*(1), 656-660.

Apergis, N., & Payne, J. E. (2010b). Renewable energy consumption and growth in Eurasia. *Energy economics*, *32*(6), 1392-1397.

Apergis, N., & Payne, J. E. (2012). Renewable and non-renewable energy consumption-growth nexus: Evidence from a panel error correction model. *Energy economics*, *34*(3), 733-738.

Asafu-Adjaye, J. (2000). The relationship between energy consumption, energy prices and economic growth: time series evidence from Asian developing countries. *Energy economics*, *22*(6), 615-625.

Aslan, A., Apergis, N., & Topcu, M. (2014). Banking development and energy consumption: Evidence from a panel of Middle Eastern countries. *Energy*, *72*, 427-433.

Assi, A. F., Isiksal, A. Z., & Tursoy, T. (2021). Renewable energy consumption, financial development, environmental pollution, and innovations in the ASEAN+ 3 group: Evidence from (P-ARDL) model. *Renewable Energy*, *165*, 689-700.

Balcilar, M., Ozdemir, Z. A., Ozdemir, H., & Shahbaz, M. (2018). The renewable energy consumption and growth in the G-7 countries: Evidence from historical decomposition method. *Renewable Energy*, *126*, 594-604.

Baten, M. Z., Amin, E. M., Sharin, A., Islam, R., & Chowdhury, S. A. (2009, December). Renewable energy scenario of Bangladesh: Physical perspective. In *2009 1st International Conference on the Developements in Renewable Energy Technology (ICDRET)* (pp. 1-5). IEEE.

Bhattacharya, M., Paramati, S. R., Ozturk, I., & Bhattacharya, S. (2016). The effect of renewable energy consumption on economic growth: Evidence from top 38 countries. *Applied Energy*, *162*, 733-741.

Birol, F. (2017). *"World Energy Outlook"*. France. www.iea.org/weo.

Bowden, N., & Payne, J. E. (2010). Sectoral analysis of the causal relationship between renewable and non-renewable energy consumption and real output in the US. *Energy Sources, Part B: Economics, Planning, and Policy*, *5*(4), 400-408.

Brown, R. L., Durbin, J., & Evans, J. M. (1975). Techniques for testing the constancy of regression relationships over time. *Journal of the Royal Statistical Society: Series B (Methodological)*, *37*(2), 149-163.

Brunnschweiler, C. N. (2010). Finance for renewable energy: an empirical analysis of developing and transition economies. *Environment and development economics*, *15*(3), 241-274.

Burrett, R., Clini, C., Dixon, R., Eckhart, M., El-Ashry, M., Gupta, D., ... & Ballesteros, A. R. (2009). Renewable energy policy network for the 21st century. *REN21 Global Status Report*.

Can, M., & Gozgor, G. (2017). The impact of economic complexity on carbon emissions: evidence from France. *Environmental Science and Pollution Research*, *24*(19), 16364-16370.

Chang, S. C. (2015). Effects of financial developments and income on energy consumption. *International Review of Economics & Finance*, *35*, 28-44.

Chang, S. C. (2015). Effects of financial developments and income on energy consumption. *International Review of Economics & Finance*, *35*, 28-44.

Chishti, M. Z., Ahmad, M., Rehman, A., & Khan, M. K. (2021). Mitigations pathways towards sustainable development: assessing the influence of fiscal and monetary policies on carbon emissions in BRICS economies. *Journal of Cleaner Production*, *292*, 126035.

Claessens, S., & Feijen, E. (2007). *Financial sector development and the millennium development goals* (No. 89). World Bank Publications.

Çoban, S., & Topcu, M. (2013). The nexus between financial development and energy consumption in the EU: A dynamic panel data analysis. *Energy Economics*, *39*, 81-88.

Cole, M. A. (2006). Does trade liberalization increase national energy use?. *Economics Letters*, *92*(1), 108-112.

Dimnwobi, S. K., Madichie, C. V., Ekesiobi, C., & Asongu, S. A. (2022). Financial development and renewable energy consumption in Nigeria. *Renewable Energy*, *192*, 668-677.

Doğan, B., Balsalobre-Lorente, D., & Nasir, M. A. (2020). European commitment to COP21 and the role of energy consumption, FDI, trade and economic complexity in sustaining economic growth. *Journal of environmental Management*, *273*, 111146.

Doytch, N., & Narayan, S. (2016). Does FDI influence renewable energy consumption? An analysis of sectoral FDI impact on renewable and non-renewable industrial energy consumption. *Energy Economics*, *54*, 291-301.

Dumrul, Y. (2018). Estimating the impact of the financial development on energy consumption: A co-integration analysis. *International Journal of Energy Economics and Policy*, *8*(5), 294.

Eren, B. M., Taspinar, N., & Gokmenoglu, K. K. (2019). The impact of financial development and economic growth on renewable energy consumption: Empirical analysis of India. *Science of the Total Environment*, *663*, 189-197.

Eren, B. M., Taspinar, N., & Gokmenoglu, K. K. (2019). The impact of financial development and economic growth on renewable energy consumption: Empirical analysis of India. *Science of the Total Environment*, *663*, 189-197.

Farhani, S., & Solarin, S. A. (2017). Financial development and energy demand in the United States: new evidence from combined cointegration and asymmetric causality tests. *Energy*, *134*, 1029-1037.

Fatima, T., Mentel, G., Doğan, B., Hashim, Z., & Shahzad, U. (2022). Investigating the role of export product diversification for renewable, and non-renewable energy consumption in GCC (gulf cooperation council) countries: does the Kuznets hypothesis exist? *Environment, Development and Sustainability*, *24*(6), 8397-8417.

Fuinhas, J. A., & Marques, A. C. Energy consumption and economic growth nexus in Portugal, Italy, Greece, Spain and Turkey.

Ghazouani, T. (2018). *Re-examining the Foreign direct investment, Renewable energy consumption and Economic growth nexus: Evidence from a new Bootstrap ARDL test for Cointegration*. University Library of Munich, Germany.

Gozgor, G., Lau, C. K. M., & Lu, Z. (2018). Energy consumption and economic growth: New evidence from the OECD countries. *Energy*, *153*, 27-34.

Gozgor, G., Mahalik, M. K., Demir, E., & Padhan, H. (2020). The impact of economic globalization on renewable energy in the OECD countries. *Energy Policy*, *139*, 111365.

Hübler, M. (2009). *Energy saving technology diffusion via FDI and trade: a CGE model of China* (No. 1479). Kiel working paper.

International Institute for Sustainable Development (IISD) (2019, January 17). Report Outlines How the Energy Transformation Will Reshape the World. *SDG KNOWLEDGE HUB.* https://sdg.iisd.org/news/report-outlines-how-the-energy-transformation-will-reshape-the world/

International Renewable Energy Agency (IRENA) (2016, September 6). Unlocking Renewable Energy Investment: The role of risk mitigation and structured finance. https://www.irena.org/events/2016/Sep/Unlocking--Renewable-Energy-Investment-the-Role-of-Risk-Mitigation-and-Structured-Finance

Irandoust, M. (2016). The renewable energy-growth nexus with carbon emissions and technological innovation: Evidence from the Nordic countries. *Ecological indicators*, *69*, 118-125.

Islam, A. K. M., Islam, M., & Rahman, T. (2006). Effective renewable energy activities in Bangladesh. *Renew Energy, 31*, 677–88.

Islam, A., Chan, E. S., Taufiq-Yap, Y. H., Mondal, M. A. H., Moniruzzaman, M., & Mridha, M. (2014). Energy security in Bangladesh perspective—An assessment and implication. *Renewable and Sustainable Energy Reviews*, *32*, 154-171.

Islam, F., Shahbaz, M., Ahmed, A. U., & Alam, M. M. (2013). Financial development and energy consumption nexus in Malaysia: a multivariate time series analysis. *Economic Modelling*, *30*, 435-441.

Islam, F., Shahbaz, M., Ahmed, A. U., & Alam, M. M. (2013). Financial development and energy consumption nexus in Malaysia: a multivariate time series analysis. *Economic Modelling*, *30*, 435-441.

Jalil, A., & Feridun, M. (2011). The impact of growth, energy and financial development on the environment in China: a cointegration analysis. *Energy economics*, *33*(2), 284-291.

Ji, Q., & Zhang, D. (2019). How much does financial development contribute to renewable energy growth and upgrading of energy structure in China? *Energy Policy*, *128*, 114-124.

Kariuki, D. (2018, September 25). Barriers to Renewable Energy Technologies Development. *Economics-policy*. https: //www.energytoday.net/economics-policy/barriers-renewable-energy-technologies-development/

Kaygusuz, K. (2007). Energy for sustainable development: key issues and challenges. *Energy Sources, Part B: Economics, Planning, and Policy*, *2*(1), 73-83.

Khan, Z., Malik, M. Y., Latif, K., & Jiao, Z. (2020). Heterogeneous effect of eco-innovation and human capital on renewable & non-renewable energy consumption: Disaggregate analysis for G-7 countries. *Energy*, *209*, 118405.

Khandker, L. L., Amin, S. B., & Khan, F. (2018). Renewable energy consumption and foreign direct investment: Reports from Bangladesh. *Journal of Accounting*, *8*(3).

Kilicarslan, Z. (2019). The relationship between foreign direct investment and renewable energy production: Evidence from Brazil, Russia, India, China, South Africa and Turkey. *670216917*.

Kim, J., & Park, K. (2016). Financial development and deployment of renewable energy technologies. *Energy Economics*, *59*, 238-250.

Koengkan, M., Fuinhas, J. A., & Vieira, I. (2020). Effects of financial openness on renewable energy investments expansion in Latin American countries. *Journal of Sustainable Finance & Investment*, *10*(1), 65-82.

Komal, R., & Abbas, F. (2015). Linking financial development, economic growth and energy consumption in Pakistan. *Renewable and sustainable energy reviews*, *44*, 211-220.

Kraft, J., & Kraft, A. (1978). On the relationship between energy and GNP. *The Journal of Energy and Development*, 401-403.

Lee, J. W. (2013). The contribution of foreign direct investment to clean energy use, carbon emissions and economic growth. *Energy policy*, *55*, 483-489.

Li, J., Zhang, X., Ali, S., & Khan, Z. (2020). Eco-innovation and energy productivity: New determinants of renewable energy consumption. *Journal of Environmental Management*, *271*, 111028.

Lin, B. (2003). Structural changes, efficiency improvement and electricity demand forecasting. *Economic Research*, *5*, 57-65.

Lin, B., & Moubarak, M. (2014). Renewable energy consumption–economic growth nexus for China. *Renewable and Sustainable Energy Reviews*, *40*, 111-117.

Lin, B., Omoju, O. E., & Okonkwo, J. U. (2016). Factors influencing renewable electricity consumption in China. *Renewable and Sustainable Energy Reviews*, *55*, 687-696.

Lindlein, P., & Mostert, W. (2020, August 20). Financing Renewable Energy. Instruments, Strategies, Practice Approaches. *KfW Discuss. Pap. 2005*. https://www.kfw-entwicklungsbank.de/Download-Center/PDFDokumente-Diskussionsbeitr%C3%A4ge/38_AMD_E.pdf.

Lu, W. C. (2017). Renewable energy, carbon emissions, and economic growth in 24 Asian countries: evidence from panel cointegration analysis. *Environmental Science and Pollution Research*, *24*(33), 26006-26015.

Lv, Y., Chen, W., & Cheng, J. (2019). Direct and indirect effects of urbanization on energy intensity in Chinese cities: A regional heterogeneity analysis. *Sustainability*, *11*(11), 3167.

Mahadevan, R., & Asafu-Adjaye, J. (2005). The productivity–inflation nexus: the case of the Australian mining sector. *Energy economics*, *27*(1), 209-224.

Maji, I. K. (2015). Does clean energy contribute to economic growth? Evidence from Nigeria. *Energy Reports*, *1*, 145-150.

Marton, C., & Hagert, M. (2017). The effects of FDI on renewable energy consumption.

Menegaki, A. N. (2011). Growth and renewable energy in Europe: A random effect model with evidence for neutrality hypothesis. *Energy economics*, *33*(2), 257-263.

Mielnik, O., & Goldemberg, J. (2002). Foreign direct investment and decoupling between energy and gross domestic product in developing countries. *Energy policy*, *30*(2), 87-89.

Moradpour, O. M., Ebrahimi, M., & Tarkaman, A. M., (2012)."Financial market development and energy demand in Iran", *Quarterly Journal of Energy and Environmental Economics, 5*(2), 187-209.

Mudakkar, S. R., Zaman, K., Shakir, H., Arif, M., Naseem, I., & Naz, L. (2013). Determinants of energy consumption function in SAARC countries: Balancing the odds. *Renewable and Sustainable Energy Reviews*, *28*, 566-574.

Muhammad, S. (2018). Financial development, investment and energy consumption in Nigeria: ARDL approach. *Acta Universitatis Danubius. Œconomica*, *15*(1).

Mukhtarov, S., Mikayilov, J. I., Humbatova, S., & Muradov, V. (2020). Do high oil prices obstruct the transition to renewable energy consumption?. *Sustainability*, *12*(11), 4689.

Ocal, O., & Aslan, A. (2013). Renewable energy consumption–economic growth nexus in Turkey. *Renewable and sustainable energy reviews*, *28*, 494-499.

Omri, A., & Kahouli, B. (2014). Causal relationships between energy consumption, foreign direct investment and economic growth: Fresh evidence from dynamic simultaneous-equations models. *Energy Policy*, *67*, 913-922.

Omri, A., & Nguyen, D. K. (2014). On the determinants of renewable energy consumption: International evidence. *Energy*, *72*, 554-560.

Paramati, S. R., Apergis, N., & Ummalla, M. (2017). Financing clean energy projects through domestic and foreign capital: The role of political cooperation among the EU, the G20 and OECD countries. *Energy economics*, *61*, 62-71.

Paramati, S. R., Ummalla, M., & Apergis, N. (2016). The effect of foreign direct investment and stock market growth on clean energy use across a panel of emerging market economies. *Energy Economics*, *56*, 29-41.

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of applied econometrics*, *16*(3), 289-326.

Qamruzzaman, M., & Jianguo, W. (2020). The asymmetric relationship between financial development, trade openness, foreign capital flows, and renewable energy consumption: fresh evidence from panel NARDL investigation. *Renew. Energy.*

Rafindadi, A. A. (2015). Econometric prediction on the effects of financial development and trade openness on the German energy consumption: a startling revelation from the data set. *International Journal of Energy economics and policy*, *5*(1), 182-196.

Rafindadi, A. A. (2016). Does the need for economic growth influence energy consumption and CO2 emissions in Nigeria? Evidence from the innovation accounting test. *Renewable and Sustainable Energy Reviews*, *62*, 1209-1225.

Rafindadi, A. A. (2016). Revisiting the concept of environmental Kuznets curve in period of energy disaster and deteriorating income: Empirical evidence from Japan. *Energy Policy*, *94*, 274-284.

Rafindadi, A. A., & Mika'Ilu, A. S. (2019). Sustainable energy consumption and capital formation: Empirical evidence from the developed financial market of the United Kingdom. *Sustainable Energy Technologies and Assessments*, *35*, 265-277.

Rafindadi, A. A., & Ozturk, I. (2016). Effects of financial development, economic growth and trade on electricity consumption: Evidence from post-Fukushima Japan. *Renewable and Sustainable Energy Reviews*, *54*, 1073-1084.

Rafindadi, A. A., & Ozturk, I. (2017). Dynamic effects of financial development, trade openness and economic growth on energy consumption: Evidence from South Africa. *International Journal of Energy Economics and Policy*, *7*(3), 74-85.

Rafindadi, A. A., & Usman, O. (2019). Globalization, energy use, and environmental degradation in South Africa: startling empirical evidence from the Maki-cointegration test. *Journal of environmental management*, *244*, 265-275.

Rafindadi, A. A., & Yusof, Z. (2014). Are the periods of currency collapse an impediment to entrepreneurship and entrepreneurial haven? Evidence from regional comparison. *International Journal of Economics and Financial Issues*, *4*(4), 886-908.

Rafique, M. Z., Doğan, B., Husain, S., Huang, S., & Shahzad, U. (2021). Role of economic complexity to induce renewable energy: Contextual evidence from G7 and E7 countries. *International Journal of Green Energy*, *18*(7), 745-754.

Rashid, A., & Yousaf, N. (2016). Linkage of Financial development with electricity-growth nexus of India and Pakistan. *EuroEconomica*, *34*(2).

Raza, S. A., Shah, N., Qureshi, M. A., Qaiser, S., Ali, R., & Ahmed, F. (2020). Non-linear threshold effect of financial development on renewable energy consumption: evidence from panel smooth transition regression approach. *Environmental Science and Pollution Research*, *27*(25), 32034-32047.

Razmi, S. F., Bajgiran, B. R., Behname, M., Salari, T. E., & Razmi, S. M. J. (2020). The relationship of renewable energy consumption to stock market development and economic growth in Iran. *Renewable Energy*, *145*, 2019-2024.

Rezagholizadeh, M., Aghaei, M., & Dehghan, O. (2020). Foreign direct investment, stock market development, and renewable energy consumption: Case study of Iran. *Journal of Renewable Energy and Environment*, *7*(2), 8-18.

Rifkin, J. (2011). *The third industrial revolution: how lateral power is transforming energy, the economy, and the world*. Macmillan.

Riti, J. S., Shu, Y., Song, D., & Kamah, M. (2017). The contribution of energy use and financial development by source in climate change mitigation process: a global empirical perspective. *Journal of cleaner production*, *148*, 882-894.

Sadorsky, P. (2009). Renewable energy consumption and income in emerging economies. *Energy policy*, *37*(10), 4021-4028.

Sadorsky, P. (2010). The impact of financial development on energy consumption in emerging economies. *Energy policy*, *38*(5), 2528-2535.

Sadorsky, P. (2011). Financial development and energy consumption in Central and Eastern European frontier economies. *Energy policy*, *39*(2), 999-1006.

Sadorsky, P. (2011). Trade and energy consumption in the Middle East. *Energy Economics*, *33*(5), 739-749.

Sadrosky, P. (2010). The Impact of Financial Development on Energy Consumption in Emerging Economics. *Energy Policy*, *38*, 2528-2535.

Saibu, O. M., & Omoju, O. E. (2016). Macroeconomic determinants of renewable electricity technology adoption in Nigeria. *Economic and Environmental Studies (E&ES)*, *16*(1), 65-83.

Salim, R. A., & Rafiq, S. (2012). Why do some emerging economies proactively accelerate the adoption of renewable energy? *Energy economics*, *34*(4), 1051-1057.

Samour, A., Baskaya, M. M., & Tursoy, T. (2022). The impact of financial development and FDI on renewable energy in the UAE: a path towards sustainable development. *Sustainability*, *14*(3), 1208.

Saud, S., Baloch, M. A., & Lodhi, R. N. (2018). The nexus between energy consumption and financial development: estimating the role of globalization in Next-11 countries. *Environmental Science and Pollution Research*, *25*(19), 18651-18661.

Sbia, R., Shahbaz, M., & Hamdi, H. (2014). A contribution of foreign direct investment, clean energy, trade openness, carbon emissions and economic growth to energy demand in UAE. *Economic modelling*, *36*, 191-197.

Shahbaz, M., & Lean, H. H. (2012). Does financial development increase energy consumption? The role of industrialization and urbanization in Tunisia. *Energy policy*, *40*, 473-479.

Shahbaz, M., Chaudhary, A. R., & Ozturk, I. (2017). Does urbanization cause increasing energy demand in Pakistan? Empirical evidence from STIRPAT model. *Energy*, *122*, 83-93.

Shahbaz, M., Hye, Q. M. A., Tiwari, A. K., & Leitão, N. C. (2013). Economic growth, energy consumption, financial development, international trade and CO2 emissions in Indonesia. *Renewable and Sustainable Energy Reviews*, *25*, 109-121.

Shahbaz, M., Khan, S., & Tahir, M. I. (2013). The dynamic links between energy consumption, economic growth, financial development and trade in China: fresh evidence from multivariate framework analysis. *Energy economics*, *40*, 8-21.

Shahbaz, M., Lahiani, A., Abosedra, S., & Hammoudeh, S. (2018b). The role of globalization in energy consumption: a quantile cointegrating regression approach. *Energy Economics*, *71*, 161-170.

Shahbaz, M., Mallick, H., Mahalik, M. K., & Sadorsky, P. (2016). The role of globalization on the recent evolution of energy demand in India: Implications for sustainable development. *Energy Economics*, *55*, 52-68.

Shahbaz, M., Shahzad, S. J. H., Mahalik, M. K., & Sadorsky, P. (2018a). How strong is the causal relationship between globalization and energy consumption in developed economies? A country-specific time-series and panel analysis. *Applied Economics*, *50*(13), 1479-1494.

Shahzad, U., Hussain, M., Qin, F., & Amir, M. (2018). Reinvestigating the Role of Coal Consumption in Indian Economy: An ARDL and Causality Analysis. *European Online Journal of Natural and Social Sciences*, *7*(2), pp-348.

Sharmin, M. (2022, July 17). Transition to renewable energy for Bangladesh. *Financial Express*. https://thefinancialexpress.com.bd/views/transition-to-renewable-energy-for-bangladesh-1658073744

Shiu, A., & Lam, P. L. (2004). Electricity consumption and economic growth in China. *Energy policy*, *32*(1), 47-54.

Simionescu, M., Păuna, C. B., & Diaconescu, T. (2020). Renewable energy and economic performance in the context of the European Green Deal. *Energies*, *13*(23), 6440.

Soytas, U., Sari, R., & Ewing, B. T. (2007). Energy consumption, income, and carbon emissions in the United States. *Ecological Economics*, *62*(3-4), 482-489.

Tabrizian, S. (2019). Technological innovation to achieve sustainable development—Renewable energy technologies diffusion in developing countries. *Sustainable Development*, *27*(3), 537-544.

Tachev, V. (2022, May 12). Renewable Energy in Bangladesh 2022 – Current Trends and Future Opportunities. Energy Tracker Asia. https://energytracker.asia/renewable-energy-in-bangladesh-current-trends-and-future-opportunities/

Tamazian, A., & Rao, B. B. (2010). Do economic, financial and institutional developments matter for environmental degradation? Evidence from transitional economies. *Energy economics*, *32*(1), 137-145.

Tiwari, A. K. (2011). A structural VAR analysis of renewable energy consumption, real GDP and CO2 emissions: evidence from India. *Economics Bulletin*, *31*(2), 1793-1806.

Toumi, S., & Toumi, H. (2019). Asymmetric causality among renewable energy consumption, CO2 emissions, and economic growth in KSA: evidence from a non-linear ARDL model. *Environmental Science and Pollution Research*, *26*(16), 16145-16156.

Uddin, M. N., Rahman, M. A., Mofijur, M., Taweekun, J., Techato, K., & Rasul, M. G. (2019). Renewable energy in Bangladesh: Status and prospects. *Energy Procedia*, *160*, 655-661.

United Nations (2020, August 10). United Nations Decade of Sustainable Energy for All.2015.https://sustainabledevelopment.un.org/content/documents/8533SG%20Report_UN%20Decade% 20of%20Sustainable%20Energy%20for%20All-advance.pdf.

United Nations Development Programme (UNDP) (2019). Policy Brief #3: Financing SDG 7. https://sustainabledevelopment.un.org/content/documents/24090pb3_cover.pdf.

United Nations Development Programme (UNDP) (2021). Goal 7: Affordable and clean energy: Financing Affordable and Clean Energy. https://www.sdfinance.undp.org/content/sdfinance/en/home/sdg/goal-7--affordable-and clean-energy.html

United Nations, 2020. Ensure access to affordable, reliable, sustainable and modern energy. *Sustainable Development Goals.* https://www.un.org/sustainabledevelopment/energy/

United Nations. What is renewable energy? https://www.un.org/en/climatechange/what-is-renewable-energy?gclid=CjwKCAjwkaSaBhA4EiwALBgQaGF9llLWu4Q3hSoUC9N5OdMN_onMSh4CdS0pnQh6t9-y6GVZWUEhihoCFmkQAvD_BwE

Vadlamannati, K. C., ÃA, T., & Pin, J. (2009). Does higher economic and financial development lead to environmental degradation: evidence from BRIC countries. *Energy Policy*, *37*, 246-253.

Wang, J., Zhang, S., & Zhang, Q. (2021). The relationship of renewable energy consumption to financial development and economic growth in China. *Renewable Energy*, *170*, 897-904.

Wang, Q., Su, M., & Li, R. (2018). Toward to economic growth without emission growth: The role of urbanization and industrialization in China and India. *Journal of cleaner production*, *205*, 499-511.

Wolde-Rufael, Y. (2004). Disaggregated industrial energy consumption and GDP: the case of Shanghai, 1952–1999. *Energy economics*, *26*(1), 69-75.

Wolde-Rufael, Y., & Menyah, K. (2010). Nuclear energy consumption and economic growth in nine developed countries. *Energy economics*, *32*(3), 550-556.

World Bank (2021, September 11). World Development Indicators. https://databank. worldbank.org/source/world-development-indicators.

Wu, L., & Broadstock, D. C. (2015). Does economic, financial and institutional development matter for renewable energy consumption? Evidence from emerging economies. *International Journal of Economic Policy in Emerging Economies*, *8*(1), 20-39.

Yahya, F., & Rafiq, M. (2020). Brownfield, greenfield, and renewable energy consumption: Moderating role of effective governance. *Energy & environment*, *31*(3), 405-423.

Yilanci, V., Ozgur, O., & Gorus, M. S. (2019). The asymmetric effects of foreign direct investment on clean energy consumption in BRICS countries: A recently introduced hidden cointegration test. *Journal of Cleaner Production*, *237*, 117786.

Yildirim, E., Saraç, Ş., & Aslan, A. (2012). Energy consumption and economic growth in the USA: Evidence from renewable energy. *Renewable and Sustainable Energy Reviews*, *16*(9), 6770-6774.

Yoo, S. H. (2006). The causal relationship between electricity consumption and economic growth in the ASEAN countries. *Energy policy*, *34*(18), 3573-3582.

Yuan, J., Zhao, C., Yu, S., & Hu, Z. (2007). Electricity consumption and economic growth in China: cointegration and co-feature analysis. *Energy economics*, *29*(6), 1179-1191.

Zagorchev, A., Vasconcellos, G., & Bae, Y. (2011). Financial development, technology, growth and performance: Evidence from the accession to the EU. *Journal of International Financial Markets, Institutions and Money*, *21*(5), 743-759.

Zeren, F., & Mustafa, K. O. C. (2014). The nexus between energy consumption and financial development with asymmetric causality test: new evidence from newly industrialized countries. *International Journal of Energy Economics and Policy*, *4*(1), 83-91.

Zhang, M., Zhang, S., Lee, C. C., & Zhou, D. (2021). Effects of trade openness on renewable energy consumption in OECD countries: New insights from panel smooth transition regression modelling. *Energy Economics*, *104*, 105649.

Zhang, Y., Shi, S., Huang, K., Chen, X., & Peng, M. (2011). Effect of Cu2+ and Fe3+ for drug delivery: Decreased binding affinity of ilaprazole to bovine serum albumin. *Journal of luminescence*, *131*(9), 1927-1931.