

https://dspace.org/

Developing our financial markets to finance the energy transition

Madungandaba, Gcebile F.

2023
University of the Witwatersrand, Johannesburg
https://hdl.handle.net/10539/38978
Madungandaba, Gcebile F. . (2023). Developing our financial markets to finance the energy transition [Master's dissertation , University of the Witwatersrand, Johannesburg]. WireDSpace. https://hdl.handle.net/10539/38978

Downloaded from a DSpace repository. https://dspace.org/

DEVELOPING OUR FINANCIAL MARKETS TO FINANCE THE ENERGY TRANSITION

By Gcebile F. Madungandaba

A research report submitted to the Wits Business School, Faculty of Finance & Accounting, University of the Witwatersrand in partial fulfilment of the requirements for the degree of Master of Management of Finance & Investments

Johannesburg

2023

ABSTRACT

Developing a financial market is complex and tedious; therefore, the needs of various stakeholders must be considered, and market efficiency must be ensured to develop the renewable energy (RE) market effectively. This study offers valuable guidance on the effective allocation of capital resources in the renewable energy (RE) market to facilitate a smooth transition to renewable energy. To achieve this aim, panel data from 42 developing nations in Africa, Asia, and South America, spanning 1990-2019, are analysed. This study uses a panel fixed effects model to investigate the relationship between renewable energy production and credit, equity, and bond market development. The results of the empirical analysis suggest that all three dimensions of financial development, namely credit, equity, and bond, are positively associated with renewable energy production, albeit to varying degrees. This work also proposes a framework to promote renewable energy production in developing countries based on the empirical findings and existing literature. The framework highlights the leading renewable energy policy categories and specific policies most effectively promoting renewable energy production in emerging markets.

Keywords
Financial Market Development; Renewable Energy; Renewable Energy Policy; Just Transition; Credit Market; Equity Market; Bond Market; Panel Regression; Fixed-Effects.

DECLARATION

I declare that this thesis is my own unaided work. It is being submitted for the degree of Master of Management in Finance & Investment at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.

[signature of candidate]
Gcebile Fezeka Madungandaba

31st day of March in the year 2023

ACKNOWLEDGEMENTS

I am immensely grateful to Dr. Sedjro Aaron Alovokpinhou, my supervisor, for his invaluable guidance, unwavering support, and constant encouragement throughout the research process. His expertise and insights were instrumental in shaping this paper, and I am grateful for the time and effort he invested in helping me to improve my work. I am also thankful for his patience and understanding as I navigated the challenges of this project. Thank you for your unwavering support and commitment to my success.

I would also like to thank my parents and financiers, Ivy and Joe Madungandaba, for their generous support and funding for this research. Their belief in me and my academic goals has constantly motivated me throughout this journey.

Thank you both for your unwavering support, guidance, and encouragement. This accomplishment would not have been possible without your contributions.

TABLE OF CONTENTS

LIST OF TABLES ..... *vi*

Glossary ..... *vii*

Chapter 1: Introduction *2*

1.1 Background **2**

1.2 Research Gap **4**

1.3 Study Objectives **4**

1.4 Research Questions **5**

1.5 Study Contributions **6**

1.6 Study Significance **7**

1.7 Chapter Outline **7**

Chapter 2: Literature Review *9*

2.1 Theoretical Review **9**

2.1.1 Renewable Energy 9

2.1.2 Energy Transition and Just Transition 12

2.1.3 Financial Market 14

2.1.4 Financial Market Development 15

2.1.5 Financial Market Development Framework 16

2.1.6 Investment/Funding Sources 17

2.1.7 Private Sector 17

2.1.8 Foreign Market Approach 19

2.1.9 Financial Policy 19

2.1.10 Financial Innovation 21

2.2 Empirical Review **21**

2.2.1 Relationship Between Financial Market Development and Renewable Energy 21

2.3 Conclusion **24**

chapter 3: Research Data and Methodology *25*

3.1 Data **25**

Credit markets 33
Equity markets (Market Capitalisation) 34
Renewable energy production 34

3.2 Methodology 35

chapter 4: Findings and Discussion 38

4.1 Empirical Analysis 38

4.1.1 Baseline Findings 38
4.1.2 Additional Analysis 40

4.2 Robustness Checks 45

4.2.1 Credit Market 46
4.2.2 Equity Market 46
4.2.3 Bond Market 47
4.2.4 Additional Control Variable 47
4.2.5 Alternative Estimation Technique 49

4.3 Discussion 52

4.3.1 Results Discussion 52
4.3.2 Which Financial Markets for the Energy Transition? 55
4.3.3 Financial Market Development Framework 62
4.3.4 Financial Market Development for Renewable Energy Framework 68

4.4 Conclusion and Recommendations 74

4.4.1 Conclusion 74
4.4.2 Recommendations 74

Appendix A: Methodology Table 77

Reference List 78

LIST OF TABLES

Table 1: Characterization of policies for the advancement of renewable energy (Haas et al., 2011). 20
Table 2: List of countries in the dataset by region. 25
Table 3: Description and sources of variables. 28
Table 4: Descriptive statistics. 31
Table 5: Correlation between financial development indicators. 32
Table 6: Baseline findings. 39
Table 7: Baseline regressions, credit market development, by region. 42
Table 8: Baseline regressions, equity market development, by region. 43
Table 9: Baseline regressions, bond market development, by region. 43
Table 10: Additional analysis, financial depth. 44
Table 11: Alternative measures for credit, equity and bond market development. 46
Table 12:Introduction of foreign direct investment as an additional control variable. .. 48
Table 13: Fixed effects vector decomposition results. 51
Table 14: Key market contributors and participants. 65
Table 15: Financial market development and renewable energy production framework (Ata, 2013; Bank for International Settlements, 2020; International Renewable Energy Agency, 2020; IRENA, 2018; Kabel & Bassim, 2019; Lu et al., 2020; OECD, 2017; REN21, 2022; Shokri & Heo, n.d.; UNEP FI, 2012). 70

GLOSSARY

CO2	Carbon Dioxide
COP	Conference of the Parties
CPI	Consumer Price Index
DOLS	Dynamic Ordinary Least Squares
EG	Economic Growth
FD	Financial Development
FDI	Foreign Direct Investment
FEVD	Fixed Effects Variance Decomposition
FIT	Feed-In Tariff
FMD	Financial Market Development
FOREX	Foreign Exchange
GDP	Gross Domestic Product
GHGs	Greenhouse Gases
GLS	Generalised Least Squares
OECD	Organization for Economic Cooperation and Development
PNG	Public Non-Guaranteed
PPG	Public & Publicly Guaranteed
R&D	Research and Development
RE	Renewable Energy
REC	Renewable Energy Consumption
REP	Renewable Energy Production
RET	Renewable Energy Technology

CHAPTER 1: INTRODUCTION

1.1 Background

Due to the rise of carbon dioxide (CO_2) levels and other pollutants, global warming has caused a notable change in the natural equilibrium, gradually increasing Earth's temperature (Wolff et al., 2020). The consequences of climate change have led to increased occurrences of extreme weather, and various regions worldwide are experiencing longer, hotter heat waves leading to more frequent droughts, heavier rainfall, or mighty hurricanes, all of which have led to dire consequences for their respective economies and citizens (MacMillan & Turrentine, 2021). Global warming has been deemed a defining issue of current times and is certainly one of the most significant challenges both current and future generations will face. Intentional efforts consisting of creative solutions are required to resolve this problem.

"Recent years have seen an increase in the development of renewable energy (RE). As a result of the growing concern over climate change, an emphasis on clean energy generation has led to a calling for migration from fossil fuel to renewable, sustainable energy production" (United Nations, n.d.). The improvement of policies related to climate change has helped propel RE growth to new heights (Abdelilah et al., 2021).

Financial market development has a considerable impact on the consumption of renewable energy. The financial market dictates the flow of capital and determines whom to lend to and what to invest in, thus having a direct impact on a firm's propensity to grow (Samour et al., 2022). Renewable energy technology (RET) investments are often considered expensive due to high initial costs relative to their expected returns and long payback periods, thus requiring loans with a longer maturity. The banking system and credit market's capacity and complexity determine the availability of long-term loans, which is crucial for RET projects. Hence, the significance of financial market development (FMD) concerning renewable energy consumption (REC) is evident (Brunnschweiler, 2010).

Current market conditions for RE favour developed countries with more evolved and complex financial markets that can cater to the expensive requirements of RET. Emerging and developing countries face countless daunting challenges, including an

inability to satisfy the capital intensity of RET and a reliance on the continued provision of fossil fuels to meet current energy needs. “The factors mentioned above contribute to higher costs and greater difficulties in implementing RE generation in the short term compared to customary fossil fuel-based technologies, particularly for large-scale generation” (UNEP FI, 2012).

The Paris Agreement of December 2015 saw world leaders reach a consensus on the need to tackle climate change. The agreement set long-term objectives to guide all nations. These can be summarised broadly into the following three main goals: to decrease global greenhouse gas (GHG) emissions significantly and constrain the rise in global temperatures to review every country’s commitment every five years and to provide financing to developing countries in their fight against climate change while building resilience to such change and enhancing their ability to adapt to the impacts (United Nations, 2015).

During the Conference of the Parties (COP26), representatives from numerous parties joined forces to expedite efforts to achieve the targets of the Paris Agreement and the United Nations Framework Convention on Climate Change. Chief among the various goals established was an urgent need to increase the world’s capacity to produce RE (Ostrom, 2017). Developing countries were identified to be major potential contributors to the world’s RE generation capability, and developed countries made renewed pledges to accelerate their growth (Mani et al., 2018). A ground-breaking multinational partnership consisting of the UK, the USA, France, Germany, and the EU settled to support South Africa’s transition away from coal through $8.5 billion in funding (United Nations, 2021). In addition, private financial institutions and central banks have declared their commitment to redirect trillions of dollars toward attaining worldwide net-zero emissions (Savaresi, 2016).

It is crucial to shift the global energy sector away from its reliance on fossil fuels and toward a zero-carbon future. Although a global transition is underway, further effort, particularly from developing countries, is required to fulfil global climate goals. To that end, the FMD of these developing nations is essential to fund and support this transition to green energy (IRENA, 2018). This research paper explores the nexus between the financial markets of developing economies and their RE consumption. Through an

empirical analysis of the underlying factors affecting FMD, a deeper understanding of how best to develop these markets to finance the energy transition effectively is sought.

1.2 Research Gap

Although there has been significant research on energy transition and FMD, there is a dearth of research on the subject of FMD in emerging and developing markets, particularly in the financial markets that fund RE projects (Bhutta et al., 2021).

First, "greater insight into the relationship between FMD and REC, with a particular focus on developing countries" within Africa, Asia, and South America, is required to determine RET implementation's driving factors (Brunnschweiler, 2010). This research will not only confirm the FMD and REC nexus within a developing economy context. However, it will also obtain knowledge of the significance of each financial market sector in this relationship. Second, further understanding of the most effective way to develop financial markets is required to ensure adequate funding consistently flows towards low-carbon energy production (Chirambo, 2016).

To this end, various key questions may arise: Is there a direct relationship between FMD and REC within emerging and developing countries, and if so, which markets have the most significant impact on REC? What new financial instruments are needed to optimise RE sector development? What is the recommended approach for introducing these instruments? What is the suggested sequence for developing the various types of financial markets and associated institutions? What policy and structural changes need to be implemented to set the direction highlighted by the previous questions?

1.3 Study Objectives

The exercise of developing a financial market is complex and tedious. The needs of the various stakeholders must be considered, and market efficiency must be ensured to effectively develop the RE market (Gielenet al., 2019). This paper offers valuable insights into the optimal deployment of capital resources in the renewable energy market for a seamless shift from fossil fuels to RE (Anton & Nucu, 2020). The primary objective of this study is to prove the essential role of FMD in RE sector development within emerging and developing markets and formulate guidelines on how best to develop the RE sector in these markets.

The secondary objectives of this study concern essential concepts that must be observed and validated to meet the primary objective. First, this research will determine whether a nexus exists between the development of the various categories of financial markets, such as equity, debt, and bond markets and RE consumption. This point will act as the base of this study. The FMD framework can be validated by determining the relationship between the independent FMD variables and the dependent REC variables. Second, once a relationship has been confirmed and deemed significant, this research will attempt to determine which financial market sector plays the most prominent role in RE consumption.

Given that FMD is essential for the financing of the energy transition, through the comparison of financial market sectors, we seek to determine and rank the most effective financial markets (debt/equities/bond market) to promote REC. Lastly, this research seeks to establish an FMD framework to promote REC in developing countries. This framework will be drawn on the study's empirical results and supported by relevant policy recommendations. Additional insights may be observed through conducting tests to fulfil the stated objectives, such as the importance of policy decisions and financial innovation and the influence of the quantity and quality of financial markets on RE.

The research objectives can be summarised as follows:

- To determine whether a relationship can be established between the development of financial markets and the production of renewable energy in developing and emerging countries.
- To explore the impact that the development of financial markets has on producing renewable energy.
- To determine the importance of financial market development for the renewable energy transition.

1.4 Research Questions

Through this study, we aim to answer the following two main research questions and ultimately provide a helpful framework to develop the financial market.

- Can a relationship be established between the development of financial markets and the production of renewable energy in developing and emerging countries? How does the development of financial markets impact the production of renewable energy? Additional sub-questions derived from the first core question include:
    - How does the credit market affect renewable energy production in emerging and developing countries?
    - What impact does the equity market have on renewable energy production in developing and emerging markets?
    - How does the bond market impact renewable energy production in emerging and developing countries?

- How important is financial market development for the renewable energy transition?
    - Additional sub-questions derived from the second core question are:
        - How important would a policy framework be for the energy transition?

While these auxiliary questions are not part of the primary research questions, they will be addressed by analysing the empirical results and providing additional insights.

- Why is financial market development critical for the successful development of the renewable energy sector?
- How will policy affect the development of financial markets?

1.5 Study Contributions

This paper aims to enhance the understanding of the determinants of renewable energy (RE) development in two key ways. Firstly, we will empirically analyse the relationship between financial market development (FMD) and RE sector development, specifically focusing on developing countries across three regions. (Brunnschweiler, 2010); and second, by establishing a framework that can be used by emerging countries to efficiently and effectively develop their financial markets to better fund the transition from fossil fuels to RE (Chami et al., 2009). The authors believe that this paper represents the first effort to develop a framework for developing countries to establish their financial markets to stimulate the growth of renewable energy consumption, to the

best of their knowledge. This study will also provide insight into the factors that driving FMD and the various risks that inhibit its growth.

1.6 Study Significance

This study will validate the nexus between FMD and REC in emerging nations and provide a meaningful framework that emerging and developing countries may use to develop their own financial markets. Successful RE financing strategies implemented in developed nations may prove to be ineffective in emerging markets. Thus, a comprehensive analysis of different emerging market regions/continents and an FMD framework would aid policymakers in ensuring that an appropriate environment for RE financing strategy implementation is established for their respective regions. This approach would ensure that capital providers, investors, and entrepreneurs allocate their resources correctly to ensure the most effective and efficient use of their funds.

1.7 Chapter Outline

This thesis consists of five chapters. The first chapter provides the background and historical context of the global transition to RE, and the considerations of emerging and developing countries when attempting to develop their respective financial markets. A research gap is defined, highlighting the underexplored area of FMD and providing the scope for further research. The primary and secondary study objectives are highlighted in this chapter, and the research questions are derived from the objectives. The contributions and significance of this study are also noted.

The second chapter comprises a literature review which provides familiarity with the research topic and outlines relevant research trends. The third and fourth chapters provide insight into the methodology used in this study. A hybrid approach was employed in the research design. Qualitative data in primary data relating to financial figures and secondary data sourced from journals and reports were gathered. Results and key findings that emerge from the methodology employed are discussed. These chapters aim to answer the previously defined research questions while unpacking various themes and any additional questions that may arise.

The final chapter concludes the research and summarizes the main points discussed, conveying study's more considerable significance. It also identifies how the gap in the literature has been addressed and explores other avenues through which the research objective may be fulfilled. Finally, recommendations that suggest specific strategies to address the issue of financing the energy transition are made, and an FMD framework for developing markets is established.

CHAPTER 2: LITERATURE REVIEW

2.1 Theoretical Review

2.1.1 Renewable Energy

Renewable Energy Defined

Renewable energy, also known as clean or green energy, refers to energy derived from natural resources that are not finite or exhaustible. These resources, such as solar, wind, water, geothermal, and gas power, are naturally replenished and deemed sustainable and non-corrosive to the environment (Balciogluet al., 2017). Current world sentiment has led to RE being the preferential source of global energy supply. Consequently, developed economies with advanced financial markets are well placed to transition to greener energy; however, emerging economies still face challenges in transitioning (Marshall et al., 2021).

Benefits of Renewable Energy

First, using RE could immediately reduce CO_2 emissions and other GHGs that contribute to global warming. A study by Rahman et al., (2022) suggested that REC reduces CO_2 emissions in both the short and long term. Thus, the transition will assist in alleviating the effects of global warming, such as extreme weather conditions and water shortages.

Second, using RE could result in improved public and environmental health. Fossil fuel–generated electricity is a significant water and air pollutant, as harmful substances, including sulphur dioxide, nitrogen oxides, and fine particle matter, are released into the atmosphere and water supply (Buonocore et al., 2019). Fossil fuel–generated electricity also requires substantial amounts of freshwater for use in the production and conversion processes of energy supply, often for cooling purposes (Spanget al., 2014).

Third, RE is an inexhaustible energy supply, replenishing itself naturally without adding other inputs. Wind, solar, hydropower, geothermal, biomass, and wave/tide energy provide inexhaustive energy sources (Owusu & Asumadu-Sarkodie, 2016).

Fourth, several economic benefits can result from RE use, such as labour market expansion, stable energy prices, and increased stability in energy generation. The RE sector is an underdeveloped market, particularly in emerging countries. The establishment of this market will necessitate a new labour force equipped with the relevant skills needed to fulfil these new job requirements. Thus, the green energy sector has the potential to stimulate employment directly and indirectly in various sectors or industries such as industrial, project development, plant construction and installation, logistics, operations, and maintenance, as well as financial, legal, and consulting services (Union of Concerned Scientists, 2017). The increased stability in energy generation through RE will improve nations' energy security. The transition will result in a shift from centralised energy production, often dominated by a few large entities, to decentralised production, in which more participants supply RE, albeit at lower volumes than fossil fuel energy generators (Ahlqvist et al., 2018).

Barriers to Renewable Energy

The various barriers to RE's adoption and implementation will be explored under the following categories: over-reliance on fossil fuels, institutional and regulatory barriers, technical barriers, and financial and economic barriers.

Over-reliance on fossil fuels. Many markets, both developed and emerging, continue to use fossil fuel–based energy because their nations are naturally endowed with ample supplies of these resources (Kariuki, 2021). They can use their current resources and infrastructure to generate cheaper energy to meet their current electricity demands. This strategy highlights the underlying structural challenges within their energy sectors, as traditional energy markets are inherently centralised to ensure energy security.

Institutional and regulatory barriers. Any realistic transition could only be led by effective policies driving RE's development and diffusion (Johnstone et al., 2008). It is critical to emphasize that the RE market is policy-driven. Delays or hindrances to RE development are often a result of poor (or no) policies that stimulate the market. The absence of policies that promote foreign direct investment (FDI), fiscal, financial, and market initiatives, and price-related policies, such as feed-in tariffs (FITs), leads to a lack of incentive for firms to enter the RE sector (Kochtcheeva, 2016). The policies

mentioned above should ensure that no excessive regulatory barriers deter the development of and participation in an RE market.

Technical barriers. Renewable energy initiatives often encounter challenges related to technology and infrastructure. In most instances, local energy grids have been designed to generate and transmit energy through a centralised model and, thus, are not suited for integrating RE technology (Kabel & Bassim, 2020). Additional planning on the national and municipal levels is required to enable this complex integration, for which specialist knowledge in various fields is required. Significant funding for infrastructure development is required to ensure that any RE generated can enter the national grid.

Moreover, technology is also considered to be a significant barrier to RET use. Renewable energy technology is a broad term that may refer to the technology used for energy generation, transmission, and storage. Significant improvements have been made to generation and transmission technology, but storage technology remains risky. There are insufficient options for the effective storage of RE, which acts as a substantial obstacle to the growth of the sector. As such, RE storage has been deemed the most vulnerable element within the RE value chain (Pueschel, 2016).

Financial and economic barriers. One of the primary difficulties emerging markets face in adopting RE is the cost. Establishing a solid financial system is crucial to overcoming the numerous financial obstacles to investing in renewable energy compared to fossil fuel-based energy, including higher infrastructure, start-up, and operating costs. This establishment requires a system that supports efficient price discovery, funding, market liquidity, and risk management (Eren et al., 2019). The advantages of REP manifest in the medium to long term and are realized at an economic, national, or societal level. However, private players who operate in competitive markets are primarily concerned with pursuing activities that yield immediate financial benefits (UNEP FI, 2012). Developed economies hold an advantage over emerging economies. The associated risks of RE are often deemed higher in the latter. Thus, the required return investors seek tends to be higher, making many RE projects in emerging economies less attainable and reducing the funding flowing to these markets.

Instances of Failed or Delayed Transitions

Chile is a prime example of a developing nation with immense RE potential but has been held back by various barriers. Even though several RE projects have received approval from regulatory authorities, they still reflect low utilisation of RE within their energy mixes. This is mainly due to a lack of access to affordable capital at reasonable interest rates, limitations within local energy grids, and a lack of RE storage options. Additionally, a lack of institutional capacity to plan and execute RE projects has led to the purposeful stagnation of RE development. This results from market manipulation by incumbent energy producers, dominated by private sector firms that aim to monopolise the energy market through cartel and anti-competitive behaviour (Pueschel, 2016).

2.1.2 Energy Transition and Just Transition

The phrase ‘energy transition’ usually denotes the shift from an economy that heavily relies on carbon to one that relies more on low-carbon alternatives (Kennedy, 2018). This refers to reducing reliance on fossil fuels and increasing the adoption of renewable energy sources aimed at reducing CO2 emissions and mitigating climate change. However, it is crucial to acknowledge the potential difficulties that vulnerable individuals, workers, and communities might encounter during the shift towards renewable energy, given the consequences of climate change. For example, the negative effects of climate change may directly impact their lives and sources of income. Severe weather conditions, like prolonged droughts and heavy floods, can inflict substantial harm to numerous households and exacerbate food and water security risks. On the other hand, many household incomes linked to fossil fuels or high-emission industries will reduce as those roles and practices discontinue during the energy transition (Presidential Climate Commission, 2022).

It is important to note when considering an energy transition that the main concerns at the national level (i.e., ensuring sufficient energy supply while diversifying the energy mix) may differ from those at the local and municipal levels (i.e., community employment and the cost of electricity) (Technical Working Group, 2021). To successfully navigate the energy transition, increased coordination between the different levels of government, local communities, mining firms, and trade unions is necessary. If a region’s development was previously reliant on a high-emission industry, it could be repurposed, and new economic opportunities other than those in the energy industry

could be identified. Implementing a strategy that considers multiple and diversified economic activities will soften the impact of an energy transition (Strambo et al., 2019).

The development and deployment of RET are significantly influenced by the legal, regulatory, and political framework of a country's electricity sector. The strength and effectiveness of the legal, regulatory, and political environment will determine the ease and efficiency with which RET can be deployed for those with the required capacity to drive it. In emerging and developing markets, electrical generation systems are frequently characterised by a state-owned national power utility that enjoys a legal monopoly (Nworie, 2017). Monopolies are inherently inefficient, and delays in the transition to RET are common, particularly in instances where these power utilities predominantly make use of fossil fuels. By fault of design, these energy structures hamper innovation and efficiency and, in many instances, lead to inefficient energy generation. “The absence of incentives and flexibility on the part of energy providers hinders the easy grid and market access of third-party and private sector independent power producers, who are often instrumental in driving RE development. This obstacle impedes progress towards reducing energy costs” (UNEP FI, 2012).

A just transition refers to policies and efforts to maximise the social and economic opportunities arising from a transition to greener energy while minimising the risks and effects of the transition. For instance, South Africa’s current energy generation capacity relies heavily on fossil fuels, namely coal. This has resulted in a highly developed and mature coal market which is a source of employment for more than 300,000 people (Smith, 2017). A transition to green energy would have a major impact on the country’s labour market and its economy. It is a multidimensional challenge. Therefore, it would be essential to consider all stakeholders during this transition and ensure employees and communities have opportunities for new employment, skills training, and social protection.

A just transition is supported by the three underlying principles of distributive, restorative, and procedural justice. Distributive justice ensures that the risks and opportunities arising from an energy transition are distributed. This means that those historically responsible for the problem must pay the transition costs rather than the workers and community. Restorative justice seeks to rectify the historical damages that

communities and the environment have incurred; this includes supporting community members' health, improving the community's energy security, increasing biodiversity through land rehabilitation, and assisting with employment opportunities. Procedural justice seeks to empower workers, communities, and small businesses and ensure they are supported through the transition. This includes ensuring that community members know what a just transition entails and participate in any decision-making process that includes them (Presidential Climate Commission, 2022).

When looking to ensure an effective, just transition, it is essential that holistic policy areas be considered. Policies related to human resource development and skills development should assist current workers in fossil-fuel-related industries in reskilling or upskilling while also preparing future labourers for the new advancing technology and RE roles. Policies related to industrial development, economic diversification, and innovation should be implemented, as new economic activities will be required. They will provide new jobs to replace those lost in the transition. Policies should also provide social protection measures, as many people will be marginalised due to the transition and unable to reskill or upskill, or simply protective measures for those suffering from the adverse effects of climate change (Smith, 2017).

2.1.3 Financial Market

In a financial market, financial products or instruments are bought and sold (Darškuvienė, 2010). It is a marketplace wherein securities may be traded, ensuring an economy's smooth operation and organization. "It plays an essential role in the development of an economy by allocating resources appropriately and creating liquidity, ultimately allowing for the sharing of risk and provision of the ideal environment for innovation to prosper. When functioning optimally, developed financial markets facilitate the transference of resources from lenders to borrowers and make the economy more resilient to shocks by allowing appropriate risk allocation" (Chami et al., 2009).

"The four primary segments of the financial market include the money market, capital market, foreign exchange market, and derivatives market" (Juko, n.d.). The capital market comprises two major components: the equity market, which includes primary and secondary markets, and the debt market, which includes bonds and loans. Alternative markets also provide additional avenues for funding, such as through peer-

to-peer lending or crowdfunding (Bodi et al., 2021). The functions of financial markets have been well defined in previous studies and can be summarised into three main roles, as follows: they are essential in the determination of securities prices; they provide liquidity within the market; and they assist in risk management.

Financial markets are important because they ensure that capital is allocated efficiently and that economic activities operate smoothly. Without financial markets, most businesses would lack the necessary cash on hand or access to credit to facilitate their trade and operations. The implication is that only those individuals and firms that historically held wealth would have the capital to innovate and grow. The result would be a stagnant economy, as individuals and firms would only proceed with the activities they are unterested in or where they would maximise their returns as opposed to exploring activities that may be less profitable but are for the benefit of the public.

2.1.4 Financial Market Development

"The Objective of financial market development is to reinforce the capacity of the financial system to gather domestic savings and foreign capital to finance investments and consumption while also facilitating effective risk-sharing. Robust and fluid markets foster clear and effective asset pricing, entice a broad range of investors, and aid in transferring risk to capable and willing parties" (Mehrotra et al., 2020). Developed financial markets allow for an environment where resources are easily transferrable from savers to investors who seek to invest funds in ventures promising positive net returns. By understanding that the fundamental basis of FMD is to enhance the financial market's capacity, the elements within the financial market that should be focused on to maximise the use of funds can be determined.

"The goal of financial market development is to establish a market that facilitates investment, funding, and risk transfer with competitive pricing. This market involves numerous participants trading large volumes with minimal bid-offer spreads. A deep and liquid market with predictable trading conditions and reliable settlement mechanisms is considered an effective market" (The South African Reserve Bank (SARB) and Financial Sector Conduct Authority (FSCA.), 2020).

Financial market development involves not only expanding the availability of financial instruments but also encompasses the creation and adoption of intermediating funds, and managing risks associated with financial transactions. Expanding and strengthening financial markets requires creativity, as new policies must reflect flexibility and adaptability to remain effective in an ever-evolving market that grows with new changes in technology and innovation (Chami et al., 2009). Concerning RE development, FMD is essential in ensuring RE initiatives have access to funding to promote development. Renewable energy projects require large amounts of exceptionally patient capital to materialise. Patient capital inherently flows to developed financial markets, as these markets not only mitigate risk for investors but are also categorised by advanced or developed regulatory bodies and effective legal systems, which ensure confidence in the market and provide protection for investors through the right of recourse (Akamiokhor, 1992).

Ito and Kawai (2018) revisited the issue of determining the degree of FMD by constructing a means to calculate both its qualitative and quantitative aspects via creating indexes for those aspects. The quantitative index consists of variables measuring various financial markets' depth and size. The variables of the qualitative index measure the market's diversity, liquidity, and efficiency (Ito & Kawai, 2018). The current study aimed to use both index measures to obtain a greater understanding of the drivers of FMD, which could then be used to determine the most effective manner of financing RET development.

Given that financial markets are essential in ensuring that economic activities continue smoothly, and that capital is allocated efficiently, developed markets with more participants and significant trade volumes signify increased market confidence and positive economic activity. This ensures that significant cost-effective and efficient capital will flow towards RE development, reflected through access to cheaper capital.

2.1.5 Financial Market Development Framework

The methodology adopted in this study is premised on the notion that the development of FMD is fundamentally contingent on the existence and conduct of market actors and can only be comprehensively comprehended in the context of their motivations, restrictions, and prospects. Consequently, the analytical framework revolves around

examining the actions of four key players (namely, borrowers, lenders, liquidity providers, and regulators) whose contributions are indispensable for the effective functioning of financial markets, intending to ascertain whether and how markets evolve in a given setting (Chami et al., 2009).

Chami et al., (2009) derived an appropriate strategy for sequencing FMD, advising that financial markets should initially be developed by the credit market, followed by the bond market, asset-backed securities, and equities and derivatives market. The strategy suggests that simpler and more easily verifiable concessions, such as maturity-collateral and seniority-control concessions, will likely be introduced initially. It also proposes that successful market improvement may involve simultaneous changes in interconnected marketsand guidelines.

2.1.6 Investment/Funding Sources

Historically, RE projects were primarily funded through either loans or equity capital. How RE projects are utilized is crucial when choosing a funding approach. Typically, loans are used for RE ventures with conventional and established technology and methods, whereas equity is more commonly employed for RE ventures that utilize new and innovative technology (Donastorg et al., 2017).

2.1.7 Private Sector

Engagement with the private sector is critical for FMD. Private sector participants can facilitate and aid in RE investment (Donastorg et al., 2017). In their work, Abolhosseini and Heshmati (2014) reviewed the three primary means of financing RE development programs: feed-in tariffs (FITs), tax incentives, and tradable green certificates. The present study examines a suitable financial and political structure to facilitate private sector engagement in renewable energy projects.

A deeper comprehension of the energy sector's key segments is necessary to grasp the factors that motivate private investment. The energy sector can be subdivided into three essential subsectors, as follows: generation, or the transformation of raw sources into electricity; transmission, or the transfer of electricity from main power stations to smaller substations in various municipalities; and distribution, or the delivery of the electricity to the end users (Schlapinski et al., 2015).

Determinants of Private Sector Investment

Fadly (2019) tested the carbon lock-in theory in the RE industry. This hypothesis refers to the interconnected social, institutional, and technological factors that can potentially create policy inertia towards migration to RET (Seto et al., 2016). In doing so, "the author explored the drivers of private sector investments and the evolution of investment probability over time, arguing that the successful transition of a country to renewable energy (RE) hinges on the timing of private sector investments and the probability of their recurrence" (Fadly, 2019).

Aslani et al., (2012) considered Middle Eastern countries, particularly Iran, and focused on the factors the private sector is concerned with when considering the countries' participation in the RE sector. "They recognised seven factors deemed as prerequisites for RE investment by the private sector: engineering efficiency, annual exploitability, regional energy potentials, finance technological, consumption market, government policies, and EPR."

A technical paper released by PricewaterhouseCoopers (2001) explored the vital elements for private sector participation in power distribution. It identified the following eight factors that have the greatest impact on private investors' decision-making processes: "the overall status of a country, the efficiency of the legal system, the state of the energy firm in question, the efficiency of the tendering process, the resource availability, the expected financial performance, the regulatory framework, and the profile or appetite of the investing firm," (PricewaterhouseCoopers Securities, 2001).

A study conducted by Azhgaliyeva et al., (2021) from 2008–2018 examined the drivers of private investment in the RE sector of 13 Asian countries. An estimate of the impact of RE policies on private sector investments across the various private funding sources was made using a regression model. The empirical results suggested that FITs are the greatest drivers of private participation in Asian countries and that low regulatory environments magnify FITs' impact on private participation (Azhgaliyeva et al., 2021). In contrast, from a global perspective, public participation in the research and development (R&D) of RE technology is the greatest driver of private participation in the RE sector. Both conclusions are logical, as FITs make accessing to the RE market

easier for private participants. At the same time, greater public investment in R&D has the dual effect of reducing the private sector's R&D costs and hastening the advancement of the required RE technology.

2.1.8 Foreign Market Approach

A steady rise in non-traditional sources of development finance has been seen in the global economy in recent years. China is known to have an active and aggressive investment policy, leading to its lending institutions emerging among the dominant players within the foreign credit market of developing and emerging economies. Development lending encompasses a wide variety of sectors and loan types. Over the years, China has gained experience in financing various energy projects, ranging from general to advanced, and in having done so, it is now able to effectively evaluate projects and provide competitive funding to ensure the efficient achievement of development goals (Kumanduri, 2021).

2.1.9 Financial Policy

"Financial policies encompass regulations, supervision, and oversight of financial payment systems, markets, and relevant bodies." These policies strive to foster financial solidity, market efficiency, and the safeguarding of client assets and consumer interests (International Monetary Fund, 2000). In recent times, "efforts to optimize the use of limited public resources have prompted a departure from direct support measures, like grants and subsidies, in favour of creating favourable circumstances that encourage greater private sector investment" (Kennedy, 2018).

A diverse range of policies is designed to encourage the RE sector development. These policies either reduce the costs of RE technology (price-driven) or facilitate greater market penetration (quantity-driven) (Chatri & Yahoo, 2021). They can be broadly categorised based on the government's involvement (direct or indirect) or regulatory focus (generation-based or investment-focused) (Haas, et al., 2011). Of the host of policies, laws, and regulations available for promoting RE development, the most significant and effective are further explored here.

The setting of national RE targets is a legal requirement set by the government to ensure RE producers source a percentage of a nation's energy generation with a determined

timeline (The World Bank, 2022). The government sets quota obligations to force power utilities to procure specific portions of power from RE sources, and policies set provisions to access the grid either through mandated grid access or by reducing transmission costs and other fees. "Feed-in tariffs are price-driven policies whereby governments offer to purchase a specific amount of energy for a set period at a guaranteed price or price range" (Chatri & Yahoo, 2021). Auction schemes, tendering, taxes, and other investment incentives also play significant roles in policies' effect on RE generation.

Table 1: Characterization of policies for the advancement of renewable energy (Haas et al., 2011).

		Direct		**Indirect**
		"Price Driven"	**"Quantity Driven"**	
Regulatory	**Investment Focused**	"Investment incentives"	"Tendering system for investment grant"	"Environmental taxes"
		"Tax credits"		"Grid access provisions"
		"Low interest/soft loans"		"National renewable energy (RE) targets & quotas"
	Generation Based	"Feed-in tariffs"	"Tendering system for long-term contracts"	"National RE targets & quotas"
		"Fixed premium systems"	"Tradable green certificate system"	
		"Auction scheme"		

The financial policies are applied through various transmission channels, such as monetary and fiscal policies, impacting renewable energy production. A decrease in

interest rates (monetary policy) would reduce borrowing costs, thus making it cheaper to finance renewable energy projects(Monnin, 2015) & (Schmidt et al., 2019). Fiscal policies such as tax, market regulations, and fiscal stimulus can impact equity prices. A decrease in equity prices reduces a firm's ability to raise capital, thus making it more difficult to finance RE projects (Sun et al., 2022).

2.1.10 Financial Innovation

Financial innovation involves developing novel financial instruments, technologies, institutions, and markets. In the ever-evolving global financial environment, new innovative products are required to meet sustainable development goals while providing efficient funding. Financing plays a pivotal role in promoting sustainable development, and there are various obstacles to securing funding for eco-friendly initiatives. Green bonds offer a viable financial instrument to finance such endeavours, enabling capital provision to support green projects (Umair Saeed Bhuttaa, 2022).

Green finance products aim to facilitate financing for green projects with less bureaucratic hurdles. "Among these products, green bonds are an alternative to conventional bonds as a debt instrument that satisfies environmental, social, and governance objectives" (Umair Saeed Bhuttaa, 2022). The green bond market provides investors with a more accessible avenue to improve their corporate social responsibility and access green or sustainable markets. Although several studies are available regarding financial innovation in developing countries, the vast majority relate to China only. Thus, there is a limited scope regarding the contextual environment of financial innovation in developing countries. Studies on other developing countries, such as South Africa, India, and Brazil, are required to understand further the green bond market to evaluate its impact and effectiveness accurately.

2.2 Empirical Review

2.2.1 Relationship Between Financial Market Development and Renewable Energy

Brunnschweiler (2010) performed a study on the effect of FMD on the usage of RE conducted in 119 countries (particularly non-members of the Organization for Economic Cooperation and Development, non-OECD) from 1980–2006. A panel generalised least squares (GLS) regression was performed whereby the dependent

variable of RE production (REP) was separated into RE types; when looking at FMD, the markets' depth or robustness was also considered (Brunnschweiler, 2010). The empirical results showed that FMD strongly and significantly impacted the amount of RE produced. The results were significant to the degree that a one standard deviation increase in FMD resulted in a 0.3 standard deviation increase in REC. Moreover, commercial banking and private credit greatly impacted RE use in emerging markets. Brunnschweiler (2010) can be considered a pioneer in this research area, as this study was the first attempt to verify FMD's role in REC empirically. Brunnschweiler (2010) highlighted that any regulatory framework that promotes RE should ensure greater participation in private-sector finance.

A focused study on India by Eren et al., (2019) investigated the influence of FMD and economic growth (EG) on REC. Using the Maki cointegration test and dynamic ordinary least squares (DOLS), they confirmed a relationship between FMD and EG on REC that was deemed statistically significant and had a positive long-run impact. They observed that developed financial markets can efficiently drive financing toward RE. In contrast, underdeveloped financial markets can prevent new RE projects from emerging despite a demand for said projects. The researchers utilised a composite financial development index as a proxy for FMD consisting of the following: "broad money as a '% of gross domestic product (GDP)"; "domestic credit provided by the financial sector as a % of GDP"; and "deposit money bank assets to deposit money bank assets plus central bank assets (%)." The study used DOLS for the homoscedastic regressions, implying a similar variance for each comparison unit. The results of the Granger causality test, used to indicate the directions of the relationships between variables, indicated a unidirectional relationship between FMD, GDP, and REC. The results suggested that RE sector development in India is a direct result of FMD in the long run. The authors' recommendations included the implementation of policies to promote FMD. However, they noted the importance of not ostracising incumbent energy producers, which could increase current energy prices. Policies such as green tax incentives and carbon taxes could prove fruitful, and alternative financing through debt, such as green bonds, was also advised (Eren et al., 2019).

Shahbaz et al., (2021) attempted to test the long-term relationship between FMD and REC in upper-middle-income developing countries by applying a Panel Pedroni cointegration on a trial of 34 countries over 20 years. The Kao cointegration test was

used to measure the robustness of cointegration. The cointegration relationship was further analysed via the fully modified OLS method to overcome autocorrelation issues (Shahbaz et al., 2021). The empirical evidence once more proved that FMD has a positive relationship with REC, but it was observed that the economic development level does have an impact. In the study, the explained variable, REC, "was calculated as a percentage of total final energy consumption." In contrast, the independent variables were financial development (FD) indicators (i.e., "domestic credit provided by the financial sector" and "domestic credit provided to the private sector by banks"), measured as a share of GDP.

Research by Kim and Park (2016) highlighted the significance of financial development (FD) in the advancement of renewable energy technologies (RET). Their findings suggested that RE markets that rely heavily on external financing experience accelerated growth in nations with more established financial markets. The study encompassed the entire financial market and scrutinized the impacts of credit and equity market development on RE progress. Most of the sample data they selected, particularly concerning the dependent variable (i.e., REC), contained zero values. To combat the effect of biased coefficients when OLS estimation is used, Tobit estimation was used.

Hassine and Harrathi (2017) Explored "the causal link amongst RE consumption (REC), real gross domestic product (GDP), trade, and foreign direct investment (FDI) for the Gulf Cooperation Council (GCC) nations from 1980 to 2012". The focus was on the relationship between REC and EG, and FD and exports were used as control variables for the production function (Hassine & Harrathi, 2017). The long-run estimation results indicated evidence of a causality linkage between private sector credit, capital, labour, exports, and REC to output. The empirical results suggested that increasing trade, REC, and FMD could lead to the economic expansion of Gulf Cooperation Council countries.

The study by Anton and Nucu (2020) provided insight into the most effective way capital resources can be deployed for RE sector development. The primary focus was on further understanding the effects of FMD on REC instead of identifying a correlation or cointegration among the respective FMD and REC variables (Anton & Nucu, 2020). The researchers aimed to analyse and quantify the significance of the development of

the respective financial markets (credit, equity, and bond) on REC. They employed a fixed-effect panel regression analysis and found that the credit and bond markets have played a significant role in developing the European RE market. In contrast, the equity market development has played a less significant role.

2.3 Conclusion

This literature review expanded the understanding of key concepts relevant to this study. Although not explicitly stated, the review was split into three categories: definitions, theories, and methods. It elaborated on fundamental definitions regarding renewable energies and financial markets, explored theories concerning the transitioning of energy sources and FMD, and investigated approaches used in developing financial market frameworks.

No study to date has explicitly aimed to offer a framework for the development of the financial markets of developing/emerging economies seeking to transition their energy sectors. Further research and analysis are required to understand better the markets and participants that drive such an energy transition. The outcomes of the current study will provide further literature for the theory of FMD, and aid borrowers, lenders, and government decision-makers interested in the RE industry.

CHAPTER 3: RESEARCH DATA AND METHODOLOGY

3.1 Data

This study uses information on 42 countries from Africa, Asia, and South America between 1990 and 2019. Note that in certain instances, the time may be further restricted depending on the availability of FMD measures. All countries were specifically chosen to understand better the role FD plays in REP in developing and emerging economies. The African country selection was based on the Absa Africa Financial Markets Index, which evaluates a country's FD based on market accessibility, openness, and transparency (Sanghani et al., 2022). The Asian and South American country selection was based on the International Monetary Fund Fiscal Affairs Department (2022) monitoring database, which tabulates countries by economic development levels based on the latest public finance developments, projections, and policies. The dataset comprised 27 countries from Africa, eight from South America, and seven from Asia.

Table 2: List of countries in the dataset by region.

Africa		**Asia**	**South America**
Angola	Mauritius	China	Brazil
Botswana	Morocco	India	Chile
Cameroon	Mozambique	Indonesia	Costa Rica
Condo, Dem. Rep.	Namibia	Kazakhstan	Ecuador
Cote d'Ivoire	Nigeria	Pakistan	Mexico
Ecuador	Rwanda	Philippines	Peru
Egypt, Arab Rep.	Senegal	Thailand	Uruguay
Eswatini	Seychelles		Venezuela, RB
Ethiopia	South Africa		
Ghana	Tanzania		
Kenya	Uganda		
Lesotho	Zambia		
Madagascar	Zimbabwe		
Malawi			

"The percentage of REP in total energy production" was employed as the dependent variable based on data availability. The impact of FMD on REP depends on both the measurement and definition of FMD. Thus, more than one FD indicator was utilised based on the literature. The first, and perhaps most used, FD measure is the "domestic credit provided by the financial sector (% of GDP)," which acts as a proxy for credit market development as seen through the studies of Anton and Nucu (2020), Kim and Park (2016) and Çoban and Topcu (2013). This measure could be further decomposed into the second and third measures. Two additional proxies for the credit market development were observed, namely "domestic credit to the private sector (% of GDP)", as utilised by Brunnschweiler (2010), and "domestic credit to the private sector by banks (% of GDP)," as used by both Brunnschweiler (2010) and Kim and Park (2016). The fourth measure of FMD used in this study was the "market capitalisation of listed domestic companies (% of GDP)." This measure was used as a proxy for equity market development in line with Kim and Park's (2016) work. Lastly, public, and publicly guaranteed debt from bonds was the final measure and was used to account for bond market development, as suggested by Kim and Park (2016).

Based on the empirical and theoretical literature, several control variables were introduced to the model specification to isolate the impact of FMD on REP. Following the work of Kim and Park (2016), Eren et al., (2019), and Brunnschweiler (2010), "the natural log of GDP per capita" was used as one of the control variables. A large body of literature suggests that energy prices may also explain RE (Anton & Nucu, 2020; Shahbaz et al., 2021). The theory behind the idea that energy prices may explain RE is rooted in the concept of economic incentives. In general, RE sources tend to have higher upfront costs than traditional fossil fuel sources but lower operational costs and environmental impact. When energy prices are high, RE's cost savings and environmental benefits of RE become more attractive to consumers and businesses. This leads to increased investment in RE infrastructure and greater adoption sources (Gielen et al., 2019).

Conversely, when energy prices are low, the economic incentives to invest in RE may be weakened. Fossil fuel sources may become more affordable and attractive, reducing RE investment. Thus, the theory behind the idea that energy prices may explain RE is that fluctuations in energy prices can significantly impact the adoption and growth of

RE sources (Oosthuizen et al., 2021). As data on RE prices are not readily available, the "inflation rate (measured as the annual growth of the consumer price index [CPI])" was used as the second control variable, as seen in the work of Chang (2014) and Sadorsky (2010).

For further insight into the role financial intermediation plays in the production of RE, information on "broad money (% of GDP)," which measures financial depth, was utilised, following Brunnschweiler (2010). Alternative FMD indicators were also used to assess the robustness of the baseline analysis. Based on available information, the robustness of the credit market development results was tested using "non-guaranteed long-term commercial bank loans from private banks and other private financial institutions." This robustness check was done using the "value of shares traded, which is the product of the total number of shares traded (including domestic and foreign) and their corresponding prices." This measure was expected to test the validity of the results for equity market development, as previously performed by Kim and Park (2016). The robustness of the findings for bond market development was also tested using "non-guaranteed long-term debt from privately placed bonds" to proxy bond market development, as seen in the work of Kim and Park (2016). Finally, "FDI (net inflows, % of GDP)" was introduced as an additional control variable as part of the robustness checks, as seen in the work of Anton and Nucu (2020).

Information on all country-level variables was retrieved from various credible and publicly available sources, including the World Federation of Exchanges, the International Monetary Fund, and the World Bank.

Table 3: Description and sources of variables.

Variable Description & Sources

Name	Category	Definition	Source
"Renewable energy production (%)"	Outcome Variable	"Renewable energy production refers to the proportion of electricity generated from renewable sources compared to the total electricity output."	World Bank
"Stocks traded, total value (% of GDP)"	Financial Development (Equity)	"The value of shares traded is the product of the total number of shares traded (including both domestic and foreign shares) and their corresponding prices."	World Federation of Exchanges
"Market capitalization of listed domestic companies (% of GDP)"	Financial Development (Equity)	"Market capitalization (also known as market value) is the result of multiplying the share price by the number of outstanding shares (including all classes) of domestically listed companies."	World Federation of Exchanges
"Domestic credit provided by financial sector (% of GDP)"	Financial Development (Credit)	"Domestic credit provided by the financial sector encompasses all credit granted to different sectors on a gross basis, except for credit to the central government, which is calculated net."	International Monetary Fund
"Domestic credit to private sector (% of GDP)"	Financial Development (Credit)	"Domestic credit to the private sector refers to financial resources provided by financial corporations (such as loans, non-equity securities purchases, trade credits, and other accounts receivable) to the private sector that establish a claim for repayment."	International Monetary Fund
"Domestic credit to private sector by banks (% of GDP)"	Financial Development (Credit)	"Domestic credit to the private sector by banks is the total amount of financial resources provided to the private sector by other deposit-taking corporations (excluding central banks), such as through loans, purchases of non-equity securities, trade credits, and other accounts receivable, that establish a claim for repayment."	International Monetary Fund

“PNG, commercial banks and other creditors (NFL, current US$)”	Financial Development (Credit)	“Nonguaranteed long-term commercial bank loans from private banks and other private financial institutions refer to long-term loans granted by private banks and other private financial institutions without any guarantee.”	World Bank
“PPG, bonds (NFL, current US$)”	Financial Development (Bond)	“Public and publicly guaranteed debt from bonds refers to debt from bonds that are either publicly issued or privately placed and guaranteed by the government.”	World Bank
“PNG, bonds (NFL, current US$)”	Financial Development (Bond)	“Nonguaranteed long-term debt from bonds that are privately placed refers to long-term debt from bonds that are privately placed and without any guarantee.”	World Bank
“Broad money (% of GDP)”	Financial Depth	“Broad money refers to the aggregate value of currency held outside banks, demand deposits (excluding those of the central government), time, savings, and foreign currency deposits of resident sectors other than the central government, bank and traveller’s checks, and other securities such as certificates of deposit and commercial paper. This value is then divided by GDP.”	International Monetary Fund
“Consumer price index”	Control Variable	“The consumer price index is used to measure inflation and reflects the percentage change in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals, such as yearly.”	World Bank
“GDP per capita (current US$)”	Control Variable	“Gross domestic product per capita is calculated by dividing the total gross domestic product by the midyear population. GDP, in turn, represents the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products.”	World Bank
“Foreign direct investment, net inflows (% of GDP)”	Control Variable	“Foreign direct investment, on the other hand, is computed as the sum of equity capital, reinvestment of earnings, other long-term capital, and short-term capital as presented in the balance of payments, and this value is divided by GDP.”	International Monetary Fund

“Asia Dummy”	Regional Dummy	“Takes value one if the country is in Asia; 0 otherwise.”	World Bank
“South America Dummy”	Regional Dummy	“Takes value one if the country is in South America; 0 otherwise.”	World Bank
“Africa Dummy”	Regional Dummy	“Takes value one if the country is in Africa; 0 otherwise.”	World Bank

The descriptive statistics for the study are depicted in Table 4, which reflects the sample of 42 countries and 988 country-year observations. In line with the work of Anton and Nucu (2020), adjustments were not made to variables with missing data, leading to the disparity in the number of observations seen in Table 4. Between 1990 and 2019, there was significant variation across the REP of the nations within the sample study, as observed through the standard deviation of REP of 35.7%, indicating high volatility. The highest REP level in total energy production was around 99.8%, suggesting almost fully REP. The lowest level was 0%, indicating no RE in the energy generation mix. Note that the REP was winsorised at the top tenth percentile to avoid skewing the data; this was done only at the top end because it is highly unlikely for a developing nation to use100% REP, but it is possible for it to have almost 0% REP.

Table 4: Descriptive statistics.

Variable	Observations	Mean	Std Dev.	Min	Max
“Renewable electricity output (%)”	988	50.83	35.70	0.00	99.82
“Domestic credit provided by financial sector (%)”	168	63.17	49.02	8.95	171.42
“Domestic credit to private sector (%)”	765	31.19	31.50	0.49	152.59
“Domestic credit to private sector by banks (%)”	946	29.15	27.01	0.45	166.50
“Market capitalisation (%)”	426	44.06	45.13	0.01	248.65
“Bonds (PPG, bn US$)”	362	1.91	1.89	–12.5	34.5
“Broad money (%)”	945	42.94	30.70	2.86	202.11
“Commercial loans (PNG, bn US$)”	602	1.80	5.48	–10.30	44.80
“Stocks traded, total value (%)”	490	15.67	28.55	0.00	355.52
“Bonds (PNG, bn US$)”	249	1.60	5.40	–7.00	41.20
“Gross domestic product per capita (US$)”	988	2,755	3,208	100	17,015
“Inflation (%)”	988	16.46	34.56	–9.62	198.52

“Foreign direct investment, net inflows (%)”	962	3.16	4.23	–6.90	57.88
“South America”	988	0.19	0.39	0.00	1.00
“Asia”	988	0.18	0.39	0.00	1.00
“Africa”	988	0.63	0.48	0.00	1.00

Table 5: Correlation between financial development indicators.

	“Energy production”	“Domestic Credit by Financial Sector”	“Domestic Credit to Private Sector”	“Domestic Credit to Private Sector by Banks”	“Market Capitalization”	“Bonds”
“Energy production”	1					
“Domestic Credit by Financial Sector”	-0.5389	1				
“Domestic Credit to Private Sector”	-0.474	0.9757	1			
“Domestic Credit to Private Sector by Banks”	-0.3083	0.8989	0.9276	1		
“Market Capitalization”	-0.553	0.7551	0.7754	0.5299	1	
“Bonds”	-0.2563	-0.1036	-0.1088	-0.1467	0.0161	1

There was also a significant variation in FMD indicators across countries. On average, “domestic credit provided by the financial sector” corresponded to around 63% of GDP, while the lowest number was about 9% and the highest was approximately 171%. Even larger variation was observed for “domestic credit to the private sector” and “domestic credit to the private sector by banks.” Equity market development indicators, “market capitalisation” and “stocks traded,” also exhibited significant variation, though most countries were placed to the left of the median value. A similar trend was observed for commercial loans and bonds. The financial depth indicator, “broad money,” revealed that while several countries exhibited a high level of financial depth (202%), most had a level closer to the low end (2.86%), with an average value of about 43%. As expected,

“GDP per capita” was around US$2,800 for the average country, Near the lower end of the global income distribution (Stanley, 2022).

The highest GDP per capita was recorded to be around US$17,000, whereas the lowest record was US$100. Inflation rates were also like what is observed in developing countries. The inflation variable was winsorised at the top two percentile to remove observations that were around 20,000%, which most likely represented outliers or errors in reporting. The average inflation rate was around 16%, much higher than that in the rest of the world (International Monetary Fund, 2023). Though some countries had deflation, the highest inflation recorded was around 200%. Lastly, most of the countries in the dataset were from Africa (63%); the rest were nearly equally distributed between South America (19%) and Asia (18%).

A positive linear relationship existed between “domestic credit by financial sector” and “domestic credit to the private sector” of 0.9757, “domestic credit by financial sector” and “domestic credit to the private sector by banks” of 0.8989, “domestic credit by financial sector” and “market capitalisation” of 0.7551, “domestic credit to the private sector” and “domestic sector to the private sector by banks” of 0.9276 and “domestic credit to the private sector” and “market capitalisation” of 0.7754. A moderate positive relationship existed between “domestic credit to the private sector by banks” and “market capitalisation” of 0.5299. A negative linear relationship existed between bonds and all credit indicators, and there was a weakly positive linear relationship between bonds and “market capitalisation”. A negative linear relationship existed between the production of renewable energy and “domestic credit by financial sector” of -0.5389, renewable energy production and domestic credit to private sector -0.474, renewable energy production and “domestic credit to private sector by banks” of -0.3083, renewable energy production and “market capitalization” of -0.553 and renewable energy production and bonds of -0.2563.
The below key implications can be drawn from the financial markets and their relationship with the defined economic factors:

Credit markets

There is a strong positive relationship between "domestic credit by the financial sector" and "domestic credit to the private sector," as well as "domestic credit to the private

sector by banks." This suggests that as the financial sector extends more credit, it often increases the private sector's credit, especially through banks. "Domestic credit to the private sector" also has a strong positive correlation with "market capitalization," indicating that as credit to the private sector grows, market capitalization tends to rise. Bonds show a negative relationship with all credit indicators, suggesting that an increase in credit activity is associated with a decrease in bond market activity.

Equity markets (Market Capitalisation)

"Market capitalization" demonstrates a positive correlation with several credit indicators, including "domestic credit by the financial sector," "domestic credit to the private sector," and "domestic credit to the private sector by banks." This indicates that as credit markets expand, market capitalization tends to increase. The relationship between "market capitalization" and "bonds" is weakly positive, suggesting a slight association between bond market activity and higher market capitalization.

Renewable energy production

Renewable energy production is negatively correlated with various credit indicators, including "domestic credit by the financial sector," "domestic credit to the private sector," and "domestic credit to the private sector by banks." Higher credit levels may not necessarily lead to increased renewable energy production. Additionally, there is a negative correlation between renewable energy production and "market capitalization," indicating that regions with higher market capitalization may have lower levels of renewable energy production.

Given that a nation's credit and equity markets serve diverse purposes beyond supporting renewable energy (RE) projects and companies, the observed negative correlation between RE production and these financial markets can be attributed to the relatively modest scale of the RE sector within a nation’s economy. Most financial resources from these markets are often channelled towards more substantial sectors like infrastructure, healthcare, and education. We observe that the financial market development indicator in the selected data set has a relatively high degree of multicollinearity. As this is the case, we note that the estimates from the panel regression may be more reliable than those from the correlation table above.

3.2 Methodology

Following a large body of literature, particularly the work of Shahbaz et al. (2021), Anton and Nucu (2020), and Kim and Park (2016), RE output was modelled as a function of various FMD measures, "the natural logarithm of GDP per capita," the annual change in the CPI and country-specific time-invariant characteristics. The regression equation estimated in this study was as follows:

$$REP_{it} = \beta_0 + \boldsymbol{\beta_1} FMD_{it} + \beta_2 \ln GDPpc_{it} + \beta_3 CPI_{it} + \beta_i + \varepsilon_{it}, \quad (1)$$

where REP_{it} is the "proportion of REP in total energy production" at time t for country i, FMD_{it} is the FMD indicator, $lnGDPpc_{it}$ is the "natural log of GDP per capita," CPI_{it} is the "CPI (annual growth)," β_i accounts for the **"**country-related fixed effects" and ε_{it} is "the error term".

Renewable energy production, the dependent variable, was measured by "the proportion of renewable electricity output in total electricity output." This variable informed about the extent to which REP contributed to energy generation. Note that data limitations on "REC (as a % of total energy consumption)" necessitated the use of "renewable electricity output (as a % of total electricity output)" as a proxy for REP. Energy production and consumption may be correlated, but the energy that is produced may not always be consumed. Thus, REP and REC can be used as a proxy for RE implementation. Here, REP was chosen because consumption cannot occur without production. This argument was based on the work of Domhnaill and Ryan (2020), who used REP as the dependent variable in a similar setting.

The FMD indicators were used as explanatory variables to understand the impact of FMD on REP. REP is expected to cost more and be priced higher than fossil-fuel-based energy sources, meaning greater FMD is required to fund these projects (Anton & Nucu, 2020). Considering this expectation, it was predicted that REP would be positively affected by FMD indicators. However, the possibility that certain FD indicators may not have a significant relationship with REP was also considered (Sisodia et al., 2016). Investigating this relationship using various measures could better inform the importance, or lack thereof, of the various mechanisms of FMD.

In the baseline regression, FMD (FMD_{it}) was measured using various proxies. For the first FMD proxy element, three indicators of credit sector development were utilised. "The credit sector is a crucial part of the financial system and supports REP by performing the essential role of financial intermediation and allowing for efficient movement of funds from savers to investors to producers," (Anton & Nucu, 2020). The most important of the indicators is "the domestic credit provided by the financial sector (% of GDP)" (Kim & Park, 2016). Additionally, "domestic credit to the private sector (% of GDP)" and "domestic credit to the private sector by banks (% of GDP)" were used to provide further context (Chang, 2014; Çoban & Topcu, 2013).

The second FMD proxy element spoke to the capital market. The equity market is another important source of funding for RE producers, and its development will aid in raising funds to invest in the energy sector, particularly for REP, which requires substantial and patient capital (Sadorsky, 2010). Thus, the fourth measure of FD used here was "the market capitalisation of listed domestic companies (% of GDP)," which is an appropriate metric for measuring development within the equity market (Kim & Park, 2016). The last proxy element used as an FMD measure was "public and publicly guaranteed debt from bonds." The bond market is another crucial source of funding and can be seen as a key contributor to financial inclusion efforts through FMD (Anton & Nucu, 2020; Chang, 2014). The coefficient of interest, β_1, captured the explanatory power of the various FMD indicators on REC. One unit of change in the FD indicator led to β_1 units change in REP. Since the REP and FD indicators were in percentages, the change could be interpreted as a percentage change.

Additional factors may also affect REP (Eren et al., 2019). To take these factors into account and better infer the relationships between the main variables of interest in the study, two control variables were included, "the GDP per capita" and changes in inflation (Brunnschweiler, 2010). The empirical literature shows that "the GDP per capita" may be positively or negatively related to REP (Eren et al., 2019; Kim & Park, 2016). Another factor that may explain RE output is energy prices. However, due to the lack of availability of energy prices, the annual change in CPI was used as a proxy for

energy prices here. Higher inflation is expected to lead to higher energy production (Anton & Nucu, 2020).

In addition to "the GDP per capita," inflation, and FD indicators, there may be unobservable, country-specific, and time-invariant factors that may explain REP. The regression model included country-fixed effects to account for these potential factors. Without these fixed effects, the coefficients of the FD indicators and the control variables could be considered biased and potentially lead to wrong inferences. Econometric estimation of panel data is typically performed using either the fixed effects, random effects, or dynamic panel model in the presence of endogeneity.

This study uses a fixed effects model, but one could also argue that a random effects model should have been chosen instead. The fixed effects model assumes that a country's fixed effects may be correlated with other regressors (in this case, GDP per capita and inflation) (Williams, 2018). "The random effects model, however, assumes that country fixed effects are not correlated with the same regressors." For this research, it was believed that there was enough reason to assume a correlation between country-fixed effects and regressors. To test this argument formally, a Hausman test (which rejects the null hypothesis of no difference between fixed effects and random effect models at a 5% significance level) was conducted and confirmed that the fixed effects model should be used.

Additionally, an important assumption of the OLS model is the constant variance of the model errors. However, in most cases, the standard error of error terms is not constant or heteroskedastic. As such, robust standard errors were used when estimating the models. After considering all aforementioned factors, this study was conducted relying on OLS estimation with fixed effects and robust standard errors, assuming that the coefficient estimations were unbiased.

CHAPTER 4: FINDINGS AND DISCUSSION

4.1 Empirical Analysis

The results of estimating various forms of Eq. (1) are presented in the following subsections. First, the baseline findings are shown, which reflect the results of estimating Eq. (1) with the selected independent variables described in the methodology chapter. Second, financial depth is introduced, and whether this FD measure is of significance in relation to the REP for the chosen countries in the test sample is checked. The empirical analysis also discusses the differing impact of the selected FD indicators on the REP across regions. Lastly, four different checks are conducted to further evaluate the robustness of the baseline observations, adding strength to the validity of the findings.

4.1.1 Baseline Findings

This section presents the findings in terms of how the development of financial markets may impact the production of renewable energy, the results are presented to answer the first core question and its associated sub-questions numerated in section 1.4, namely: What impact does the credit market have on the production of renewable energy in developing and emerging markets? What impact does the equity market have on the production of renewable energy in developing and emerging markets, and what does the bond market have on the production of renewable energy in developing and emerging markets following the estimation of Eq. (1).

The first three columns of Table 6 measure FMD through credit market indicators, namely “domestic credit by the financial sector,” “domestic credit to the private sector,” and “domestic credit to the private sector by banks.” The results in the first column indicate that the “domestic credit by financial sector” significantly increased the REP at the 1% significance level. This led to a roughly 0.1% increase in REP. In a similar analysis, Anton and Nucu (2020) reported that a 1% increase in the “domestic credit by financial sector” is associated with around a 0.03% increase in REC in EU member states. This effect is statistically significant at the 1% level. This is comparable with the results presented in this study. The statistical significance in both studies confirmed the significance of “domestic credit by financial sector” in REP; however, the magnitude of the effect was larger in the current study.

Table 6: Baseline findings.

Dependent Variable: Renewable Energy Production					
	"Domestic credit by financial sector"	"Domestic credit to private sector"	"Domestic credit to private sector by banks"	"Market capitalisation"	"Bonds (PNG)"
	(1)	(2)	(3)	(4)	(5)
Financial development	0.095***	0.048	0.030	0.035***	0.098*
	(0.033)	(0.042)	(0.030)	(0.012)	(0.000)
Gross domestic product per capita	–9.711***	–7.983***	–6.921***	–6.702***	–3.617***
	(1.721)	(1.270)	(0.897)	(0.776)	(0.552)
Inflation rate	–0.023	–0.001	–0.010	0.141**	0.029***
	(0.018)	(0.009)	(0.009)	(0.063)	(0.006)
Constant	119.077***	105.717***	99.490***	88.066***	62.050***
	(11.866)	(8.511)	(6.161)	(6.132)	(4.260)
Country fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	165	762	946	426	358
Adjusted R-squared	0.986	0.878	0.897	0.962	0.978
"Robust standard errors in parentheses, *** p < 0.01, ** p < 0.05, * p < 0.1"					

Columns (2) and (3) measure FMD through "domestic credit provided to the private sector" and "domestic credit provided to the private sector by banks," in line with Brunnschweiler (2010). The results suggested that neither indicator significantly changed the REP. This is where this study's results diverted from those given in the literature, as Brunnschweiler (2010) showed that a positive relationship exists at the 5% significance level for non-OECD countries for these indicators.

Column (4) measures the impact of "market capitalisation" on REP. The analysis found that a 1% increase in "market capitalisation" led to a 0.0035% increase in REP. Although the overall effect was in the same direction as that found by Kim and Park (2016), whose study showed that a 1% increase in equity market development leads to a 1.42% annual growth in the solar renewable sector, it would have been slightly misleading to compare these effect ranges here as different designs were instituted in each study.

Lastly, column (5) measures the effect of bond market development on RE output. A US$1 billion increase in "public and publicly guaranteed debt from bonds" led to a less than 0.1% increase in the REP. Like the effect of equity market development, the effect of bond market development was also observed to be similar to that demonstrated in the findings of Kim and Park (2016). Regarding the control variables, the coefficient of "GDP per capita" was statistically significant at a 1% significance level in all regressions, indicating a negative relationship between GDP per capita and REP following the work of Anton and Nucu (2020). The inflation rate did not have a statistically significant effect on the RE output in relation to the credit market proxies. However, it could be deemed statistically significant regarding the equity and bond market proxies, as the effect of inflation on REP was observed as positive.

From the initial baseline findings, it was observed that credit, equity, and bond market development have a noteworthy impact on REP as seen through the analysis of the proxy variables in the estimation through Eq. 1. This result is in line with this study's original assumption that financial markets do have an association with renewable energy, as well as the results of supporting literature (Anton & Nucu, 2020; Brunnschweiler, 2010; Kim & Park, 2016; Sadorsky, 2010; Shahbaz et al., 2021).

4.1.2 Additional Analysis

The baseline regressions performed in the previous sections informed about the average impact of various FMD indicators on REP. This section introduces an alternative FD indicator, and the relationship between FMD and REP across three different continental regions is examined.

Regional Differences

The nations chosen for this study are classified as developing countries and, as such, exhibit variations in the degree to which FMD impacts their REP. Eq. (1) was estimated for each continental region regarding the FD measure to understand those differences better. Table 7 presents the respective region results of the estimations for credit market development. These results reveal insights into the importance or significance of the respective credit market development indicators in each region, which would allow us to establish a better-suited location-based framework. Columns (1) to (3) of Table 7 reveal that the positive impact of "domestic credit provided by the financial sector" on

REP was led by African countries. The following three columns, (4) to (6), imply that the “domestic credit to the private sector” had a significant and positive impact on REP in Asian countries; however, this effect was not evident in the full sample. Finally, the last three columns, (7) to (9), show that “domestic credit to the private sector by banks” was effective in increasing RE generation. However, this impact was limited only to the Asian countries.

Columns (1) to (3) of Table 8 show the results of the estimations for the equity market measure across the three identified continental regions. These findings revealed that the impact on the African countries led to the impact of “market capitalisation” on REP. Lastly, Table 9 presents the regional differences for the bond market measure, and the findings indicated that the effect of bond market indicators on REP was evident in the Asian countries.

Table 7: Baseline regressions, credit market development, by region.

	Dependent Variable: Renewable Energy Production								
	"Domestic credit by financial sector"			"Domestic credit to private sector"			"Domestic credit to private sector by banks"		
	South America	Asia	Africa	South America	Asia	Africa	South America	Asia	Africa
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Financial development	0.135	0.009	**0.078****	0.033	**0.160*****	–0.021	0.053	**0.041****	–0.013
	(0.091)	(0.037)	(0.034)	(0.040)	(0.041)	(0.072)	(0.044)	(0.018)	(0.068)
Gross domestic product per capita	–15.739***	2.044	–3.857***	–11.784***	–3.308***	–9.079***	–11.444***	–2.308***	–7.935***
	(2.129)	(3.210)	(1.340)	(1.518)	(0.797)	(1.860)	(1.351)	(0.407)	(1.505)
Inflation rate	–0.001***	–0.376	–0.153***	–0.001*	0.354***	–0.000***	–0.001*	0.000	–0.000
	(0.000)	(0.241)	(0.058)	(0.000)	(0.116)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	184.950***	–5.834	77.479***	169.440***	36.014***	114.231***	164.999***	34.208***	109.236***
	(15.501)	(23.527)	(7.778)	(12.608)	(4.484)	(11.879)	(11.491)	(2.828)	(9.591)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	69	20	76	128	124	510	162	182	602
Adjusted R-squared	0.982	0.733	0.989	0.944	0.88	0.85	0.926	0.892	0.868
"Robust standard errors in parentheses, *** p < 0.01, ** p < 0.05, * p < 0.1"									

Table 8: Baseline regressions, equity market development, by region.

	Dependent Variable: Renewable Energy Production		
	"Market Capitalisation"		
	South America	Asia	Africa
	(1)	(2)	(3)
Financial development	–0.003	0.002	0.054***
	(0.044)	(0.013)	(0.014)
Gross domestic product per capita	–12.507***	–1.238**	–9.296***
	(1.924)	(0.515)	(1.333)
Inflation rate	–0.013	0.070	0.094
	(0.123)	(0.052)	(0.082)
Constant	168.076***	26.906***	107.327***
	(16.965)	(3.893)	(10.309)
Country fixed effects	Yes	Yes	Yes
Observations	106	132	188
Adjusted R-squared	0.943	0.909	0.964
"Robust standard errors in parentheses, *** p < 0.01, ** p < 0.05, * p < 0.1"			

Table 9: Baseline regressions, bond market development, by region.

	Dependent Variable: Renewable Energy Production		
	"Bonds (PPG)"		
	South America	Asia	Africa
	(1)	(2)	(3)
Financial development	–0.000	**0.105***	0.000
	(0.000)	(0.000)	(0.000)
Gross domestic product per capita	–7.613***	–1.821***	–6.924***
	(1.393)	(0.457)	(1.654)
Inflation rate	0.001	0.121*	0.001**
	(0.001)	(0.066)	(0.000)
Constant	131.453***	31.527***	81.701***
	(11.908)	(3.365)	(12.733)
Country fixed effects	Yes	Yes	Yes
Observations	96	163	99
Adjusted R-squared	0.972	0.902	0.972
"Robust standard errors in parentheses, *** p < 0.01, ** p < 0.05, * p < 0.1"			

Financial Depth

Following the work of Brunnschweiler (2010), this study also investigated the influence of financial depth on REP. As previously mentioned, this was measured using "the share of broad money (M2) in GDP" (Becket al., 1999). In line with the GLS estimations used by Brunnschweiler (2010), it was found that financial depth did not significantly impact RE output.

Table 10: Additional analysis, financial depth.

	Dependent Variable: Renewable Energy Production
	Broad Money
	(1)
Financial development	0.030
	(0.030)
Gross domestic product per capita	–6.819***
	(0.882)
Inflation rate	–0.000
	(0.000)
Constant	98.079***
	(5.708)
Country fixed effects	Yes
Observations	945
Adjusted R-squared	0.897
"Robust standard errors in parentheses, *** p < 0.01, ** p < 0.05, * p < 0.1"	

Considering the baseline findings and this study, looking through a historical lens, it could be observed that differing factors drove RE sector growth within the respective regions. Certain financial market drivers had a greater impact in certain regional markets over others. All noted market development indicators were considered significant to RE growth, and the regional analysis put into further context the strength of the respective FMD indicators via an understanding of the underlying drivers.

Focusing on the credit market, Africa's credit market was primarily driven by the financial sector. In contrast, financing to the private sector from either banks or other institutions predominately drove Asia's credit market. South America's results were insignificant, which could be interpreted as signalling a need for further development of the region's credit markets. A negative correlation was observed between the African

credit market, the private sector, and REP. It could be inferred that this relationship existed due to the exorbitantly high costs of private credit in Africa, emphasising the need for government participation in expanding financial inclusion within this market (Dimnwobi et al., 2022).

4.2 Robustness Checks

The previous sectionsshowed that the various FMD measures confirmed the hypothesis that FMD positively affects REP. To further test this hypothesis, alternative measures of FMD were introduced to measure credit, equity, and bond market development in line with the literature. The robustness analysis was further enhanced by introducing an additional control variable to the baseline regressions following the literature. The robustness checks were intended to ensure that the present study's findings were robust to different assumptions and specifications to increase confidence in the validity of the results. This paper could be indirectly considered policy-relevant research through the intended FMD framework; thus, the results may have significant implications for decision-making.

Table 11: Alternative measures for credit, equity and bond market development.

	Dependent Variable: Renewable Energy Production		
	"Commercial Loans"	"Stocks Traded"	"Bond (PNG)"
	(1)	(2)	(3)
Financial development	0.165***	0.047***	0.000
	(0.000)	(0.009)	(0.000)
Gross domestic product per capita	–5.899***	–6.140***	–3.191***
	(0.527)	(0.652)	(0.599)
Inflation rate	0.001	0.002***	0.004***
	(0.000)	(0.001)	(0.001)
Constant	86.090***	87.484***	52.398***
	(3.862)	(5.029)	(4.709)
Country fixed effects	Yes	Yes	Yes
Observations	602	489	249
Adjusted R-squared	0.969	0.967	0.975
"Robust standard errors in parentheses, *** p < 0.01, ** p < 0.05, * p < 0.1"			

4.2.1 Credit Market

Credit market development may alternatively be measured by "non-guaranteed long-term commercial bank loans from private banks and other private financial Institutions." Column (1) of Table 11 presents the results of the baseline regression estimations [Eq. (1)] when commercial loans measure FMD. In line with the findings mentioned above in this study, the results implied that credit market development significantly and positively impacts REP in emerging markets. This effect is robust to an alternative measure of credit market development.

4.2.2 Equity Market

Similarly, equity market development can also be measured with an alternative proxy. "The value of shares traded, which is the total number of shares traded (both domestic and foreign) multiplied by their respective matching prices," was introduced as the proxy here. This measure was expected to test the validity of the results for equity market development, as done by Kim and Park (2016). Column (2) of Table 11 shows that an increase in the "total value of stocks traded" leads to higher RE output. This is in

line with the baseline findings of market capitalisation regarding equity market development.

4.2.3 Bond Market

The robustness of the findings for bond market development was also tested. To do so, "non-guaranteed long-term debt from bonds that are privately placed" was used as a proxy for bond market development (Kim & Park, 2016). The results in column (3) of Table 11 revealed that the link between bond market development and RE output may be weaker than previously estimated. Although the baseline findings showed a weak link at best, this robustness check provided the necessary evidence reflecting the bond market's weak effect on REP.

4.2.4 Additional Control Variable

As a final robustness check, in Table 12, "FDI (net inflows, % of GDP)" was introduced as an additional control variable, following Anton and Nucu (2020). Foreign direct investment is typically associated with technology and knowledge transfer, but its effect on REP is ambiguous. The literature presents both negative (Anton & Nucu, 2020; Salim et al., 2017) and positive (Kutan, et al., 2018) effects of FDI on RE output and consumption. As shown in Table 12, FDI had a substantial and negative effect on REP, in line with the results from Anton and Nucu (2020) and Salim et al. (2017). This negative relationship could be due to a variety of reasons. For instance, FDI may be allocated to industries that rely on conventional energy sources, meaning an increase in FDI would lead to a decrease in REP.

Moreover, FDI inflows may come with certain conditions from foreign investors, which may conflict with the local government's RE policies. Lastly, while FDI may bring advanced technologies from foreign countries, these technologies may not necessarily focus on REP. If foreign investors bring in technologies that are more focused on conventional energy production, this could reduce REP (Kiliçarslan, 2019; Zhang et al., 2023).

After the inclusion of the additional control variable, only minor variances in the coefficient estimates were observed. Thus, all previously suggested links between the

various FMD indicators and REP remained valid. Therefore, it could be concluded that the additional analysis and robustness checks further confirmed the hypothesis that the various forms of FMD may have a significant and positive effect on RE output.

Table 12:Introduction of foreign direct investment as an additional control variable.

	Dependent Variable: Renewable Energy Production				
	"Domestic credit by financial sector"	"Domestic credit to private sector"	"Domestic credit to private sector by banks"	"Market capitalisation"	"Bonds (PNG)"
	(1)	(2)	(3)	(4)	(5)
Financial development	0.107***	0.052	0.037	0.041***	0.104**
	(0.031)	(0.040)	(0.029)	(0.012)	(0.000)
Gross domestic product per capita	–8.892***	–7.734***	–6.600***	–6.338***	–3.729***
	(1.586)	(1.189)	(0.809)	(0.747)	(0.539)
Inflation rate	–0.001***	–0.000***	–0.000	0.144**	0.002***
	(0.000)	(0.000)	(0.000)	(0.063)	(0.001)
Foreign direct investment	–0.630**	–0.221*	–0.331***	–0.615***	–0.408***
	(0.263)	(0.114)	(0.103)	(0.188)	(0.142)
Constant	113.767***	104.419***	97.870***	86.747***	64.232***
	(10.894)	(7.922)	(5.528)	(5.965)	(4.202)
Country fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	165	762	946	426	358
Adjusted R-squared	0.986	0.879	0.898	0.964	0.978
"Robust standard errors in parentheses, *** p < 0.01, ** p < 0.05, * p < 0.1"					

4.2.5 Alternative Estimation Technique

A fixed effects estimation was employed to estimate the baseline regression, following Anton and Nucu (2020). However, certain variables, such as the contribution of RE to the total energy supply, within the regression equation varied slightly or not across countries. The use of fixed effects could potentially prove to be problematic, particularly in the context of RE (Marques et al., 2010). The fixed effects variance decomposition (FEVD) technique proposed by Plümper and Troeger (2007) was used to handle this problem and increase the estimates' efficiency.

This approach involved a three-stage estimation procedure. The first stage estimated a standard fixed effects regression to retrieve the predicted country fixed effects or unitary effects. Using standard OLS estimation, the second stage regressed those unitary effects on the slightly varying variables to decompose the fixed effects into explained and unexplained categories, which were the residuals. The third stage used OLS techniques and regressed the dependent variable on the variable of interest, control variables, and residuals retrieved from the second stage. The FEVD procedure differs slightly from the standard fixed effects estimation in that the former decomposes the fixed effects into explained and unexplained categories (Marques et al., 2010).

The estimation of the FEVD is shown in Table 13. Column (1) confirms the results of the baseline analysis regarding "domestic credit by financial Sector." According to this measure, FD appeared to have a notable and favourable influence of FD on REP. Column (2) illustrates whether the second FD measure, "domestic credit to the private sector," had a significant effect on RE. Using FEVD as the estimation technique, it was found that "domestic credit to the private sector" seemed to become a positive and significant explanatory variable for REP.

Similarly, the results of a closely related credit market development indicator, "domestic credit to the private sector provided by banks," also showed a positive significance of FD for REP, as presented in Column (3). The results in columns (3) and (4) differed from those of the baseline analysis, which initially showed that they do not significantly impact REP. Rather, the results of the FEVD estimation supported the findings of Brunnschweiler (2010), showing that a positive relationship existed at the

5% significance level for non-OECD countries in relation to “domestic credit provided to the private sector” and “domestic credit provided to the private sector by banks.”

Turning to the equity market development indicator, “market capitalisation,” whether this FMD measure confirmed the significance of the relationship was analysed. As shown in column (4), “market capitalisation” was a noteworthy and positive factor that explained the variation in REP. These findings were consistent with the baseline results in Table 6. Lastly, the results reflected in column (5) confirmed that the initial results with fixed effects (baseline findings) continued to hold with the use of the FEVD estimator to test the relationship between bond market development and RE. However, note that increasing the statistical significance of the results, and the coefficient estimates of FEVD, should be approached with caution, as will be discussed further below.

The findings derived from use of the FEVD technique should indeed be approached with caution. Greene (2011) showed that FEVD can be problematic and might be equivalent to random effects. Breuschet al., (2011a) confirmed the findings of Greene (2011) and Breuschet al., (2011b), showing that the standard errors estimated by the FEVD procedure can be dramatically lower than those of fixed effects regression, which can lead to biased coefficient interpretation. Indeed, a comparison of the standard errors in Table 6 and Table 12 revealed that the new standard errors were significantly lower than the original ones. Following the advice provided in recent literature on the reliability of FEVD, the standard fixed effects model is preferred in the current study, even though it may produce less efficient estimates than the FEVD technique. Note that if FEVD procedures produce estimates similar to those of random effects or significantly lower standard errors, the interpretation of coefficients can be highly misleading.

Table 13: Fixed effects vector decomposition results.

	Dependent Variable: Renewable Energy Production				
	"Domestic credit by financial sector"	"Domestic credit to private sector"	"Domestic credit to private sector by banks"	"Market capitalisation"	"Bonds (PNG)"
	(1)	(2)	(3)	(4)	(5)
Financial development	0.095***	0.048***	0.027***	0.035***	0.101**
	(0.007)	(0.008)	(0.009)	(0.006)	(0.000)
Gross domestic product per capita	–17.601***	–11.950***	–11.447***	–4.749***	1.678***
	(0.239)	(0.342)	(0.302)	(0.348)	(0.237)
Inflation rate	0.003***	0.002***	0.002***	0.775***	0.030***
	(0.000)	(0.000)	(0.000)	(0.046)	(0.000)
Constant	179.658***	134.241***	132.184***	67.268***	20.390***
	(1.924)	(2.731)	(2.419)	(2.931)	(1.829)
Fixed effects variance decomposition	Yes	Yes	Yes	Yes	Yes
Observations	165	762	946	426	358
Adjusted R-squared	0.988	0.885	0.903	0.966	0.980
"Robust standard errors in parentheses, *** p < 0.01, ** p < 0.05, * p < 0.1"					

4.3 Discussion

4.3.1 Results Discussion

Financial market development is a process in which improvements are made to a financial system's efficiency and stability, resulting in its evolution and sophistication over time (World Bank Group, 2019). The credit, equity, and bond markets can be seen as the foundational pillars of the financial system and, thus, were used to understand FMD in this study. The development of the three foundational pillars defined above is often associated with lower risks, higher transparency, contraction of borrowing costs, and better access to capital (Anton & Nucu, 2020). "This, in turn, is expected to reduce the costs of REP while boosting the share of RE output in total output," (Sadorsky, 2010).

Pointedly, the development of the credit market leads to easier access to financing, promotion of financial stability, improved resource allocation, and increased competition while encouraging financial innovation (Lumpkin, 2009). The development of the equity market attracts more companies through facilitation of increased access to capital, encouragement of entrepreneurship, improved corporate governance, and enhanced investor diversification (Isaksson, 1999). The bond market acts as an important mechanism in providing alternative sources of financing, thus enabling the financing of socially responsible projects which attract socially responsible investors, which play a substantial role in RE deployment. The bond market also acts as a platform for long-term investments, which are essential for RE projects requiring patient capital (OECD Green Investment Financing Forum, 2015).

Considering this principle understanding and in line with previous studies, this study is expected to derive a positive link between FMD and REP. Despite there being evidence of this positive relationship in the literature, it was essential to prove the existence of such a relationship and define what role it plays in developing countries. Therefore, this study focused on developing nations from South America, Asia, and Africa and employed various FMD measures to provide further insights about the most active and effective financing channels.

First, this study's findings reveal a solid and positive relationship between FMD and REP. When the results of this research were compared to those of other studies focusing on developed nations, it was observed that the magnitude of the relationship is greater in developing nations. “Domestic credit provided by the financial sector” seemed to play a more important role in developing countries than developed ones.

Second, following credit market development, equity market development was found to play the next most significant role in REP. The findings of this study were robust to alternative equity market measures and presented a stronger association between the equity market and RE output than other literature works. These results suggested that this form of FMD may be considered significant for the emerging markets included in the study sample.

Lastly, the importance of the different forms of financing significantly depended on the geographic region, signalling the relevance and degree of priority each financing mechanism should hold. These differences were discussed within the scope of this research, but to better understand their underlying causes, further research is necessary. This could further boost the utilisation of RE through FMD in South American, Asian, and African countries.

Overall, these results indicated that more weight should be placed on credit market development, which should go in conjunction with the development of the banking system. Additionally, the equity market also offers vast opportunities and is an important catalyser of REP. The link between bond market development and REP was the weakest among all other FMD indicators, but this does not necessarily mean the bond market should be neglected. In theory, the bond market also plays an important role in boosting RE output; this mode of financing should also be considered, though with less urgency.

At this juncture, it is important to highlight and discuss a few findings that do not sufficiently support the primary hypothesis that financial market development is positively related to renewable energy production, as seen in tables 7, 8, and 9. Additionally counterintuitive results observed such as the GDP per capita variable being

consistently negatively and significantly related to renewable energy production and a negative FDI factor in Table 12, all suggest a fault in the hypothesis.

To explain these relationships and concerns with the hypothesis various factors and dynamics must be considered. Firstly, we refer to chapter 3, where when analysing the correlation matrix, a negative correlation between RE production and financial markets could be observed. This is where the economic structure of developing markets become increasingly relevant, as the observed phenomenon could be attributed to the relatively modest scale of the RE sector within a developing nation's economy. This is a key consideration given that developing countries lack economic diversification, (Usman & Landry, 2021), as their economies are heavily reliant on traditional, resource-intensive industries such as agriculture, mining, manufacturing, and infrastructure. The implication is that these sectors contribute more significantly to GDP; thus most financial resources would be channelled to them.

Secondly, developing countries prioritise economic growth and infrastructure development over renewable energy projects (Eisenmenger et al., 2020). A larger share of their financial resources is allocated to sectors that stimulate growth and development as opposed to adopting renewable energy. These growth sectors include manufacturing and heavy industries, which are energy-intensive, which links to the third and final consideration, energy sources. Most developing nations, particularly those chosen for the purposes of this study, are still heavily reliant on fossils fuels to meet their energy demands. If the priority is to promote economic growth which would seek to do so in the most cost-efficient manner, the cheapest energy source would naturally be applied, this would negatively impact renewable energy production. The three considerations above provide possible reasons for the deviations in our hypothesis and seek to provide explanations for the negative relationships observed in the results.

4.3.2 Which Financial Markets for the Energy Transition?

This section demonstrates the importance of financial market development for the renewable energy transition. In the previous section, we answered the first core research question, where we discussed the importance of the credit, equity and bonds markets for the energy transition. We now explore the second core research question and its associated sub-question. We seek to prove the importance of a policy framework for the energy transition. We end this discussion by proposing a framework for the energy transition.

This study has made sound efforts to prove the importance of financial markets in the transition to RE. The empirical evidence provided not only confirms the relationship between RE and financial market but also highlights the strength or impact each financial market has on the transition. Thus, it can be said that further development of these markets would lead to increased RE. This relationship can be interpreted and reasoned through the understanding of certain financial market fundamentals which pertain to capital requirements, risk management, liquidity, innovation, and scalability.

Renewable energy projects require significant capital investments. Thus, FMD will provide a greater platform for investors to invest in such projects and the pool of funds providing the necessary capital to develop and expand RE infrastructure (Louche, et al., 2019). In terms of risk management, financial markets provide the tools for managing risks associated with RE projects. Financial instruments such as futures, options, and swaps can be used to hedge against price volatility, weather-related risks, and other uncertainties (REN21, 2022). Additionally, financial markets provide a platform for risk sharing among investors while supplying information on market trends, performance, and other factors that can aid investors in assessing the risks associated with RE projects.

Financial market development also enhances the liquidity of RE investments, which in turn enables investors to trade RE assets more easily and, thus, allocate their capital effectively. A report by the Global Sustainable Investment Alliance (2019) noted that sustainable investment growth is driven by the increasing availability of financial instruments and products that enable investors to allocate capital to RE projects. Increased FMD provides an environment for the development of innovative financing

mechanisms that can further support the RE transition. Green bonds and other sustainable finance instruments can be used to finance RE projects and enable investors to participate in the energy transition (United Nations, 2022). Lastly, considering the above-mentioned factors, it can be observed that FMD is essential for scaling up RE deployment. By providing a platform for the efficient allocation of capital and risk management, financial markets can enable RE projects to reach economies of scale, reduce costs and become more competitive with traditional energy sources.

Based on the results discussed above, as well as the relevant literature, FMD plays a role in REP and REC.

Credit Market Development

Considering the findings of this study and the supporting literature, the credit market was found to be the most effective financial market in promoting RE within emerging markets. It provides energy entrepreneurs with the necessary access to substantial funding at a lower cost than other forms of financing. Although it is the optimal form of financing, the development of this market faces significant challenges that vary by country and region but largely remain common in substance.

African credit market development. There are several challenges and barriers to credit market development in Africa, including limited financial infrastructure. Many African nations lack the financial infrastructure to support credit market development (Chuhan-Poleet al., 2018). This includes a lack of credit bureaus, payment systems and reliable collateral registries. Several African countries are plagued by weak legal and regulatory frameworks, which creates a challenging environment for credit market development. Issues including inadequate contract enforcement, lack of bankruptcy laws, and insufficient protection of creditor rights add to this challenging environment (Agenor & Canuto, 2017). As they are considered emerging and developing markets, many African countries' markets reflect high levels of informality. "The majority or a significant portion of these nations' economic activity occurs in the informal sector, which is known to lack information. This makes it difficult and, in some instances, impossible for lenders to assess creditworthiness and causes difficulty in enforcing contracts," (Tchamyou, 2017).

Moreover, “African nations face limited access to financing for both individuals and businesses, predominately due to a lack of financial literacy as well as the limited availability of credit for small and medium-sized enterprises,” (OECD, 2017). This bottleneck essentially limits accessibility to the credit market to only those who can meet the stringent loan covenants and already have significant capital. Further, political instability in certain nations can discourage foreign investment and hinder credit market development. The lack of collateral impedes the development of credit markets in Africa.. Collateral is often a lender requirement as a form of security for loans. However, many African countries lack formal land titles and property rights, which limits the availability of collateral for borrowers (Ayyagari et al., 2016. Lastly, poor credit history makes it difficult for borrowers to access credit, as credit providers are unable to accurately assess a borrower’s risk profile and deem whether they are worthy of credit.

South American credit market development. The challenges and barriers to credit market development in South America include limited financial inclusion. “Access to fundamental financial services, such as bank accounts, is limited for many individuals in this region, which in turn restricts their participation in the credit market,” (Dabla-Norris et al., 2015). The presence of economic volatility and, in some instances, extreme volatility can lead to high inflation rates, currency fluctuations, and other macro-economic challenges, making it increasingly difficult to develop stable credit markets (Mishkin & Savastano, 2002). Furthermore, many South American countries are plagued with weak legal and regulatory frameworks, high political instability, lack of collateral, high levels of informality, and limited access to finance.

Asian credit market development. Challenges and barriers faced by the Asian credit market are related to limited financial inclusion, economic and political instability, limited credit information/history, weak legal and regulatory frameworks, lack of collateral, and limited access to finance. The reasons for the defined barriers are like those for the barriers to African credit market development. In addition, the Asian credit market faces cultural and linguistic barriers, making it more difficult for lenders to understand the needs and preferences of borrowers within the different regions of Asia with greater nuance (Roulet, 2022).

Many of the highlighted barriers are interrelated and, often, a result of other barriers. Weak legal and regulatory frameworks permeate the informal markets, which in turn limits access to finance. Limited financial infrastructure leads to a continued lack of credit history, which again results in limiting general access to finance (Becket al., 2003). The inherent interrelated nature of these barriers and challenges leads to a circular effect of the perpetual worsening of the credit markets. Only by resolving these issues at their source can the cycle be broken, and the credit markets improved. Addressing these problems will require a concerted effort from governments, regulators, and financial institutions to improve and develop the financial infrastructure, strengthen legal and regulatory frameworks, promote financial literacy, and encourage EG and stability in the name of credit market enhancement.

Capital (Equity) Market Development

Based on the results of this, study as well as the supporting literature, it was found that the equity market could play a crucial role in promoting RE within emerging markets by providing access to long-term capital, attracting investment, and promoting sustainability. By facilitating the financing of RE projects through raising capital, the equity market could contribute to the development of a more sustainable energy system and help address the challenges of climate change. Although it is an essential form of financing, the development of this market faces significant challenges and barriers that vary by country and region but largely remain common in substance.

African equity market development. Paying particular focus to significant market participants and institutions, several challenges, and barriers to equity market development in Africa were observed. The limited availability or lack of reliable financial data weakens an investor's ability to make informed decisions. The presence of unreliable financial data on African companies also makes it more difficult for market participants to accurately analyse and value securities (Dahou, et al., 2009). Moreover, many African equity markets reflect low market capitalisation, which makes it difficult for significant market participants, such as institutional investors and investment banks, to justify the cost of investing in the markets (Aykut & Blaszkiewicz-Schwartzman, 2018). Weak governance and corruption discourage foreign investment while eroding investor confidence. Institutions such as regulators, exchanges, and other market intermediaries must operate at high levels of transparency and accountability to

promote trust in the markets (Global Financial Integrity, 2021). Without this trust, the markets will not grow, as investors may deem them too risky to enter.

“Limited market infrastructure is another challenge African equity markets face. The absence of necessary infrastructure, including trading platforms and clearing and settlement systems, hinders the efficiency of trading across the market, thus limiting participation,” (Mahama, 2013). Furthermore, limited legal and regulatory frameworks impact equity market development by creating uncertainty and hindering market development. For markets to operate efficiently, securities regulators and stock exchanges must operate with clear and enforceable rules that promote investor protection, transparency, and fair trading (Agenor & Canuto, 2017), which in turn will boost investor confidence and stimulate market development. Lastly, foreign exchange risk is a significant barrier to African equity market development. African markets are exposed to foreign exchange (FOREX) risks due to the volatility of many African currencies. This could potentially escalate the cost of investing and make it more difficult for market participants to accurately price and hedge their investments (The African Private Equity and Venture Capital Association, 2022).

South American and Asian equity market development. The South American and Asian equity markets also face challenges and barriers related to limited availability of financial data, low market capitalisation, weak governance and corruption, limited market infrastructure, limited legal and regulatory frameworks, and foreign exchange risk. The reasons for the defined barriers are like those for the challenges to African equity market development. In addition, the South American and Asian equity markets face issues regarding a limited investor base, as the number of institutional investors in South America and Asia is relatively small compared to that of other regions. This can limit the demand for equity investments, which makes raising capital significantly more difficult, ultimately resulting in a lack of liquidity.

Many of the highlighted barriers are interrelated and, in many instances, a result of other barriers. Like the credit market, the inherent interrelated nature of these barriers and challenges leads to a circular effect of perpetual worsening of the equity market.

Bond Market Development

Based on the results of this study, as well as the supporting literature, it was found that the bond market could play a role in promoting RE within emerging markets, albeit less significantly than the credit and equity markets. The bond market promotes RE within emerging markets by providing access to long-term capital and diversifying sources of capital while supporting government RE targets. There is a growing demand for sustainable investment by investors, providing an opportunity for RE firms to access a new pool of capital (OECD, 2022). Despite its clear benefits, the development of this market faces significant challenges and barriers that vary by country and region but largely remain common in substance.

African bond market development. The challenges and barriers to bond market development in Africa are significant, numerous, and varied. These include a lack of deep and liquid markets, as many countries lack a bond market entirely, let alone a well-developed one. This leads to a market with low liquidity, low trading volumes, and high trading costs. This issue is compounded by the fact that African bond markets are isolated from the global, thus making it difficult for international investors to participate (Muet al., 2013). Moreover, African nations are plagued by poor credit ratings, which impacts their ability to access capital at reasonable rates. This makes issuing bonds more difficult, as investors are wary of the nations' high risk. Regulatory barriers also play a significant role in impeding bond market development because complex and restrictive regulatory environments make operating within the bond market environment difficult. Once more, this reduces liquidity and increases costs, as potential participants are deterred from entering the market (Mezui & Hundal, 2013).

Lack of investor education is also a significant barrier to African bond markets. A healthy bond market is supported by a healthy contingent of local investors who participate in the market. Their participation increases demand and, thus, liquidity and aids in improving market efficiency. Therefore, a lack of informed local investors heavily impacts a bond market's development (OECD, 2017). In addition, like the credit and equity markets, the African bond markets face challenges and barriers related to political instability and infrastructure limitations.

South American & Asian bond market development. The South American and Asian bond markets face challenges and barriers related to a lack of deep and liquid markets, poor credit ratings, regulatory barriers, lack of investor education, limited legal and regulatory frameworks, and foreign exchange risk. The reasons for the defined barriers are like those affecting African bond market development. In addition, the South American and Asian equity markets face a lack of standardisation among bond contracts and market practices, making the effective comparison and valuation of bonds difficult (Fabella & Madhur, 2003).

Again, the circular nature of the difficulties in development that the bond market faces can be observed. Weak regulations and a lack of infrastructure lead to an unstable and vague environment in which investors have no confidence to invest. The lack of information and lack of trust in the system or country, as seen through poor credit ratings, results in low participation in the market. A bond market is only truly effective when it is liquid, and the participants are active, allowing efficient allocation of capital.

Access to financial markets. Considering the significant challenges mentioned above in developing the credit, equity, and bond markets in these regions, it is important to consider who currently has or will have access to these financial markets while they are in the process of development. Assuming that the respective markets are developing, considering they are in emerging and developing markets, the systemic issues defined above will make accessing them difficult and limited to a relatively small group of individuals and institutions.

Those with access would include large multinational corporations and institutional investors, which have both the financial resources and expertise to effectively navigate the challenges that exist in less-developed financial markets (Allen et al., 2014). Due to their inherent size, network, and reputation resulting from historic performance, they may have access to specialised financial products and services that are not readily available to other, smaller market participants. Such products and services may include traditional finance, asset-based finance, and hybrid instruments, such as mezzanine financing (Cusmano & Koreen, 2015). High-net-worth individuals who have healthy and significant financial resources to invest in markets that face barriers (OECD, 2008) can also access finance, as credit providers may deem them risk-worthy. They may also

have supporting assets they may use as collateral or healthy credit scores/history, which may give capital providers confidence.

Additionally, government entities and development organisations can gain access to financial markets by playing a key supportive role. They may provide the necessary capital to add liquidity to the markets and technical support to add stability to the market infrastructure; develop and enforce laws and regulations to ensure security within the financial environment; and perform various other functions, such as aligning political interests to overcome any other existing barriers (Sleem, 2010).
Lastly, local financial institutions have prime access to financial markets. Acting as both a market creator (by providing capital) and an intermediary between participants, they are best equipped to navigate the challenges and barriers to FMD (Arteta & Kasyanenko, 2020). The most significant concern for these institutions may be limited capital and familiarity biases in terms of market development decisions.

To make financial markets efficient and effective, they must become more inclusive. Greater efforts need to be made to improve market accessibility, which will improve activity and liquidity, thus promoting development. All stakeholders within a financial market must be aligned for a market to experience meaningful growth. This growth should be driven by a leader (in most cases, a government or government representative entity), who will outline a development framework.

4.3.3 Financial Market Development Framework

"Financial market development is characterised by an increase in the market size and liquidity, a broadening of the range of financial instruments available, the development of new financial intermediaries, and the establishment of regulatory frameworks to protect investors and maintain market stability," (Sahay et al., 2015). The proposed FMD framework seeks to impose the above-mentioned solutions by suggesting a set of policies and procedures aimed at promoting the growth and efficiency of financial markets. A framework aimed specifically at promoting RE requires a comprehensive and multifaceted approach that considers the unique characteristics of the RE market and involves both policy- and market-based interventions.

Chami et al.'s (2009) study on FMD frameworks posed questions concerning the necessary new financial instruments, the best way to introduce them, and the ideal sequence for developing various types of markets and associated institutions. These questions were partly answered through the current study's analysis. Regarding the promotion of Renewable Energy Production (REP) in emerging markets, the study's findings suggest an optimal development sequence for financial markets and associated institutions, which is as follows: credit markets, equity markets, and then bond markets. The suggested frameworks described below have been structured to develop the financial markets in this order.

The development of financial markets depends on the activities of key players, including borrowers, lenders, liquidity providers, and regulators. "For financial markets to thrive, borrowers and lenders must be willing and able to engage in fair contracts, while liquidity providers must have favourable conditions for trading financial instruments. Regulators can facilitate market development by removing obstacles that discourage participation by borrowers, lenders, and liquidity providers, and by creating appropriate incentives to encourage each party to fulfil their contractual obligations," (Chami et al., 2009).
When considering the agents in the financial market paradigm, it is essential to note the roles they play as critical components of the primary and secondary financial markets within the FMD framework. "The primary financial market involves the issuance of new securities to raise funds. Its development involves an increase in the number of new securities being issued as well as an expansion of the variety of securities available for investment," (Cantu & Chui, 2020). This in turn attracts more investors, which leads to an increased flow of funds into the market. The secondary financial market is where previously issued securities from the primary market are traded. Its development involves volume increases in trading, expanding or broadening of the range of securities available and improving the efficiency of trading systems (Árvai & Heenan, 2008). This leads to more efficient price discovery and better price transparency. Developing both the primary and secondary markets is essential for a robust FMD framework.

At this juncture, it is important to list and highlight the key contributors to and participants of the markets under consideration. These are the market participants to

whom the FMD framework is most applicable. Thus, a clearer understanding of them and their functions will aid the framework's interpretation and value.

Table 14: Key market contributors and participants.

Credit Market	
Contributor	Discussion
Domestic Banks	Often, the primary source of credit in developing economies; may provide loans to individuals, small businesses, and large corporations.
International Financial Institutions	Organisations such as the World Bank, International Monetary Fund, and regional development banks may provide loans and other forms of credit to developing economies.
Microfinance Institutions	Offer microcredit and other financial products to underserved individuals and small enterprises who lack access to mainstream banking services.
Government Agencies	May provide credit and financing to support economic development projects and initiatives.
Private Investors	Include venture capitalists and angel investors, who may offer financial support to emerging companies and other entrepreneurial ventures in developing nations.
Non-Governmental Organisations	May provide credit and other forms of financial support to help promote social and economic development in developing economies.
Development Finance Institutions	May provide long-term financing and other forms of support to help promote economic growth and development in developing economies.
Insurance Companies	May provide credit insurance or other forms of financial protection to lenders in developing economies.

Equity Market	
Contributor	Discussion
Domestic Institutional Investors	Pension funds, insurance companies, and mutual funds; invest in local companies.
Foreign Institutional Investors	Hedge funds and private equity firms invest in companies listed on the local stock exchange.

Sovereign Wealth Funds	Government-owned investment funds that invest in equity markets worldwide.
Individual Investors	Invest in stocks through brokerage firms or online trading platforms.
Venture Capital Firms	Invest in early-stage companies with high growth potential.
Investment Banks	Underwrite and facilitate initial public offerings of companies on the local stock exchange.
Stockbrokers and Other Financial Intermediaries	Facilitate trading in the equity market and provide advice to investors.
Research Firms and Financial Analysts	Provide analyses and recommendations on individual companies and the equity market.
Government and Regulatory Bodies	Play a role in promoting and regulating the equity market in developing economies.

Bond Market	
Contributor	Discussion
Governments	Issue bonds to fund infrastructure development, social programs, and other public expenditures.
Corporations	Issue bonds to finance their operations, expansion, and investment plans.
Financial Institutions	Banks and insurance companies invest in bonds as a source of income and to manage risk.
Foreign Investors	Institutional investors and sovereign wealth funds invest in local bonds for diversification and yield opportunities.
Pension Funds and Other Institutional Investors	Invest in bonds to meet long-term liabilities and diversify their portfolios.
Individual Investors	Invest in bonds through brokerage firms, mutual funds, and exchange-traded funds.
Multilateral Development Banks	Include the World Bank and the Asian Development Bank; issue bonds to finance development projects in developing economies.
Rating Agencies and Credit Analysts	Provide assessments of the creditworthiness of bond issuers and their debt securities.

Investment Banks and Other Financial Intermediaries	Underwrite and distribute bonds to investors and provide market-making services.
Regulatory Bodies and Central Banks	Oversee and regulate the bond market to ensure transparency, stability, and investor protection.

4.3.4 Financial Market Development for Renewable Energy Framework

The final discussion of this study is structured around an FMD framework (Table 15) that highlights the primary types of RE policy categories and specific policies that are effective in promoting REP in emerging markets.

Renewable Energy Policy Categories

Financial policies include a range of incentives to promote RE, such as tax credits, rebates, and low-interest loans. They are set to help stimulate investment in and reduce the initial costs of RE projects. Regulatory policies aim to regulate the RE market and establish a level playing field within the market while making it more attractive to investors (International Renewable Energy Agency, 2020). Capacity-building policies aim to build local capacity and expertise in the RE sector in the hope that this may lead to further investment and job creation in the future. Research and development policies help to drive innovation and make the RE sector more competitive in international markets and fossil-based energy sources. Public-private partnership policies help reduce the risk of RE project implementation that investors may face through diversification, which ultimately aids in creating a more stable investment environment for RE (UNEP FI, 2012). International cooperation policies are aimed at providing support for RE market development within emerging and developing markets in addition to promoting the global initiatives of RE adoption and carbon emission reduction.

A combination of policies, market-based interventions, and collective efforts from all stakeholders within the energy market are required to promote the development of RE sectors through FMD within developing and emerging markets. Governments and related entities are the catalysts of this development, and the rate at which financial markets develop to reach a point whereby they are efficient enough to effectively support the RE markets will be based on governmental efforts. The mere existence of effective policies will not result in the stimulation of FMD and promotion of RE expansion. Without concerted efforts from governments and the relevant regulatory bodies that implement and enforce such policies, they may never become effective. Moreover, sufficient financing is essential for policy implementation, as is the deployment of passionate and skilled individuals within the relevant FMD or RE structures that require strengthening.

We would like to highlight that a positive relationship between FMD and RE has been determined through this study. The credit market and equity markets have shown to be the most significant components of FMD in this relationship; thus policy recommendations should be tailored to focus on these two primary factors. The policy recommendations for credit market development would involve providing renewable energy financing guarantees, which would reduce the perceived risk of lending for RE projects (Mir & Bhat, 2022). Reducing interest rates and providing incentives to reduce the cost of borrowing and make RE projects more financially attractive for all participants in the market (OECD, 2002). Lastly, policies that improve credit scoring and risk assessment mechanisms for RE projects aid financial institutions in better evaluating the credit worthiness of potential borrowers in the sector. Improved risk assessment could lead to more favourable loan terms for borrowers.

The policy recommendations for equity market development would involve incentives and tax benefits that promote green investments. These incentives could include tax credits or preferential tax treatment, deductions, and other exemptions, all aimed at encouraging investment in RE projects. Policies that promote the formation of renewable energy investment funds whose primary mandate would be to provide equity capital as well as additional expertise to ensure the success of the RE startups and projects (OECD, 2013). Lastly, policies that would ease the listing and trading of RE companies on local stock exchanges as well as those that aim to reform the regulatory environment to create a supportive ecosystem that encourages transparency and disclosure in the RE sector, (Kumanduri, 2021). These would promote confidence in investors ,who in-turn will be more secure in their participation in the market.

Table 15: Financial market development and renewable energy production framework (Ata, 2013; Bank for International Settlements, 2020; International Renewable Energy Agency, 2020; IRENA, 2018; Kabel & Bassim, 2019; Lu et al., 2020; OECD, 2017; REN21, 2022; Shokri & Heo, n.d.; UNEP FI, 2012).

The Financial Markets Development for Renewable Energy Framework

Renewable Energy Policy Categories	
I. Financial Policies	IV. Research & Development Policies
II. Regulatory Policies	V. Public-Private Partnerships Policies
III. Capacity Building Policies	VI. International Cooperation Policies

Specific Policies Effective in Promoting Renewable Energy

Policy Category	**Specific Policy**	**Definition**	**Reference**
I. Financial Policies:			
	A. Tax Incentives		
	- Investment Tax Credits	Tax credits that reduce the amount of taxes paid on an investment in a renewable energy project.	(OECD, 2002)
	- Accelerated Depreciation	Allows investors to recover their investment in renewable energy equipment more quickly than they would with traditional depreciation methods.	(OECD, 2002)
	- Reduced Tax Rates	Lower tax rates for renewable energy projects.	(OECD, 2002)
	B. Subsidies		
	- Feed-In Tariffs (FITs)	A policy mechanism where a fixed price is paid for electricity generated from renewable sources.	(Rickerson, Laurent, Jacobs, Dietrich, & Hanley, 2012)
	- Power Purchase Agreements (PPA's)	Direct payments made to renewable energy project developers for the energy they produce.	(Rickerson, Laurent, Jacobs, Dietrich, & Hanley, 2012)
	C. Green Bonds	Bonds issued to finance environmentally friendly projects, including renewable energy.	(Rickerson, Laurent, Jacobs, Dietrich, & Hanley, 2012)

	D. Crowdfunding	A financing method where small amounts of capital are raised from many people to fund a project.	(Bernardino & Santos, 2020)
	E. Carbon Pricing	A policy mechanism that puts a price on carbon emissions to create a financial incentive for renewable energy production.	(Baranzini, et al., 2016)
	F. Green Banks	Financial institutions that provide low-interest loans, loan guarantees, and other financial products to support renewable energy projects.	(Mir & Bhat, 2022)
II. Regulatory Policies:			
	A. Renewable Portfolio Standards (RPS)	Policies that require a certain percentage of a country or state's electricity generation to come from renewable sources.	(Rickerson, Laurent, Jacobs, Dietrich, & Hanley, 2012)
	B. Net Metering	A policy that allows customers with renewable energy systems to sell excess electricity back to the grid.	(Rickerson, Laurent, Jacobs, Dietrich, & Hanley, 2012)
	C. Feed-In-Tariffs (FITs)	Defined above.	(Rickerson, Laurent, Jacobs, Dietrich, & Hanley, 2012)
	D. Tradable Green Certificates (TGCs)	Tradable certificates that represent a certain amount of renewable energy production.	(Rickerson, Laurent, Jacobs, Dietrich, & Hanley, 2012)
	E. Energy Efficiency Standards & Labelling	Policies that require energy efficiency standards for appliances and buildings and labelling programs that help consumers choose more efficient products.	(International Energy Agency (IEA), 2015)
III. Capacity Building Policies:			
	A. Training Programs for Renewable Energy Projects Development	Programs that provide training for project developers on how to develop and implement renewable energy projects.	(UNESCO-UNEVOC International Centre for TVET, 2020)

	B. Technical Assistance for Project Implementation	Assistance provided to renewable energy project developers to help them implement their projects.	(UNESCO-UNEVOC International Centre for TVET, 2020)
	C. Workforce Development Programs for the Renewable Energy Sector	Programs that provide training for workers in the renewable energy sector.	(UNESCO-UNEVOC International Centre for TVET, 2020)
	D. Building Institutional Capacity for Renewable Energy Planning & Implementation	Programs that support the development of institutions and policies to promote renewable energy planning and implementation.	(Kimuli, et al., 2017)
IV. Research & Development Policies			
	A. Research Grants for Renewable Energy Technology Development	Grants provided to support research and development of renewable energy technologies.	(European Commission, 2020)
	B. Innovation Prizes for Breakthrough Renewable Energy Technologies	Prizes offered to incentivize the development of breakthrough renewable energy technologies.	(World Economic Forum in collaboration with KPMG, 2018)
	C. Public-Private Partnerships for Renewable Energy Research	Partnerships between public and private entities to support renewable energy research.	(Rajpurkar, 2015)
	D. Demonstration Projects for New Renewable Energy Technologies	Projects designed to showcase new renewable energy technologies and demonstrate their feasibility.	(Backstrom, 2015)
V. Public-Private Partnerships Policies:			
	A. Joint Investment Funds for Renewable Energy Projects	Funds set up by public and private entities to invest in renewable energy projects.	(OECD, 2013)
	B. Joint Venture Agreements Between Public and Private Entities for Renewable Energy Projects	Agreements between public and private entities to jointly develop renewable energy projects.	(OECD, 2013)

	C. Public-Private Partnerships for Renewable Energy Research and Development	Partnerships between public and private entities to support renewable energy research and development.	(Rajpurkar, 2015)
	D. Co-Development of Renewable Energy Projects by Public and Private Entities	Joint development of renewable energy projects by public and private entities.	(Rajpurkar, 2015)
VI. International Cooperation Policies:			
	A. Technical Assistance and Capacity Building for Renewable Energy Planning and Implementation	Support provided to developing countries for renewable energy planning and implementation.	(REN21 - Renewables Now, 2022)
	B. Financial Support for Renewable Energy Projects in Developing Countries	Financial support provided to developing countries for renewable energy projects.	(UNEP FI, 2012)
	C. International Collaboration on Renewable Energy Research and Development	Collaboration between countries on renewable energy research and development	(REN21 - Renewables Now, 2022)
	D. Support for Renewable Energy Deployment in Developing Countries Through International Climate Funds	Support from funds such as Green Climate Fund (GCF) or Global Environment Facility (GEF)	(UNEP FI, 2012)

4.4 Conclusion and Recommendations

4.4.1 Conclusion

The primary objective of this study was to prove the essential role of FMD in the development of the RE sector within emerging and developing markets and formulate guidelines on how best to develop this sector in these markets. To meet this objective, the existence of a nexus between FMD and RE consumption was determined and proved significant using a panel regression whereby the fixed effects model was implemented. Additional robustness tests were performed to further support the validity of the findings, followed by a detailed analysis that explored the empirical results in relation to existing literature.

Discussions related to FMD emphasised the challenges and barriers the different financial markets may face, and common themes were highlighted. Many of the barriers are interrelated, and this inherent correlation leads to a circular effect of the perpetual worsening of markets, as one challenge leads to another. For example, weak legal and regulatory frameworks perpetuate the informal markets, which in turn limits access to finance. Limited financial infrastructure leads to a continued lack of credit history, which again results in limited general access to finance.

After consideration of the sequence or rank of each financial market based on the impact its development would have on REP and REC, an FMD framework was proposed to promote REC in developing countries; financial, regulatory, capacity-building, R&D, public-private partnership, and international cooperation policies were advised. The promotion of REP in emerging markets requires a multifaceted approach that involves a combination of policies, market-based interventions, and collective efforts from all stakeholders within the energy sector to promote the development of RE sectors through FMD.

4.4.2 Recommendations

Methodology

Future studies should consider expanding on the methodology employed in this study by increasing the sample size of the nations selected to obtain a more accurate understanding of FMD in their respective continental regions and potentially increase

the focus by dividing the countries within each region into emerging nations and developing nations to attain a more granular understanding. Additionally, expanded robustness tests could be explored whereby alternative testing methods are used and the results investigated.

Financial Market Development Framework

Further research that explores the nature of the sequencing question in relation to primary and secondary market development in emerging markets should be performed, with sequencing referring to the appropriate order in which markets should be developed. The establishment of a primary market facilitates the development of a secondary market, but in many instances, the success of the former may be linked to the growth of the latter. The venture capital market (equity market) is a good example of this: it is only effective if a liquid secondary market, where shares are easily traded, exists, therefore providing a desired exit strategy from the initial investment. Similarly, the primary bond market's performance is directly linked to the strength and depth of the secondary market. Thus, further study is required to understand the interdependence of the primary and secondary financial markets in emerging markets to better promote REP through more easily accessed financing.

Regulatory, Policy, and Market-Based Intervention Frameworks

Further studies should be conducted to explore the relationship between regulations and policies that promote REP and FMD. As well as the connection between financial market development (FMD) and market-based initiatives that encourage renewable energy (RE) can be explored. An impact assessment on the efficacy of such policies and interventions would greatly assist policymakers with future decisions.

Additional and Alternative Financial Markets

Future research could expand on the current study by exploring additional and alternative financial markets. Markets such as venture capital, peer-to-peer lending, and crowdfunding markets could be analysed. Moreover, greater insight regarding the developmental finance landscape, a significant participant in the development of emerging financial markets, could be obtained. Additionally, the potential of alternative financial instruments or sources of funding could be explored, as concepts such as credit

enhancements, FDI guarantees, and derivatives may aid in the development of emerging financial markets by providing increased depth and liquidity.

APPENDIX A: METHODOLOGY TABLE

Title	Author	Period	Countries	Variables	Technique	Result
				Main literature referenced in paper		
The effect of financial development on renewable energy consumption. A panel data approach	(Anton & Nucu, 2020)	1990 - 2015	28 EU Member States	Renewable energy consumption (% of total final energy consumption), Domestic credit provided by the financial sector (% of GDP) Stock market turnover ratio (%), Outstanding international private debt securities to GDP (%), Economic development, Consumer price index (2010 1/4 100), Foreign direct investment, net inflows (% of GDP), GRDP Grpwth (annual %)	Panel Fixed Effect Model	Financial Development has a positive relationship with Renewable energy Consumption
Finance for renewable energy: an empirical analysis of developing and transition economies	(Brunnschweiler, 2010)	1980 - 2006	119 non-OECD countries	Renewable resource electricity generation (billion kwh per capita), Hydroelectric power generation (billion kwh per capita), All non-hydro RE power generation (billion per capita), Commercial banks' asset share versus that of the central banks, Credit provided by financial institutions to the private sector (% GDP), Financial depth measured as broad money (M2/GDP)	GLS Estimation	Financial Development has a positive relationship with Renewable energy Consumption
Effects of financial developments and income on energy consumption	(Chang, 2014)	1999 - 2008	53 Countries	Energy use in kg of oil equivalent per capita (energy), Real GDP per capita, Consumer price index, Domestic credit to the private sector as a percentage of GDP (%), Domestic credit Domestic credit provided by the banking sector (% GDP), Stock market capitalization (%GDP), Stock market total value traded (% GDP), net inflows of foreign direct investment to GDP (%)	GMM Model	Financial Development has a positive relationship with Renewable energy Consumption
The nexus between financial development and energy consumption in the EU: A dynamic panel data analysis	(Çoban & Topcu, 2013)	1990 - 2011	27 EU states (15 Old members & 12 New members)	Energy use in kg of oil equivalent per capita, Real GDP per capita, Net inflows of foreign direct investments (%GDP), Deposit money bank assets (%GDP), Financial system deposits (%GDP), Liquid liabilities (%GDP), Private credit (%GDP), Bank overhead costs, Net interest margin, Concentration ratio, Return on assets, Return on equity, Cost-income ratio, Z-score, Stock market turnover ratio, Stock market capitalization (%GDP), Stock market value traded (%GDP) and number of listed companies per 10,000 people.	GMM Model	Financial Development has a positive relationship with Renewable energy Consumption
The impact of financial development and economic growth on renewable energy consumption: Empirical analysis of India	(Eren, Taspina, & Gokmenoglu, 2019)	1975 - 2015	India	Renewable energy consumption (% of total final energy consumption), Broad money (% of GDP), Domestic credit provided by the financial sector (% of GDP), Deposit money bank assets to deposit money bank assets plus central bank assets (%), GDP per capita (constant 2010 US$),	GLS Estimation	Financial Development has a positive relationship with Renewable energy Consumption
Financial development and deployment of renewable energy technologies	(Kim & Park, 2016)	2000 - 2013	Argentina, Australia, Austria, Brazil, Canada, Chile, China, Ecuador, El Salvador, France, Germany, Greece, India, Indonesia, Italy, Japan, Republic of Korea, Mexico, New Zealand, Norway, Pakistan, Peru, Philippines, Portugal, Spain, Thailand, Turkey, the United Kingdom, the United States, and Uruguay.	Capacity of renewable energy ,GDP per capita, feed-in tariff (FIT) policy dummy, Renewable sectors' share of electricity generation, Stock market capitilization ratio, Stock market turnover ratio (%GDP)	Panel Fixed Effect Model	Financial Development has a positive relationship with Renewable energy Consumption
The impact of financial development on energy consumption in emerging economies	(Sadorsky, 2010)	1990 - 2006	Argentina, Brazil, Chile, China, Colombia, Czech Republic, Egypt, Hungary, India, Indonesia, Israel, South Korea, Malaysia, Mexico, Morocco, Peru, Philippines, Poland, Russia, South Africa, Thailand, and Turkey	Energy use in kg of oil equivalent per capita (energy), Real GDP per capita, Consumer price index, Foreign direct investment Net inflows (% GDP), Deposit money bank (% GDP), Stock market capitalization (%GDP), Stock market total value traded (% GDP), Stock market turnover ratio	GMM Model	Financial Development has a positive relationship with Renewable energy Consumption
The effect of financial development on renewable energy demand: The case of developing countries	(Shahbaz, Topcu, Sarıgül, & Vo, 2021)	1994 - 2018	Albania, Armenia, Azerbaijan, Brazil, Bulgaria, China, Colombia, Costa Rica, Dominica, Dominican Republic, Ecuador, Fiji, Gabon, Grenada, Guatemala, Guyana, Iran, Islamic Rep. Jamaica, Jordan, Kazakhstan, Malaysia, Mauritius, Mexico, North Macedonia, Paraguay, Peru, Samoa, Sri Lanka, South Africa, St. Lucia, St. Vincent and the Grenadines, Thailand Tonga Turkey	Renewable energy consumption (% of total final energy consumption), Domestic credit provided by financial sector (%GDP), domestic credit to private sector by banks (%GDP)	Random Effect Model: Full	Financial Development has a positive relationship with Renewable energy Consumption
The effect of sample size on European Union's renewable energy investment drivers	(Sisodia, Soares, & Ferreira, 2016).	1995 - 2011	27 EU states (15 Old members & 12 New members)	Solar Investments, Wind Investments, levelized cost of generation through solar, levelized cost of generation through wind, Regulations perception, carbon emissions, annual sunshine hours	Random Effect Model	No relationship between economic growth & Renewable Energy

REFERENCE LIST

Abdelilah, Y., Bahar, H., Criswell, T., Bojek, P., Briens, F., Moorhouse, J., & Jiménez, G. R. (2021). *Renewables 2021 - Analysis and forecast to 2026.* Internation Energy Agency.

Abolhosseini, S., & Heshmati, A. (2014). The main support mechanisms to finance renewable energy development. *Elsevier: Renewable and Sustainable Energy Reviews* (40), 876–885.

The African Private Equity and Venture Capital Association. (2022). *Currency risk management practices in African private equity and venture capital.*

Agenor, P.-R., & Canuto, O. (2017). Access to finance, product innovation and middle-income traps. *Research in Economics*, 63–82. doi:10.1016/j.rie.2017.03.004

Ahlqvist, V., Holmberg, P., & Tangeras, T. (2018). *Centralization versus decentralization in electricity markets.* Stockholm: EFORIS.

Akamiokhor, G. (1992). The role of regulatory bodies in capital market development: the Nigerian experience. *CBN Bullion, 16*(2), 12–22.

Allen, F., Carletti, E., Cull, R., Qian, J., Senbet, L., & Valenzuela, P. (2014). The African financial development and financial inclusion gaps. *Journal of African Economies, 23*(5), 614–642.

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

Arteta, C., & Kasyanenko, S. (2020). Financial markets development. In M. A. Kose, & F. Ohnsorge (Eds.), *A decade after the global recession: Lessons and challenges for emerging & developing markets* (pp. 163–208). Washington, D.C.: The World Bank.

Árvai, Z., & Heenan, G. (2008). *A framework for developing secondary markets for government securities.* Paris: International Monetary Fund.

Aslani, A., Naaranoja, M., & Zakeri, B. (2012). The prime criteria for private sector participation in renewable energy investment in the Middle East (case study: Iran). *Renewable and Sustainable Energy Reviews, 16*, 1977–1987.

Ata, N. K. (2013). The impact of government policies in the renewable energy investment: Developing a conceptual framework and qualitative analysis. *Global Advanced Research Journal of Management and Business Studies*, 67–81.

Aykut, D., & Blaszkiewicz-Schwartzman, M. (2018). *Shaping the future of Africa: Markets & opportunities for private investors*. Washington, D.C.: International Finance Corporation.

Ayyagari, M., Juarros, P., Peria, M. S., & Singh, S. (2016). *Access to finance and job growth: Firm-level evidence across developing countries*. World Bank Group.

Azhgaliyeva, D., Beirne, J., & Mishra, R. (2021). *What matters for private investment financing in renewable energy globally and in Asia?* Tokyo: Asian Development Bank Institute.

Balcioglu, H., EL-Shimy, M., & Soyer, K. (2017). 1 Renewable energy - Background. In *Economics of variable renewable sources for electric power production*. Germany: Lambert Academic Publishing.

Bank for International Settlements. (2020). *Financial market development, monetar7 policy and financial stability in emerging market economies.*

Baris Memduh Eren, N. T. (2019). The impact of financial development and economic growth on renewable energy consumption: Empirical analysis of India. *Elsevier*, (663), 189–197.

Beck, T., & Levine, R. (2002). Industry growth and capital allocation: Does having a market- or bank-based system matter? *Journal of Financial Economics, 64*(2), 147–180.

Beck, T., Demirgiiu-Kunt, A., & Levine, R. (1999). *A new database on financial development & structure.* Washington, D.C: World Bank.

Beck, T., Demirgiiu-Kunt, A., & Maksimovic, V. (2003). *Financial and legal institutions & firm size.* World Bank Group. doi:10.1093/wber/lhi027

Bhutta, U. S., Tariq, A., Farrukh, M., Raza, A., & Iqbal, K. (2021). Green bonds for sustainable development: Review of literature on development and impact of green bonds. *Elsevier, 175*.

Bodi, Z., Kane, A., & Marcus, A. J. (2021). *Investments* (Vol. 12). New York: McGraw-Hill Education.

Breusch, T., Ward, M. B., Nguyen, H., & Kompas, T. (2011a). On the fixed-effects vector decomposition. *Political Analysis, 19*, 123–134.

Breusch, T., Ward, M. B., Nguyen, H., & Kompas, T. (2011b). FEVD: Just IV or just mistaken? *Political Analysis, 19*, 165–169.

Brunnschweiler, C. (2010). Finance for renewable energy: an empirical analysis of developing and transition economies. *Environment and Development Economics, 15*(3), 241–274.

Buonocore, J. J., Hughes, E. J., Michanowicz, D. R., Heo, J., Allen, J. G., & Williams, A. (2019). Climate and health benefits of increasing renewable energy deployment in the United States. *Environmental Research Letters,* (14), 1–13.

Cantu, C., & Chui, M. (2020). Financial market development and financial stability. *BIS Papers,* (113), 19–28.

Chami, R., Fullenkamp, C., & Sharma, S. (2009). *A framework for financial market development.* IMF Institute.

Chang, S.-C. (2014). Effects of financial developments and income on energy consumption. *International Review of Economics & Finance,* (35), 28–44.

Chatri, F., & Yahoo, M. (2021). The importance of renewable energy expansion in power generation sector in Iran: a computable general equilibrium approach. In *Design, analysis, and applications of renewable energy systems* (pp. 393–411). Academic Press.

Chirambo, D. (2016). Addressing the renewable energy financing gap in Africa to promote universal energy access: Integrated renewable energy financing in Malawi. *Elsevier, 6*, 793–803.

Chuhan-Pole, P., Calderon, C., Kambou, G., Blimpo, M., & Korman, V. (2018). *An analysis of issues shaping Africa's economic future.* Washington, D.C.: World Bank Group. doi:10.1596/978-1-4648-1291-0

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.

Cusmano, L., & Koreen, M. (2015). *New approaches to SME & entrepreneurship financing: Broadening the range of instruments.* Paris: OECD.

Dabla-Norris, E., Deng, Y., Ivanova, A., Karpowicz, I., Unsal, F., VanLeemput, E., & Wong, J. (2015). *Financial inclusion: Zooming in on Latin America.* International Monetary Fund.

Dahou, K., Omar, I. H., & Pfister, M. (2009). *Deepening African financial markets for growth & investment.* NEPAD-OECD.

Darškuvienė, V. (2010). F*inancial Markets - Vytautas Magnus University. Kaunas, Lithuania.* Retrieved from https://www.bcci.bg/projects/latvia/pdf/7_Financial_markets.pdf

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.

Domhnaill, C. M., & Ryan, L. (2020). Towards renewable electricity in Europe: Revisiting the determinants of renewable electricity in the European Union. *Renewable Energy, 154*, 955–965.

Donastorg, A., Renukappa, S., & Suresh, S. (2017). Financing renewable energy projects in developing countries: A critical review. *IOP Conference Series: Earth & Enironmental Science, 83*, 9.

Eren, B. M., Taspina, 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.

Fabella, R., & Madhur, S. (2003). *Bond market development in East Asia: Issues and challenges.* Asian Development Bank.

Fadly, D. (2019). Low-carbon transition: Private sector investment in renewable energy projects in developing countries. *World Development, 122*, 552–569.

Frequently Asked Questions on just transition. (n.d.). Retrieved from https://www.ilo.org/global/topics/green-jobs/WCMS_824102/lang--en/index.htm

Gielen, D., Boshell, F., Saygin, D., Bazilian, M. D., & Wagner, N. (2019). The role of renewable energy in the global energy transformation. *Energy Strategy Reviews, 24*, 38–50.

Gielen, D., Boshell, F., Saygin, D., Bazilian, M. D., Wagner, N., & Gorini, R. (2019). The role of renewable energy in the global energy transformation. *Energy Strategy Reviews, 24*, 38–50.

Global Financial Integrity. (2021). *Trade-related illicit financial flows in 134 developing countries.*

Global Sustainable Investment Alliance. (2019). *2018 global sustainable investment review.*

Greene, W. (2011). Fixed effects vector decomposition: A magical solution to the problem of time-invariant variables in fixed effects models? *Political Analysis*, 135–146.

Haas, R., Panzer, C., Ragwitz, M., Reece, G., & Held, A. (2011). A historical review of promotion strategies for electricity from renewable energy sources in EU countries. *Renewable and Sustainable Energy Reviews*, *15*(2), 1003–1034.

Hassine, M. B., & Harrathi, N. (2017). The causal links between economic growth, renewable energy, financial development and foreign trade in Gulf Cooperation Council countries. *International Journal of Energy Economics and Policy*, *7*(2), 76–85.

IMF Fiscal Affairs Department. (2022). *Economy Groupings.* Retrieved from https://www.imf.org/en/Publications/SPROLLs/Publications-on-Emerging-Markets#sort=%40imfdate%20descending

International Monetary Fund. (2000). *Supporting Document to the Code of Good Practices on Transparency in Monetary and Financial Policies Part 1—Introduction.* Retrieved from https://www.imf.org/external/np/mae/mft/sup/part1.htm#appendix_III

International Monetary Fund. (2023). *World economic outlook update.* Washington, D.C.

International Renewable Energy Agency. (2020). *Renewable energy policies in a time of transition: Heating & cooling.*

IRENA. (2018). *Power system flexibility for the energy transition, part 1: Overview for policy makers.* Abu Dhabi.

Isaksson, M. (1999). *Investment, financing & corporate governance: The role & structure of corporate governance arrangements in OECD countries.* Vilnius: OECD.

Ito, H., & Kawai, M. (2018). Quantity and quality measures of financial development: Implications for macroeconomic performance. *Pun*, *XIV*(5), 803–834.

Johnstone, N., Hascic, I., & Popp, D. (2008). *Renewable energy policies and technological innovation: Evidence based on patent count.* Cambridge: National Bureau of Economic Research.

Juko, S. (n.d.). *Role of financial markets: A general overview of functions and benefits.* Retrieved from https://www.cemla.org/actividades/2019-final/2019-09-financial-markets/2019-09-financial-markets-1.pdf

Kabel, T. S., & Bassim, M. (2019). Literature review of renewable energy policies and impacts. *European Journal of Marketing and Economics, 2*(2), 28–41.

Kabel, T. S., & Bassim, M. (2020). Reasons for shifting and barriers to renewable energy: A literature review. *International Journal of Energy Economics and Policy*, *10*(2), 89–94.

Kariuki, D. (2021). *Barriers to renewable energy technologies development.* Murang'a: Research Gate.

Kennedy, S. F. (2018). *The global energy transition and its contradictions: Emerging geographies of energy and finance in Indonesia and California.* Los Angeles: UCLA.

Kiliçarslan, Z. (2019). The relationship between foreign direct investment and. *International Journal of Energy Economics and Policy, 9*(4), 291–297.

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

Kochtcheeva, L. V. (2016). *Renewable energy: Global challenges.* Environment, Climate Change and International Relations.

Kumanduri, N. (2021). *Energy finance to developing energy sectors: An analysis of Chinese policy bank lending on energy production in developing countries and determinants of energy lending.* Colorado: University of Colorado.

Kutan, A. M., Paramati, S. R., Ummalla, M., & Zakari, A. (2018). Financing renewable energy projects in major emerging market economies: Evidence in the perspective of sustainable economic development. *Emerging Markets Finance and Trade*, 1761–1777.

Louche, C., Busch, T., Crifo, P., & Marcus, A. (2019). Financial markets and the transition to a low-carbon economy: Challenging the dominant logics. *Organization & Environment*, *32*(1), 3–17.

Lumpkin, S. A. (2009). *Regulatory issues related to financial innovation.* Paris: OECD.

MacMillan, A., & Turrentine, J. (2021). *Global Warming 101*. Retrieved from https://www.nrdc.org/stories/global-warming-101

Mahama, A. C. (2013). *The state of African stock markets.* Theseus.

Mani, M., Hussein, Z., Gopalakrishnan, B. N., & Wadhwa, D. (2018). *Losers, Paris Climate Agreement and the global economy winners and.* South Asia Region: World Bank Group.

Marques, A. C., Fuinhas, J. A., & Manso, J. P. (2010). Motivations driving renewable energy in European countries. *Energy Policy, 38*, 6877–6885.

Marshall, C., Boffo, R., & Mazzone, G. (2021). *Financial markets and climate transition opportunities, challenges and policy implications*. Paris: OECD.

Mehrotra, A., Schanz, J., Chui, M., & Cantú, C. (2020). *Financial market development, monetary policy and financial stability in emerging market economies.* BIS Papers.

Mezui, C. A., & Hundal, B. (2013). *Structured finance - Conditions for infrastructure project bonds in African markets.* African Development Bank.

Mishkin, F. S., & Savastano, M. A. (2002). Monetary policy strategies for emerging market countries: Lessons from Latin America. *Chinese Economic Studies, 44*, 45–82.

Mu, Y., Phelps, P., & Stostsky, J. G. (2013). Bond markets in Africa. *Review of Development Finance, 3*, 121–135.

Nworie, I. (2017). *The economics of electricity market reforms in developing countries: An African experience and lessons.* Portsmouth: University of Portsmouth.

OECD. (2008). *The OECD's project on high net worth individuals.* Cape Town.

OECD. (2017a). *Financing SMEs and entrepreneurs 2017: An OECD scorecard.*

OECD. (2017b). *Policy framework for investor education.* Paris.

OECD. (2022). *Green, social, sustainability and sustainability-linked bonds in developing countries: How can donors support public sector issuances?* Paris.

OECD Green Investment Financing Forum. (2015). *Green bonds: Mobilising the debt capital markets for a low-carbon transition.* Paris.

Oosthuizen, A. M., Inglesi-Lotz, R., & Thopil, G. A. (2021). The relationship between renewable energy and retail electricity prices: Panel evidence from OECD countries. *Energy, 238*, 1–9.

Ostrom, E. (2017). *An analysis of the Paris Agreement: A study of the Agreement in the light of the theory of the eight design principles.* Uppsala: Uppsala University.

Owusu, P. A., & Asumadu-Sarkodie, S. (2016). A review of renewable energy sources, sustainability issues and climate change mitigation. *Cogent Engineering, 3*(1), 1–14.

Plümper, T., & Troeger, V. E. (2007). Efficient estimation of time-invariant and rarely changing variables in finite sample panel analyses with unit fixed effects. *Political Analysis, 15*(2), 124–139.

The Presidential Climate Commission. (2022). *A framework for a just transition in South Africa.*

PricewaterhouseCoopers Securities. (2001). *Key factors for private sector investment in power distribution.* Washington: Energy Sector Management Assistance Programme.

Pueschel, J. C. (2016). *Barriers to renewable energy development: A Chilean & Moroccan cross-country comparison.* Copenhagen: Copenhagen Business School.

Rahman, M. M., Alam, K., & Velayutham, E. (2022). Reduction of CO2 emissions: The role of renewable energy, technological innovation and export quality. *Energy Reports, 8*, 2793–2805.

REN21. (2022). *Renewables 2022 - Global status report.*

Roulet, C. (2022). *Financial market developments and conditions in Asia.* Paris: OECD.

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

Sahay, R., Čihák, M., N'Diaye, P., Barajas, A., Bi, R., Ayala, D., . . . Yousefi, S. R. (2015). *Rethinking financial deepening: Stability & growth in emerging markets.* Washington, D.C.: International Monetary Fund.

Salim, R., Yao, Y., Chen, G., & Zhang, L. (2017). Can foreign direct investment harness energy consumption in China? A time series investigation. *Energy Economics,* (66), 43–53.

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*(1208), 1–14.

Sanghani, N., Jacobs, J., Mailing, E., Pearce, T., & Liu, K. (2022). *The Absa Africa Financial Markets Index.* Official Monetary and Financial Institutions Forum & Absa Group Limited.

Savaresi, A. (2016). The Paris Agreement: A new beginning? *Journal of Energy & Natural Resources Law,* (1), 16–26.

Schlapinski, J., Haque, M., Brister, M., Jewett, B., Moderhack, L., Winborn, R., & Beach, A. (2015). *Private investing in the power sector in emerging markets.* Washington: Emerging Markets Private Equity Association.

Seto, K. C., Davis, S. J., Mitchell, R. B., Stokes, E. C., Unruh, G., & Urge-Vorsatz, D. (2016). Carbon lock-in: Types, causes, and policy implications. *Annual Review of Environment and Resources, 41*, 425–4452.

Shahbaz, M., Topcu, B. A., Sarıgül, S. S., & Vo, X. V. (2021). The effect of financial development on renewable energy demand: The case of developing countries. *Renewable Energy: An International Journal, 178*, 1370–1380.

Shokri, A., & Heo, E. (n.d.). *Energy policies to promote renewable energy technologies; learning from Asian countries experiences*. Seoul: Seoul National University.

Sisodia, G. S., Soares, I., & Ferreira, P. (2016). The effect of sample size on European Union's renewable energy investment drivers. *Applied Economics, 48*(53), 1–9.

Sleem, K. (2010). *A theoretical role for government in the financial markets*. Florida: University of North Florida.

Smith, S. (2017). *Just transition A report for the OECD.* Just Transition Centre.

South African Reserve Bank and Financial Sector Conduct Authority. (2020). *Financial markets review.* Pretoria: South African National Treasury.

Spang, E. S., Moomaw, K. S., Gallagher, K. S., Kirshen, P. H., & Marks, D. H. (2014). The water consumption of energy production: an international comparison. *Environmental Research Letters,* (9), 1–14.

Stanley, A. (2022). *Finance & development: Global inequalities.* Retrieved from https://www.imf.org/en/Publications/fandd/issues/2022/03/Global-inequalities-Stanley

Strambo, C., Burton, J., & Atteridge, A. (2019). *The end of coal? Planning a "just transition" in South Africa.* Stockholm: Stockholm Environment Institute.

Tchamyou, V. S. (2017). The role of knowledge economy in African business. *Journal of the Knowledge Economy*, 1189–1228. doi:10.1007/s13132-016-0417-1

Technical Working Group. (2021). *Theme report on energy transition towards the achievement of SDG 7 & net-zero emissions.* United Nations.

Umair Saeed Bhuttaa, A. T. (2022). Green bonds for sustainable development: Review of literature on development and impact of green bonds. *Elsevier, 175*, 16.

UNEP FI. (2012). *Financing renewable energy in developing countries: Drivers and barriers for private finance in sub-Saharan Africa.* Geneva.

Union of Concerned Scientists. (2017). *Benefits of renewable energy use.* Retrieved from https://www.ucsusa.org/resources/benefits-renewable-energy-use

United Nations. (n.d.). *Renewable energy – powering a safer future*. Retrieved from https://www.un.org/en/climatechange/raising-ambition/renewable-energy

United Nations. (2015). *Paris Agreement.* Paris.

United Nations. (2021). *Report of the Conference of the Parties on its twenty-sixth session, held in Glasgow from 31 October to 13 November 2021.* Glasgow.

United Nations. (2022). *Financing for sustainable development report 2022.*

Williams, R. (2018). *Panel data 4: Fixed effects vs random effects models*. South Bend: University of Notre Dame.

Wolff, E., Fung, I., Hoskins, B., Mitchell, J. F., Palmer, T., Santer, B., . . . Wuebbles, D. (2020). *Climate change evidence & causes.* National Academy of Sciences.

The World Bank. (2022). *Renewable energy*. Retrieved from https://ppp.worldbank.org/public-private-partnership/renewable-energy

World Bank Group. (2019). *Global financial development report: Bank regulation and supervision a decade after the global financial crisis*. Washington, D.C.

Zhang, Z., Nuţă, F. M., Dimen, L., Ullah, I., Xuanye, S., Junchen, Y., . . . Yi, C. (2023). Relationship between FDI inflow, CO2 emissions, renewable energy consumption, and population health quality in China. (F. Shahzad, Ed.). *Frontiers in Environmental Science*, 10.