RENEWABLE ENERGY GENERATION IN DEVELOPING COUNTRIES: INFLUENCING FACTORS AND ENABLERS

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RENEWABLE ENERGY GENERATION IN DEVELOPING COUNTRIES: INFLUENCING FACTORS AND ENABLERS

By

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DEDICATION

This dissertation is dedicated to my brother, Honest Ncube and my late mother, Ms Tammy Ncube.

DECLARATION

I declare that the dissertation hereby submitted to the University of Limpopo, for the degree of Master of Commerce in Accounting has not previously been submitted by me for a degree at this or any other university; that it is my work in design and in execution, and that all material contained herein has been duly acknowledged.

Banda, S (Ms) .... 28 October 2021 ....

Surname, Initials (title) Date

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ABSTRACT

Since 2008, South Africa has been experiencing significant bottlenecks in its energy supply. The transition to renewable energy is no longer just an option but a necessity. In demonstrating the commitment to the Kyoto Protocol, which requires a reduction in greenhouse gases and is a response to the electricity crisis, various mechanisms have been applied to stimulate renewable energy production. This study examines the effect of the influencing factors and enablers on renewable energy generation in selected developing countries. To this end, the study investigated if the amount invested in renewable energy, economic, governance, environmental and social factors have an impact on renewable energy output produced in the selected emerging economies. Secondary data which comprised of the renewable energy output, investment and proxy data for the other factors being tested was used in the investigation. A quantitative research design was used, and panel data for the periods 2000-2016 was analysed. Results of the study revealed that the renewable energy generation is impacted diversely by the elements tested. A positive causal link was found between the dollar amount invested and the production of renewable energy. Additionally, the study found that governance, economic, environmental, and social factors can influence renewable energy output favourably or unfavourably. Results of the study suggest that policymakers should consider the effect of these variables when formulating policies to accelerate the transition to a sustainable energy supply system. Furthermore, the results provide possible solutions for budgetary constraints which have limited the transformation of the energy industries in the selected developing countries. Potential to investigate this study further on a country by country basis as data becomes available exists. Additionally, mixed methods may be applied to explore a qualitative element in the study.

Keywords: **Renewable Energy, Non-renewable energy, Green energy**

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CHAPTER ONE: GENERAL INTRODUCTION

1.1 Brief Introduction

This chapter contains a brief introduction, the background, the problem statement, motivation for the study for the study. Furthermore, the Chapter outlines the hypotheses tested in this study, the research objectives and the research method. The terms used in the study are also defined in this chapter. Additionally, the significance of the study, the study outline and the summary of the chapter are outlined herein. Section 1.1 introduces the study and Section 1.2 describes the background of the study. Section 1.3 explains the problem statement while Section 1.4 discusses the motivation for the study. The hypotheses tested in this study and the research objectives are reflected in Section 1.5 and Section 1.6 respectively. Section 1.7 outlines the research method applied while Section 1.8 defines terms used in the study. The significance of the study is discussed in Section 1.9 whereas the outline of the study is shown in Section 1.10. Lastly, Section 1.11 lays out the summary of this chapter. The following section discusses a brief introduction to the study, which highlights the basis for this study.

Energy is vital to the functioning of all, if not most, of the industries in any economy (Maradin, Cerovic & Mjeda, 2017). The Sustainability Development Goals report of 2020 emphasised that countries need to increase sustainable energy to alleviate energy shortages (United Nations, 2020). According to Maradin *et al.* (2017), the deployment of renewable energy causes a corresponding rise in the development of a nation. Furthermore, the energy resources a nation has at its disposal are proportional to its development and industrial advancement (Aliyu, Dada & Adam, 2015). According to Ettmayr and Lloyd (2017), as economies develop their energy needs also increase. Due to the anticipated growth, economies face a challenge to reduce the environmental damages of fossil fuel usage while growing at a rapid rate (Ettmayr & Lloyd, 2017). In response to the anticipated growth, transition towards clean energy is one of the Sustainability Development Goal (SDG 7) towards which most countries have committed to work towards (United Nations, 2020). Additionally, the African Union has devised a 10 year plan, termed Agenda 2063 that is aimed at alleviating energy shortages, poverty and ensuring environmental sustainability (African Union, 2015). Researchers such as Perticas, Florea, and Simut (2017), opine that if the rising energy needs are not monitored, they can hinder economic growth. Additionally, Saidi and Hammami (2015), opine that the increased energy demand due to internationalisation indicates that in the next century energy security will become a challenge. Hence, Costantini and Martini (2010), hold forth that a change from less efficient energy resources to an active, sustainable option will stimulate economic growth.

The promotion of renewables as opposed to fossil fuel use has been the principal mitigation approach so far (Moriarty & Honnery, 2014). In favour of this argument, the Intergovernmental Panel on Climate Change (IPCC) (2012), noted that successful CO_2 mitigation strategies should consider how to reduce emissions from electricity generated from fossil fuel. Additionally, to their susceptibility to depletion, Lo (2014), believes that fossil fuels result in air, water and soil pollution when burnt. The G8 Summit of 2007 agenda highlighted that climate change could damage the natural environment and the global economy. As a result, studies on the causes and how to slow the process have been conducted worldwide (Sebitosi & Pillay, 2008; Alam, 2013; Renukappa, Akintonye, Egbu & Goulding, 2013). Countries regularly converge for the United Nations Framework Convention on Climate Change to discuss climate change mitigation strategies. Moriarty and Honnery (2014), are among those who conducted studies on how to slow climate changes and its causes.

1. 2 Background of the study

The deployment of renewable energy has swiftly risen globally over the last decade. The increased employment of renewable energy is due to energy deficiency (Dombrovski, 2015), the high cost of fossil fuel extractions relative to past years, (Abolhosseini & Heshmati 2014) and the dire climate change effects of fossil fuels (Olz & Beerepoot, 2010; Harrison, 2015; Nakumuryango & Inglesi-Lotz, 2016). Yazdanie and Rutherford (2010), as well as Kumar (2020), argue that the generation of renewable energy is affected by social, environmental, political, and economic factors. Social factors can be described as the human development aspects that should be considered by any nation when formulating its policies (Kumar, 2020). The Organisation for Economic Cooperation (OECD) (2001), asserts that social indicators include educational and health quality proxies, among others. Environmental and economic factors such as increased greenhouse gas emissions and economic growth, respectively, have also influenced the rate at which countries produce renewable energy (Bridge, Bouzarovski, Bradshaw & Eyre, 2013; Timmons, Harris & Roach, 2014). According to Sanderink (2020), governance has a vital role to play in creating a sustainable energy solution that comprises mainly green energy. Financing was also identified as an obstacle for renewable energy generation (Kumar, 2020). According to Maradin *et al.* (2017), countries are experiencing expeditious economic growth which has, in turn, resulted in the regular use of renewable energy.

Market imperfections, as a result of subsidies on fossil fuel, limit the generation of renewable energy (UNEP, 2014). Due to the current legislation regulating renewable energy, REIPPPP, buyers only purchase electricity during bids which are complicated and expensive. The development of renewable energy is lagging in terms of aspiring policy. The absence of a legal framework for Independent Power Producers' utility interconnection requirements is another barrier faced by investors (Msimanga & Sebitotsi, 2014). Presently, in qualifying for the REIPPPP bidding process investors are required to post bid bonds, or guarantees equivalent to $12 500 per MW of full load sustained capacity, and the amount is doubled once the announcement of the preferred bidder is made (Eberhard, 2014). The REIPPPP also requires paying 1% tax on project revenues to the government (Eberhard, 2014). This tax payment does not consider the fact that the business might be working at a loss in the first years of operation. According to Taleb (2009), barriers to renewable energy production could be due to the appropriate stakeholders being unaware of available incentives, a lack of political support as well as the lack of incentives.

For instance, in South Africa, the bidding system has resulted in fewer companies winning; and the ownership of the industry becoming more concentrated (Baker & Wlokas, 2015). According to Dombrovski (2015), renewable energy sources react differently to policies. Therefore, multiple policies must resolve the renewable energy generation problem (Abolhosseini & Heshmati, 2014). According to the International Energy Agency (2015), the right policies and governance, the improvement of financial conditions, and the adoption of new business models are key to increasing renewable energy investments. Considerations include effective implementation of policy frameworks, access to the power grid, reduction of regulatory barriers, removal of fossil fuel subsidies, an efficient price completion mechanism and improved financial conditions. The study by Bischof-Niemz (2018), revealed that renewable energy eased the energy crisis, positively impacted the economy, and had an immense financial benefit. The rising prices of fossil fuels and grid expansion costs also make it imperative to stimulate renewable energy production.

Perticas *et al.* (2017), argue that green energy is the most viable means to curb fossil fuel pollution. Fossil fuels are non-renewable resources that play a vital role in energy formation and a variety of other purposes. According to the IEA (2010), 41 percent of the greenhouse gas emissions in the world are transmitted by the electricity sector. Fossil fuel energy results in global warming, which is one of the most significant challenges faced globally (UNICEF, 2014). The study by Begg, van der Woerd and Levy (2005), shows that the main reason for climate change is the increased greenhouse gases in the atmosphere. Moreover, Stern (2007), opines that carbon dioxide (CO_2), which radiates from the burning of fossil fuels such as crude oil, gas and coal contribute most to climate change. Furthermore, Alam (2013), also identified fossil fuels as a significant contributor to carbon dioxide (CO_2) and predicted that CO_2 emissions would continue to increase in the coming years. Greenhouse gas production in growing economies exceeded those of developed economies in 2008, and this trend is expected to continue as economies develop (International Energy Agency (IEA), 2010; Jakob, Haller and Marschinski, 2012). According to a report by the Rhodium Group (2021), the emissions of China, a developing nation exceeded those of all developing nations combined in 2019. While the measures taken to curb the spread of COVID-19 resulted in a temporary reduction of emissions, GhG emissions continued to rise in 2020 (World Meteorological Organization, 2021). Khan (2020), both developing and developed nations are major contributors of CO2 emissions.

Perticas *et al*. (2017), argue that a robust positive cause and effect relationship exists between GDP and the production of green energy. According to Gul Akar (2016), an increment in the long run per capita income and greenhouse emissions are the main drivers of investment in renewable energy. Da Silva, Cerqueira, and Ogbe (2018), state that renewable energy production is influenced by GDP per capita and energy demand. Additionally, Owusu and Asumadu-Sarkodie (2016), stated that a direct positive relationship exists between greenhouse emissions and renewable energy generation. It is apparent from the discussion above that previous literature has used proxies of economic, social, environmental, and governance factors to explore their impact on the generation of renewable energy. Besides providing economic power, energy resources also play a critical role in modern society (Aliyu, Dada & Adam, 2015). It is also evident from the above literature that various factors influence renewable energy generation.

1.3 Problem statement

The inability of stakeholders to succinctly evaluate the factors or drivers of renewable energy generation might have limited opportunities to fully harness the potential to reduce dependence on fossil-based energy systems. This is evident from previous studies indicating that most governments have not fully explored the renewable energy sector (Yazdanie and Rutherford, 2010; Walwyn & Brent, 2015; Worldatlas, 2017; IRENA, 2019). According to the researcher, there have been few studies conducted to determine the factors which influence sustainable renewable energy generation. As such, it is expedient to examine those factors, especially in developing countries, that influence the generation of commitment to renewable energy production. Some of these considerations include the amount invested in renewable energy as well as governance, economic, environmental, and social factors. Moreover, previous studies have focused on evaluating the effect of the proxies of these variables individually on renewable energy (Winkler, 2005; Zhao, Tang & Wang, 2013; REN21, 2017; Dombrovski, 2015). This study explores if the dollar amount invested, economic, governance, environmental and social factors influence renewable energy output generated in developing countries. The next section discusses the motivation for the study.

1.4 Motivation for the study

Presently, a significant portion of South Africa's energy is sourced primarily from non-renewable sources such as coal and nuclear power (Walwyn & Brent, 2015; Uhunamure & Shale, 2021). The use of fossil energy is based on the premise that renewable energy is expensive, while fossil and nuclear energy are affordable (Gets, 2013). While coal deposits are abundant in South Africa and coal is considered a preferred fuel type, the country is regarded amongst the countries with exceptional solar capacity because its annual solar-direct nominal irradiation (DNI) is among the highest in the world (Van Niekerk, 2012). Despite this, South Africa has a greater reliance on coal for its energy production based on the argument that fossil and nuclear technologies are inexpensive compared to renewable energy (RE) technologies (Gets, 2013). Investigation of the energy sector revealed that 90% of South Africa's energy is generated from coal (Department of Energy, 2015; Uhunamure & Shale, 2021). South Africa ranks as the fifth-largest consumer of coal and sixth largest producer of coal globally (Eberhard, 2011; Uhunamure & Shale, 2020). However, South Africa has responded to the need to reduce carbon emissions through its Integrated Resource Plan (IRP) promulgated in 2010, which was aimed at expanding the local renewable energy market (McDaid, 2016).

In acknowledging the contribution of coal-generated energy to the increasing problems of global climate change, the need to achieve a sustainable energy composition by developing renewable energy sources was realised. This has resulted in the enactment of the White Paper on Renewable Energy in 2003 The Integrated Resource Plan (IRP) in 2010 and most recently the Renewable Energy Independent Power Producer Procurement Program (REIPPPP) in 2014 (Department of Minerals and Energy, 2003; Department of Minerals and Energy, 2010; Eberhard, Kolker & Leigland, 2014). The White Paper on Renewable Energy Act of 2003 raised awareness of the use of renewable energy, how to efficiently use it, and set well-structured tariffs to encourage renewable energy investment. The IRP 2010 is a 20-year long-term plan with principal targets, amongst others, to enlarge energy production from solar and wind resources (Nakumuryango & Inglesi-Lotz, 2016). The feed-in tariffs (FITS) system was substituted by the enactment of REEIPPP, which favours a competitive tender administration (Sebitosi & Pillay, 2008). The feed-in tariff system failed due to its inconsistency with public finance and procurement laws. The program had not resulted in any difference because, in the two years of its existence, no power agreement had been signed (Eberhard, 2014). South Africa's REIPPPP has been successfully implemented and has brought about diversification in the electricity generation sector by increasing the power producers from one to 64 in the first three rounds of bidding (Walwyn & Brent, 2015). Consequently, this has resulted in the acquisition of electricity at prices that are competitive in comparison to current grid prices and has expedited the response to its energy crisis. Furthermore, the REIPPPP attracted private investment in the renewable energy sector (Leigland & Eberhard, 2018).

Even though the REEIPPPP has successfully brought various companies into the power generation sector, it is likely that in the subsequent bidding rounds the pool of companies that succeed will become smaller (Walwyn & Brent, 2015). The program's target is 9% renewable energy by 2030 and is mostly focused on supply security and not access to power (Gets, 2013). Regardless of South Africa's dominant economic position in the African continent, its implementation of renewable energy is not the best among African countries. Furthermore, Nakumuryango and Inglesi-Lotz's (2016), comparison of South Africa to OECD countries shows that South Africa has a long way to go to achieve a sustainable environment. Alam (2013), found that it is imperative for policymakers to address the increasing energy demand and need to improve as well as develop alternative sources of energy.

Moreover, Europe has shown that it is possible to have a significant portion of renewable energy in the energy mix. South Africa has been ranked the 15th most appealing destination for the development of renewable energy, according to the Renewable Energy country attractiveness index done by EY (previously Ernest and Young) (EY, 2015). The ownership of the renewable energy industry has become an alarming issue as significant international associations are becoming dominant either directly or indirectly (Baker & Wlokas, 2015). Moreover, in South Africa, developers have either failed projects or consorted with international companies to source the required technology or financing. Notwithstanding the efforts of the South African government to create a competitive industry which addresses national interests, smaller national players were forced out of the market and could not compete against international companies. Furthermore, due to the design of REIPPPP, smaller local companies have neither entered nor retained a market share as the program progresses (Baker & Wlokas, 2015).

The costs of investing in renewable energy are mostly upfront (McDaid, 2016). This high initial capital outlay needs to be financed by the developer (Baker & Wlokas, 2015). The playing field is also not level as international companies have access to cheaper capital in contrast to local companies in the sector (McDaid, 2016). China, for instance, charges less than one percent interest on funds lent to investors, whereas bank financing costs 7% - 8% in interest. This results in a third of the project cost being saved by the Chinese project. Moreover, investors contend that the prerequisites of the REIPPPP system in South Africa have led to high compliance costs (Baker & Wlokas, 2015). According to Murombo (2015), the current environmental legislation has been ineffective in promoting renewable energy generation in South Africa. According to the PricewaterhouseCoopers (PWC) (2011), fact sheet, disincentives such as carbon tax might not encourage the use of renewable technology; instead, they might only be a penalty. Blohm (2021), argues that a combination of carbon tax and imposing mandatory CO2 limits may reduce emissions in the energy sector. Based on the above arguments, it is evident that current support mechanisms are inadequate to support the effective application of funds to stimulate renewable energy investments.

It can be deduced from the above that intervention by the state must empower local companies to compete on level ground with international players in the renewable energy sector.

1.5 Research hypotheses

The following are the research hypotheses for this study.

H_1: The dollar amount invested influences the volume of renewable energy output generated in selected developing countries.

H_2: Governance factors influence renewable energy output generated in selected developing countries.

H_3: Economic factors influence renewable energy output generated in selected developing countries.

H_4: Environmental factors influence renewable energy output generated in selected developing countries.

H_5: Social factors influence renewable energy output generated in selected developing countries.

1.6 Research Objectives

The primary purpose of this study is to examine which independent variables influence and enable renewable energy generation in developing countries.

Hence, the study will seek to achieve the following sub-objectives:

- To examine the influence of the dollar amount invested on renewable energy output generated in selected developing countries

- To examine the influence of governance factors on renewable energy output generated in selected developing countries
- To examine the influence of economic factors on renewable energy output generated in selected developing countries
- To examine the influence of environmental factors on renewable energy output generated in selected developing countries
- To examine the influence of social factors on renewable energy output generated in selected developing countries

1.7 Research method

A positivist research framework was adopted due to the objective and quantitative nature of the study. To analyse the relationship between the dollar amount invested as well as the effect of economic, governance, social and economic factors on the renewable output generated, an explanatory causal research design was applied. The choice of the combination of independent variables being tested was influenced by the individual variables identified by previous researchers. Panel data for a sample of selected developing countries were used in the investigation. Data collected consisted of sixteen countries, and it covered the years ranging from 2002 to 2016. The sample comprised cross-sectional and time-series data; thus, multiple panel data regression analysis was used to investigate the relationship between the variables. The data used in the research was collected from the World Bank database and the British Petroleum (BP) Statistics database. In instances where effects were identified, the Hausman test was applied to determine if those were fixed or random effects.

1.8 Definition of terms

Renewable energy – this is energy derived from resources that are replenished naturally and are infinite (Owusu & Asumadu-Sarkodie, 2016).

Non-renewable energy: energy that is drawn from limited resources that deplete over time (Rabbani, Sattary, Mamun, Rahman & Khan, 2017).

Green energy: energy that produced in a way that minimises environmental damage (Kalyani, Dudy & Pareek, 2015).

1.9 Significance of the study

Academia

I envision that this research will encourage other researchers to investigate if the mixture of support mechanisms used to stimulate renewable energy investments in South Africa continue to be effective. South Africa has set targets for renewable energy that should be generated throughout until 2030. Continuous evaluation of the relationship between the amount of investment made and the renewable energy produced will be necessary to minimise an ineffective application of funds and to ensure that the application of the mixture of support mechanisms is efficient. Furthermore, the investigation of the relationship between the effects that governance, economic, environmental, and social factors have on renewable energy output will enable the developing economies that were investigated to identify enablers that these economies should use to boost green energy production.

Economy

The research intends to propose how to effectively apply funds provided and how the currently available mixture of mechanisms can generate more renewable energy. Value will be added to the economy through job creation, improvement of the skills base in the economy, and increased enterprise development. Moreover, local manufacturing of energy will be encouraged, and reliance on imported fuels, which are prone to political instability and trade disputes, will be reduced. The sustainable improved power generation and distribution channels are expected to attract local and foreign investments. Furthermore, production halts due to energy shortfalls are projected to decrease and supply to increase; this has the potential to increase GDP.

Government

Results from this study will assist the government to identify additional measures required to ensure that renewable energy generated from the funds invested is maximised. Any identified ineffectiveness of the currently available mixture of support mechanisms may be corrected, and the effect will be an increase in renewable energy investments by South African companies. The revenue collection will improve as well because the pool of taxpayers will be enlarged by the increase in individuals and entities which earn disposable income. The pressure on government to create employment or cater for the unemployed will be eased as job creation is anticipated as investments in renewable energy increase.

Environment**t**

Renewable energy is a clean source of energy that has either very low or no carbon emissions. The increase in investments in renewable energy will decrease our dependence on non-renewable energy. The impact of this is a reduction of carbon emissions, and so the environment will be sustained. Furthermore, the diversification of the energy supply will assist in saving scarce water resources as the other renewable energy sources seldom use water. Moreover, water contamination caused by remains from fossil fuels will be minimised.

Society

The actualisation of a competitive atmosphere due to the increased number of renewable energy producers in the energy sector will drive entities to set the best reasonable prices which are affordable to consumers. Also, the increase in energy supplied has greater potential to cater for the primary energy needs of the economy as a whole. As these goals are achieved the livelihood of societies is improved, and the less polluted air is inhaled. As local producers of renewable energy increase, jobs are created and the community as a whole benefit. It is hoped that entrepreneurial skills will be cultivated and demonstrated.

1.10 Study outline

Chapter One of the study outlines the summary of the study, the motivation for the study, and describes how the research will be conducted. Chapter Two consists of the literature review, which outlines the theoretical framework, which comprises the natural capitalism and externality theory. Additionally, Chapter Two discusses the literature relating to the hypothesis being tested in this study. The research methodology applied to test the hypotheses is discussed in Chapter Three. The presentation, interpretation and discussion of the results are outlined in Chapter Four. The final chapter comprises the summary, conclusions, and recommendations of the study.

1.11 Summary of chapter

This chapter provides a background to the study. Moreover, the statement of the research problem, the research questions, and the research aim, and research objectives are discussed. The relevant definitions of the key terms used in this study are fully defined in this chapter. This chapter also contains the research methodology and design, limitations of this study, ethical considerations and the significance of this chapter. The following chapter contains the theoretical lens and literature review for this study.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

Chapter One provided the introduction, the background to this study, as well as the objective and problem statement of this study. This chapter discusses the theoretical framework used in this study and the relationship between renewable energy investments and the output generated. Furthermore, the chapter discusses the current mechanisms applied to stimulate renewable energy investments worldwide and how fiscal policies are used in this regard. Section 2.2 of this study discusses the theoretical framework. Section 2.3 describes the relationship between renewable energy and non-renewable energy while Section 2.4 explains the mixture of mechanisms used to encourage renewable energy generation in the world. Section 2.5 and Section 2.6 discuss the relationship between renewable energy and the output generated as well as governance factors that have an impact on renewable energy output respectively. Section 2.7 and Section 2.8 describe the economic and environmental factors that may influence the production of green energy respectively. The impact of social factors on renewable energy output is discussed in Section 2.9. Lastly, Section 2.10 lays out the summary of this chapter. The following section discusses the theoretical framework, which underpins this study to explain why it is essential to encourage investments in renewable energy.

2.2 Theoretical frameworks

According to Radhakrishma, Yoder, and Ewing (2007), the theoretical framework outlines the relevance of the research. The theoretical framework enhances the quality of research and enables the researcher to justify the results of the study against existing literature (Caliendo & Kyle, 1996; Abd-El Khalick & Akerson, 2007). This study is premised on two theories, natural capitalism and the externality theory. The following two sub-headings describe these theories.

2.2.1 Natural capitalism

The preservation and value assessment of natural capital are gaining momentum (Vassallo, Paoli, Rovere, Montefalcone, Morri & Bianchi, 2013). It has become evident that the availability of natural capital constrains economic growth. Capital refers to the resources used to produce income by an economy or country. Manufactured, human, and natural capital are all forms of capital (Costanza, d'Arge, de Groot, Farberk, Grasso, Hannon, Limburg, Naeem, O'Neill, Paruelo, Raskin, Sutton, & van den Belt, 1997). Natural capitalism, which forms the theoretical basis of this study, has been diversely defined by researchers. Natural capital comprises non-exhaustible and exhaustible resources and the ecosystem. As such, Goodwin (2003), opines that natural capital encompasses the natural assets provided by the Earth and its ecosystem services. Hawken, Lovins, and Lovins (1999), maintain that ecological systems that provide life support to society and the planet's natural resources are termed natural capital. Hawken *et al*. (1999), described ecosystem services as nature's self-regulation procedure such as regulating the atmosphere and climate, pollination and biodiversity. Natural resources and ecosystems contribute significantly to the generation of income and wealth creation. Natural capitalism focuses on ways to increase resource productivity (Greenwood, 2001). This means that society, economic activity, and companies require natural stocks to survive.

Hawken *et al*. (1999), argue that the life-sustaining nature of the environment is a limiting factor in production and cannot be regarded as an equal factor in output. The depletion of the ozone layer, pollution of the atmosphere, extinction of certain animal species, aquatic and terrestrial plants suggests that the natural capital concept exists. More often, natural capital negatively impacts economic activity due to its depletion. According to British Petroleum (BP) (2014), the way the world's inhabitants use natural capital impacts on the environment and its capability to create value consistently. In preserving the available aggregate natural capital at the current level, natural capital needs to be maintained (Costanza & Daly, 1992). Moreover, if a nation's capital accounting excludes natural capital, the sustainability of the economy will be misunderstood. The core argument of natural capitalism is the recognition of the effects of waste and the non-renewable nature of resources.

Natural capitalism is based on four pillars which include increasing the productivity of natural resources drastically, usage of biology-inspired production models and materials, service and flow business model, and reinvestment in natural resources (Lovins, Lovins & Hawken, 1999). The concept of natural capitalism seeks to eliminate waste and to promote the efficient use of natural resources (Hawken *et al*., 1999). The efficient use of natural resources will, in turn, reduce the level of usage of non-renewable energy, slow down the depletion of resources, and minimise climate change. Goodwin (2003), states that for development to be sustainable, the earth must maintain or increase the natural capital which is usually depleted during economic production. The use of renewable natural capital without depleting it creates a sustainable socio-economic system. This means that natural resources are undiminished, and minimal damage is done to the atmosphere through contamination by CO_2 when renewable energy is generated and used (Panwar, Kaushik & Kothari, 2011). The effect of the increase in renewable energy investments is, therefore, expected to address the theory of natural capital. The use of renewable energy will assist in preserving the level of non-renewable resources that currently exist sustainably and curb the level of CO_2 emissions. The study of the effect that renewable energy enablers have on the green energy produced will enable countries to preserve the natural capital.

2. 2.2 Externality theory

According to externality theory, taxes should be high where negative social costs emanate from the activity, while activities with positive social benefits should have a low tax effect. Taxes should encourage growth or hamper it as minimally as possible (Baliamoune-Lutz & Garello, 2013). According to the United Nations Environment Programme (UNEP) (2014), fiscal policies are the most powerful instruments amongst various policy interventions that can be used to promote green economic activity. Wood, Blylund and Bradley (2016), assert that individual entrepreneurs also consider government tax and regulatory policies in evaluating renewable energy investment decisions. The UNEP (2012), states that the Sustainability Development Goals (SDGs) can be achieved using fiscal policies. It points out that renewable energy production can be supported by fiscal policies such as energy taxes, carbon pricing mechanisms and incentives for renewables (Abolhosseini, & Heshmati 2014). Moreover, national policymakers are continually revising their policies to support renewable energy deployment (Ogunlana & Goryunova, 2017).

Renewable energy investments are increasing due to the availability of favourable fiscal policies (Hitaj, 2013). Abdmouleh, Alammari and Gastli (2015), argue that fiscal policies can, however, reduce the operational effectiveness of an investment if not stringently executed and supervised. For example, wind power generation in China was slow before the enactment of effective energy policies; afterwards, substantial growth was experienced (Wang, 2010). According to KPMG (2016), favourable tax incentives are becoming one of the reasons why investors finance renewable energy investments. Different phases of renewable energy require different policies that are best tailored for each phase. Policymakers should understand the impact of renewable energy policies on all stakeholders (International Renewable Energy Agency, 2016). According to Corneli (2012), tax incentives are crucial for increasing investment in renewable energy. The increment in renewable energy also results in increased competition and innovation. Policymakers can stimulate renewable energy generation investments by selecting the most efficient financial and fiscal instruments (Dombrovski, 2015). Incentives should make investments in renewable energy feasible at first glance (Damuri & Atje, 2012).

Dombrovski (2015), asserts that supportive instruments should be tailored to suit a country. The specific renewable technology targeted should be aligned with the country's policy design. Corneli (2012), argues that tax incentives can be used in conjunction with Renewable Portfolio Standard programs to stimulate renewable energy investments and cost reductions. According to Zhao, Zuo, Fan and Zillante (2010), a renewable energy development policy framework notably results in renewable energy development. However, Nam, Khanh, Nguyen, and Binh (2012), opine that policymakers must identify incentives that can attract investment in renewable energy. These incentives comprise financial incentives, fiscal incentives, subsidies and concessions or exemptions from laws and standards (UNCTAD, 2011). Energy subsidies should make investments feasible through the provision of financial support. Measures intended to alleviate current market imperfections that are an obstacle to renewable energy are, however, not viewed as incentives (Waliwimpi, 2012). Fiscal incentives are provided to lower the costs related to investing in renewable energy and plant operation.

The most significant incentive offered by the USA is the renewable energy production tax credit. This incentive has been established to be a significant determinant of the number of new investments in wind energy (Black, Holley, Solan & Bergloff, 2014). Wind developers relocate to states with favourable economic and fiscal incentives, and the discontinuance of the fiscal incentives may lead to a reduction in renewable energy as well as the loss of other economic benefits such as job creation, tax revenues and economic growth (Black *et al*., 2014). European countries have achieved impressive results using tax incentives as well as other forms of state support for renewable energy and conventional energy production (Ogunlana & Goryunova, 2017). According to Krupa and Burch (2011), policies devised to encourage investments in renewable energy should incorporate tax incentives, tax holidays, initial investment grants and take fiscal policy into account. This notion is supported by findings from the research interviews conducted by Krupa and Burch (2011). The United States experienced a positive change in the wind production market due to the extension of the federal incentives available for wind projects (Wiser & Bolinger, 2015). Zhao *et al*. (2013), opine that developing countries need to adopt support mechanisms applied by countries that have successfully promoted renewable energy (RE) mechanisms. States and private partnerships are necessary to stimulate investments in renewable energy (Yamusa & Ansari, 2013). According to Onifade (2015), fiscal support mechanisms make it easy for investors to plan because the returns expected are predictable. There is a risk also that investors might benefit from the support mechanisms without a corresponding increase in energy generated, and it may result in centralised energy production (Onifade, 2015). India implemented a production-based support mechanism to counter the risks identified above. Support mechanisms that are applied before actual production were found to be ineffective because lower renewable energy was produced (Onifade, 2015). These findings argue that a combination of government interventions can strengthen renewable energy generation. The efforts taken to encourage renewable energy generation are supported by results found by da Silva *et al*. (2018), that state that renewable energy production should be prioritised given the severe climate changes and energy crises faced by nations.

2.3 The relationship between renewable energy and non-renewable energy

The global movement towards the increased use of renewable energy was necessitated by energy deficiency problems, among other things. Additionally, the deployment of renewable energy results in a reduction in the usage of fossil fuels, prospectively.

In Nigeria, electricity demand is more than supply, thereby affecting the country's socioeconomic and technological development (Obadote, 2009; Sambo, Garba, Zarma & Gaji, 2012). In concurrence, Aliyu *et al.* (2015), also argued that the socio-economic and technological development in Nigeria had been influenced by the high demand for electricity which exceeds its supply. Additionally, China experienced extensive electricity outages due to the sudden increase in its energy demand (Lo, 2014). The South African energy supply crisis, which intensified in mid-2014, is expected to continue until 2018 (Baker & Wlokas, 2015). Eskom, which is the national energy provider in South Africa, struggled to defend its competence when the nation experienced power outages due to its poor operational state (Hipkin, 2013). Electricity shortages in South Africa have damaged the economy (OECD, 2015). The scarcity of energy also negatively impacted the effective productivity of the Pakistan industry, its people and commerce (Haq, 2007).

Uninterrupted energy flow is therefore required for an economy to function efficiently and effectively. Moreover, world energy consumption is sure to increase over time (Abolhosseini & Heshmati, 2014). In light of the relationship between economic growth and energy consumption resources, and to sustain the growing need for energy, alternative resources must be identified and developed (The Federal Government, 2007). According to Munasinghe (2002), sustainable development should take energy into account. Therefore, it is evident that renewable energy and energy efficiency (REEE) policies will have significant implications for energy security, climate change, economic competitiveness, pollution and human livelihood (Lo, 2014).

Despite the adverse effects fossil-based energy has on climate change, sustainability, and efficient energy distribution, most economies are dependent on it. Furthermore, renewable energy only contributed 2% of the globe's energy consumption in 2011. According to British Petroleum (BP) (2013), more than 80% of the 522 *exajoules* primary energy used by the world in 2012 came from fossil fuels. Two thirds of the electricity generated in the world in 2019 was from fossil fuels (IEA, 2019). The number of countries producing renewable energy in 2020 was 32, this is significantly higher than the recorded number of 19 countries a decade ago (REN21, 2020). The renewable energy sector globally experienced a boom phase for five years leading to 2019. During that period net installations for renewable energy outperformed fossil based and nuclear energy combined (REN21, 2020; IRENA, 2021). Despite the advancement experienced in the renewable energy sector in the past decade, CO2 emissions have continued to increase and governments globally continue to excessively invest in fossil-based energy infrastructure (Shearer, Mathew-Shah, Myllyvirta, Yu & Nace, 2019; IRENA, 2021). The dependency on fossil fuels has resulted in social and environmental problems and the depletion of the conventional resources thereof (United Nations Economic Commission for Africa, 2011). Other economies contend that renewable energy technology cannot satisfy the current power needs (Van De Putte & Short, 2011), despite some researchers proving otherwise (International Energy Agency (IEA), 2009). Zambia sources its primary energy from biofuel and waste, hydropower and imported petroleum and oil products (International Energy Agency (IEA), 2009). In 2010, 99.7% of Zambia's electricity was sourced from hydropower (World Bank, 2012). Zambia continues to mainly produce hydropower however a significant portion of its population relies on traditional biomass (Taliotis, Shivakumar, Ramos, Howells, Mentis, Sridharan, Broad & Mofor, 2016; Kachapulula-Mudenda, Makashini, Malama

& Abanda, 2018). Hence it is evident that it is possible to generate economy substantial portion of energy from renewable energy.

The major sources of energy in Indonesia include petroleum oil, natural gas and coal (Aiman, Simamora, & Hendrana, 2018). Although Indonesia has an abundance of renewable energies, they are mostly undeveloped, and its vital energy sources are fossil fuels such as coal and oil (Damuri & Atje, 2012). Similarly, Pinilih and Chairunnisa (2019), contend that Indonesia has strong potential for renewable energy generation however its use has not reached optimal usage. Over the years, Indonesia has been increasing the portion of renewable energy in its energy mix (IRENA, 2017). In 2017, coal accounted for a third of the energy supplied and bioenergy was the main form of renewable energy used in the country (IRENA, 2017). Uddin, Shaikh, Khan, Shirazi, Rashid, and Qazi (2021), contend that Pakistan has taken the appropriate measures by investing in renewable energy infrastructure. Subsidies for petroleum are one of the reasons why Indonesia's renewable energy sources are undeveloped (Damuri & Atje, 2012). Vietnam's major energy commodities are diesel oil, gasoline, heavy oil, coal, and liquefied petroleum gas, of which all are fossils (Zhi, Sun, Li, Xu & Su, 2014). Angola and Libya, on the other hand, derive 60% and 80% of their government revenues from natural gas and oil exports, respectively (Central Intelligence Agency, 2011). The reasons for dependency on fossil fuel as a source of energy may vary among economies. An analysis by World Atlas shows that 35 out of the 50 countries examined are heavily dependent on fossil fuel energy, with more than 90% of their energy supply being derived from fossil fuel energy (Worldatlas, 2017). Five (5) of the 35 countries heavily reliant on fossil energy have a 100 % dependency (Worldatlas, 2017).

Nigeria is endowed with abundant conventional (fossil fuel) energy sources such as oil, coal and gas. These energy sources dominate the fuel sources for electrical power production for the society, and mainly contribute over 90% of the country's income (Aliyu *et al*., 2015). The depletion of Nigeria's conventional energy resources, increasing pressure to reduce carbon footprints, and attempts by other nations to seek alternative energy sources is anticipated to affect its income (Aliyu *et al.*, 2015). The over-reliance of the energy sector on petroleum has slowed down Nigeria's development of alternative fuels. As per Nakumuryango and Inglesi-Lotz (2016), findings, South Africa derives nearly 90% of its energy from coal, hence, is among the countries which negatively contributed to the pollution of the environment in recent years. Renukappa et al. (2013), argue that South Africa adopted the fossil fuel energy-use strategy from the apartheid administration. On the other hand, Cameroon has a substantial potential to produce renewable energy but the absence of a clear renewable energy policy and the lack of interest from the government are significant factors that have stalled the deployment of its renewable energy (Ackom, Alemagi, Ackom, Minang & Tchoundjeu, 2013; Wirba, Mas'ud, Muhammad-Sukki, Ahmad, Tahar; Rahim, Munir & Karim, 2015). Conventionally, China's electricity sector relied heavily on coal until the enactment of the Renewable Energy Law in 2006.

As energy demand increased beyond the supply, fossil fuel prices sharply increased due to the limited nature of fossil fuel reserves (Nam *et al.*, 2012) hence, the attention of economies was drawn to the need for sustainable clean energy security solutions. Countries have set about exploring the use of renewable energy as an alternative to fossil-based energy. Sebitosi and Pillay (2008), identify that there has been a remarkable development around the world in renewable energy production driven by the need to reduce the adverse environmental effects of fossil fuels.

The Nigerian government is promoting renewable energy through the development of a variety of energy policies, regulations and reforms (Aliyu *et al*., 2015). Worldatlas (2017), issued an article on the 11th of December 2015 which states that global reliance on fossil fuels has decreased in relation to total energy use since 1971 and it is anticipated that the trend will continue as nations change to greater use of renewable resources for energy. The United States has attempted to increase the quota of electricity generated from renewable sources to minimise climate change and improve energy security (Hitaj, 2013). Most of the states in the United States of America have different policies to promote renewable energy. These US states employed a variety of incentives for renewable energy such as corporate, sales and property tax credits as well as production incentives (awarded on a cents /kWh basis) and renewable portfolio standards (Hitaj, 2013). Furthermore, China has made renewable energy and energy efficiency a national priority. In the last decade, China became the largest photovoltaic (PV) manufacturer in the world, and its PV production has grown expeditiously due to the joint promotion of the global market and domestic policies (Qiang, Honghang, Yanxi, Yurui & Jun, 2014). Likewise, Pakistan is devising energy policies to solve its energy problems. The energy mix in Pakistan comprises mainly of oil based energy (Raza, 2015). Economic development has been impeded by the excessive reliance it has on imported fuels (Raheem, Abbasi, Memon, Samo, Taufiq-Yap, Danquah & Harun, 2016). According to Khan[1], Khan[2], and Chang, (2020), Pakistan should prioritise transitioning to renewable energy to solve its energy crisis. The reliance by the Gulf Cooperation Council on gas and oil revenues is diminishing as they have begun to diversify from fossil fuel-based economy (Flamos, 2010).

Public-private partnerships were encouraged by the Vietnamese government to attract investment in renewable energy. Vietnam has also devised an energy development strategy which takes renewable energy into account (Nam et al., 2012). Indonesia has set the year 2025 target for its energy mix, which comprises of 17% renewable energy through its Presidential Decree 26 of 2006 (Damuri & Atje, 2012). Nigeria has begun to explore the use of other forms of energy sources due to the constant exhaustion of its traditional energy resources, an energy crisis, unstable oil prices on global markets and the rising demand to decrease carbon footprints which affect the nation's income and energy security (Aliyu *et al*., 2015). Despite efforts by various countries to encourage the production of renewable energy, other factors such as its cost of production, electricity demand, trade openness and economic development affect its deployment (Gul Akar, 2016). Karakosta et al. (2013), also opine that the deployment of renewable energy will not succeed due to difficulties such as the inadequacy of the regulatory system and the inefficient targets that are set.

2.4 A mixture of mechanisms used to encourage renewable energy generation in the world

According to da Silva *et al*. (2018), it is vital for economies to understand the factors that influence renewable energy generation and the effects of the policies it implements. According to Ohler and Fetters (2014), renewable energy is a pre-requisite for the world to evolve into industrialisation, energy security and economic growth. Despite the availability of possible benefits, renewable energy is subject to and still contributes a small portion to the aggregate energy supply. In 2010, less than 21% of the total electrical energy produced in the world was from renewable energy (Zhao *et al*., 2013). Irrespective of the low contribution made by renewable energy, it has tremendous potential to increase beyond the world's energy needs (Ellabban *et al*., 2014). According to Gul-Akar (2016), most of the energy needs faced by countries are met through the use of non-renewable energy. More than 80% of the energy used worldwide comprises of fossil fuel energy (Wustenhagen & Menichetti, 2012). In agreement Zhao, Tang and Wang (2013), argue that most nations principally use traditional sources of energy such as natural gas, coal and oil. Renewable energy contributes to an insignificant portion of the total energy used worldwide (Zhao *et al.,* 2013). Likewise, South Africa is also heavily reliant on coal-fired electricity (Burer & Wustenhagen, 2009). Moriarty and Honnery (2014), contend that the growth in renewable energy is too slow to influence the current energy mix. Findings from the study by da Silva *et al*. (2018), also argue that countries in the Sub Saharan region have abundant renewable energy; however, these resources are unexplored.

Similarly, Nigeria's energy mix has remained mainly constituted of fossil fuel energy because its capacity to produce clean energy is not fully exploited (Aliyu *et al*., 2015). The energy mix in China is dependent on fossil fuels despite the rapid growth in clean energy production it has experienced (Zhao *et al.*, 2010). The energy sectors in both developed and developing countries have been identified as the main emitters of greenhouse gases that cause climate change (Polzin, Migendt, Taube & Flotow, 2015). This is evidence that developing countries mainly use conventional energy sources. It is noteworthy that clean energy has been increasing from 2004 until 2014 (United Nations Environmental Programme, 2016). Consistent with this finding, Bridle and Kitson (2014), state that support policies for non-renewable energy are significantly higher than those for clean energy. Countries are, therefore, more likely to focus on the production of non-renewable energy. The results of the study conducted by Kurkoti (2016), revealed that BRICS countries had shifted their focus towards the production of renewable energy, with China being the most significant investor in renewable energy. Brazil and India have increased their clean energy production too. South Africa is also transitioning into the use of clean energy (Kurkoti, 2016). Uhunamure and Shale (2021), argue that aged coal powered plants remain challenge and cause for the energy crisis in South Africa. Over the years, the country successfully increased its renewable energy however the renewable energy sector still faces significant obstacles (Renaud, Tyler, Roff & Steyn, 2020). A report by Deloitte (2019), states that the REIPPPP has successfully transformed the renewable energy sector since its implementation. Likewise, Greencape (2019), concurs that the REIPPPP, aided the process of increasing renewable energy in the energy mix.

According to the researcher, it is evident from the above literature that countries have not invested enough in renewable energy.

Extensive efforts are required to fulfil the current and future energy needs through all possible sources (Yamusa & Ansari, 2013). Furthermore, there is no best overall approach for the design of renewable energy policies (Puig & Morgan, 2013; IRENA, 2016). Investment incentives and feed-in tariffs were identified as the only incentives that can stimulate certain investments (Zhao, Tang & Wang, 2013). Germany and a number of other European countries stimulate solar energy production through financial and fiscal mechanisms, mainly devised for that technology (Ferreira, Kunha, Fagnania, De Souzab, Tonezer, Rodrigues dos Santos & Coimbra-Araújo, 2018).

According to Abdmouleh, Alammari and Gastli (2015), tax measures may be used to stimulate renewable energy investments and incite companies and individuals to invest in sustainable energy. The application of fiscal policies to encourage the generation of sustainable energy has been slow though. However, Hafez (2014), suggests that further support mechanisms can be used to counter this challenge. Investors are more likely to conform to their previous investment patterns; therefore, they need to be encouraged to invest in renewable energy (Wustenhagen & Menichetti, 2012). The world need to cater to the ever-increasing energy needs require intervening measures to be taken to stimulate renewable energy. The production of renewable energy can be stimulated by various policies such as direct subsidies in the form of tax credits and rebates, production credits, other types of tax incentives, priority to grid access, and direct public financing (Puig & Morgan, 2013). The generation of renewable energy can be enhanced to the desired level using the mechanisms mentioned above. Moreover, the current electricity crisis if not attended to is likely to affect the taxable income of existing companies and the state of the economy eventually.

2.5 Investment in renewable energy versus output generated

Globally, governments have committed to increasing their renewable energy determinations as a means to curb CO_2 emissions and increase green energy (Burer & Wustenhagen, 2009). Many studies have outlined how investments in renewable energy can or have been increased for countries to either meet their renewable energy targets or progress. For example, the International Renewable Energy Agency (IRENA) (2014), stated that China should increase its investment in renewable energy by USD 145 billion to reach its 26% share of the renewable energy target by 2030. Furthermore, China committed to spending 95 billion Chinese yuans so that it may reach its anticipated solar power output of 1.8 gigawatts by 2020. Brunnschweiler (2010), also argued that more accessible funding is required to increase renewable energy generation. According to Hafez (2014), to realise the renewable energy objectives set by the EU, the United Kingdom (UK) requires an investment of billions of pounds over the next decade (Hafez, 2014). Thus, to encourage extensive renewable energy investments, the UK intends to increase funding acquirable for projects (Hafez, 2014). The investment in renewable energy was estimated between USD400 billion-USD500 billion by 2020, rising from USD260 billion in 2011 (REN21, 2013).

On the other hand, South Africa has invested an aggregate of 192 billion in renewable energy sources from 2011 till June 2015, which was intended to produce 6 323 MW (Greencape, 2016). In aggregate, renewable energy investments have increased significantly from a low of 52 billion dollars in 2004 to a high of 243 billion dollars in 2010 (Gadomski, 2011). Between 2004 and 2014, countries with low income, and industrial and economic activities, have increasingly invested in renewable energy. On the other hand, Yamusa and Ansari (2013), argue that investments and technology are necessary to develop renewable energy and enhance energy security. Wustenhagen and Menichetti (2012), state that to achieve the public policy goal of further developing renewable energy, a considerable amount of private investment is required. The question one would ask is whether the increase in the amount of investment translates into a change in the renewable energy output generated. According to Bekhet and Harun (2017), a long-run cause and effect relationship which is bi-directional exists between capital invested and renewable energy generated. The capital invested results in direct stimulation of renewable energy generated.

Investment, economic growth and labour result in the possible sustainable energy being produced as these variables are strongly linked (Bekhet & Harun, 2017). Moreover, the ranking by Liebreich (2012), demonstrated that there is a positive cause and effect relationship between the amount invested and the renewable energy generated. Countries that have had an increase in the amount invested have experienced an increase in renewable energy produced. Some countries had a decrease in the amount invested yet they produced more renewable energy and managed to get a higher ranking for producing green energy. However, investments in renewable energy generation worldwide declined by 12% from USD279 billion in 2011 to USD244 billion in 2012 (Ellabban, Abu-Rub & Blaabjerg, 2014). Regardless of the decline in the amount of investment made, the renewable energy generated and supplied increased from 19% in 2011 to 21.7% in 2012 (Ellabban *et al*., 2014). Policy uncertainty resulted in a reduction of investments made but this was countered by the cost reductions in technologies and overall energy generated increased (Ellabban *et al*., 2014).

In 2016, a reduction in the average capital expenditure required to finance photovoltaic (PV) and the onshore wind dropped by 13% and 10% respectively. Due to the counter, an extreme decline in the capital cost of renewable technologies such as wind and solar photovoltaic, the reduction in renewable energy investment in 2016 did not result in a decline in renewable energy produced (UNEP, 2017). Moreover, projects financed in late 2015 were commissioned in 2016; thus, increasing the output in 2016 without a corresponding increase in the investment value in 2016 (UNEP, 2017). In the past years, wind power and photovoltaics have grown substantiallyresulting in yearly growth rates of 15-40% (United Nations Environment Programme, 2017). In 2002, of the 17 billion dollars invested wind power and solar photovoltaic had large portions.

In 2011, the world experienced a year on year increase of 17% in renewable energy produced because of the 257 billion dollars invested (Ming, Ximei, Yulong & Lilin, 2013). The investment in renewable energy of 51 billion dollars by China in 2011 constituted 19.8% of total global investment, resulting in increased installed capacity of renewable energy. China, which has been ranked the renewable energy production leader for three consecutive years, invests on average 24.9 billion dollars per year in its renewable energy sector (Konstantinos & Kolybiris, 2012; Michi & Takashi, 2013). In 2010, the primary producers of renewable energy; China, Germany, Italy, Brazil and the United States of America invested a total of 150 billion dollars (UNEP, 2011). According to REN21 (2016), an increase in investment from 273 billion dollars to 285.9 billion dollars resulted in a 5% increment in the renewable energy generated in 2015. China dominated the renewable energy market by investing an additional 17% in 2015.

Japan experienced a renewable energy boom phase in 2015 due to the increased investment amounting to 36.2 billion dollars (UNEP, 2016). Investments in renewable energy reached their peak in 2015 and the additional capacity added was noteworthy. The renewable energy produced in that year totalled 134 gigawatts and was 53.6% of the total energy produced. The increase in renewable energy investments from 2004 to 2015 was 18% globally (KPMG, 2016). In 2015, renewable energy generation grew by 147 gigawatts worldwide (KPMG, 2016). India is among the countries that experienced an increase in its renewable energy generation due to the increase in investments in renewable energy (Liebreich, 2017). Furthermore, the investment of 14.5 billion made in the wind power subsector resulted in the United States obtaining an increment of 8 589 mega-watts which represented 12% of the cumulative wind capacity. Total investments in renewable energy were 17% up in 2013, and the corresponding output as well increased from 1 578 gigawatts to 1 712 gigawatts. The world experienced an increase in investment from only USD45 billion since 2004 to USD560 billion by 2013. An increase of 475 gigawatts complemented this increase during 2004-2013. It is evident from the above review that the increase in the amount invested in renewable energy has resulted in an increased output of renewable energy.

2.6 Governance factors

According to Chaudhry, Malik and Khan (2009), government administration is a critical factor in building a sustainable economy. Huffy (2011) argues that economic policies and their outcomes are impacted by governance. Kaufmann, Kraay, and Mastruzzi (2009), state that governance comprises various aspects such as voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, the rule of law and control of corruption. This study focuses on government effectiveness, regulatory quality, the rule of law and control of corruption. Voice and accountability, as well as political stability and absence of violence, are irrelevant to this study, they focus mainly on the level of democracy a nation has achieved in selecting its government and how likely the government may be dethroned.

Control of corruption

A substantive body of literature concluded that corruption might positively or negatively impact economic development (Leff, 1964; Pellegrini & Gerlagh, 2004; Johnson, LaFountain & Yamarick, 2011; Almfraji & Almsafir, 2014). Corruption is defined as the usage of public power for personal benefits (Kaufmann, Kraay & Mastruzzi, 2010). According to Fouinhas and Marques (2013), the most significant challenge faced by the energy sector is corruption. Deceitful conduct negatively affects investment and economic development (Meon & Sekkat, 2005; Swaleheen, 2011). Nel and Komendantova (2015), classified corruption as one of the significant challenges faced by investors. Expenditures on infrastructure by foreign investors in the Sub-Saharan have been slowed down by the high level of corruption (Sobják, 2018). Moreover, Mahmud, Jamasb and Llorca (2018), opine that the effectiveness of the renewable energy industry can be slowed down by corruption. Nigeria was noted by PwC (2016), as one of the countries with a high level of corruption. The PWC report (2016), further states that the level of investment and living standards are affected by corruption. Similarly, Sumah (2018), opines that corruption hinders economic growth, destroys the legitimacy of a state and lowers investments. Davoodi and Tanzi (2000), argued that a causal relationship exists between corruption and the level and quality of investment, and the consideration to invest in projects. Inadequate control of corruption by governments in the Middle East and North Africa resulted in lower investments in renewable energy (Bellakhal, Ben Kheder & Haffoudhi, 2017). Control of corruption has a positive causal relationship with renewable energy generation. Additionally, it has been argued that there is a causal relationship between the quality of regulation, the extent of corruption and governance (Persson, Rothstein, Teorell, 2012; Rothstein, 2014; Rothstein & Tannenburg, 2015; Department for International Development (DFID), 2015). The South African REIPPPP program has been free of corruption, and as such, it is considered to be very competitive and a substantial success (McEwan, 2017).

Quality of the government regulatory framework and the rule of law

According to Kaufmann, Kraay and Mastruzzi (2010), the rule of law and regulatory quality indicators measure the perceived level of adherence by agents with contract enforcement. These indicators also measure the rules of society and the capability of the state to create comprehensive policies that encourage private sector development. Weak quality institutions and inequalities have been identified as hurdles to renewable energy generation (Bouoiyour, Selmi & Shahbaz, 2014). Komendantova, Patt, Barras, Battaglini and Antonella (2009), opine that transparency and robust regulations are crucial for achieving cooperation in renewable projects between North Africa and Europe. Higgins (1995), also argued that international law that relates directly to renewable energy projects needs to be revised to encourage investment. The Global Subsidies Initiatives (GSI) report on the study conducted in February 2018 concluded that governance and political instability are among the most significant challenges in the renewable energy field (Bridle, Gass, Halimajaya, Lontoh, McCulloch, Petrofsky & Sanchez, 2018). The study submits that investors in the renewable energy sector need to be consulted when regulations in the field are made, and subsequently, this will enhance investor confidence (Bridle *et al*., 2018). Moreover, Komendantova *et al*. (2009), argue that regulations enacted by governments play an essential role in shaping the renewable energy field. The Department of Energy (2015), declares that a favourable legal framework is necessary to encourage investment in green energy. In 2019, South Africa promulgated the Integrated Resource Plan (IRP) which outlines the preferred technology and the level of diversity required to meet energy demand (Republic of South Africa, 2019). Furthermore, the IRP states that the government aims to reduce CO2 emissions through increased investments in renewable energy (Republic of South Africa, 2019). Investments in renewable energy in Germany, Spain and California have boomed because of the conducive regulatory environments (Burer & Wustenhagen, 2009). This is evidenced by an opinion of one investor who said when making an investment decision, consideration of regulation played a significant role (Burer & Wustenhagen, 2009). Investors in Norway lost confidence in the government as a result of a significant reduction in renewable energy support policies. According to Bridle, Gass, Halimajaya, Lontoh, McCulloch, Petrofsky and Sanchez, (2018), the termination of feed-in tariffs and the limitations imposed by governance ministries on the purchase prices of green energy discourages investors.

Additionally, frequent changes to rules within the renewable energy field result in high compliance costs which may render projects infeasible (Barradale, 2010). A significant change in the bio-energy policy that was enacted in Norway resulted in investors losing a significant portion of their investments, after that the credibility of the state was diminished and subsequently investment levels decreased tremendously (White, Lunnan, Nybakk & Kulisic, 2013). The study by the United Nations Conference for Trade and Development (2008), identified government effectiveness and the regulatory environment as significant risks when investing in renewable energy was being considered. Zhao *et al*. (2010) state that a positive cause and effect relationship exists between regulations enacted and the number of green energy projects in an economy. Polzin *et al.* (2015), argue that enacted laws have the potential to increase investments in green energy. The study by Hua, Oliphant and Hu (2016), concluded that China, a developing country and Australia a developed country, both use laws to promote the production of renewable energy and have set objectives relating to renewable energy generation. According to Haas, Panzer, Resch, Ragwitz, Reece and Held (2011), deregulation has a significant effect on renewable energy deployment.

Polzin *et al*. (2015), further argue that delayed payments and the high regulatory reliance hinder the growth of green energy. Moreover, the social and political desirability of green energy, as Jefferson (2008), asserts, require rules to be enacted as a measure to encourage investments in renewable energy. In encouraging the development of its renewable energy industry, China, for instance, has implemented and continuously amended various laws and mechanisms. The Renewable Energy Law is one of the laws that was amended to encourage investment in renewable energy (Zhao *et al.*, 2010). The enactment of the Renewable Energy Law encouraged the involvement of investors in renewable energy (Zhao *et al*., 2010). In addition, China issued a regulatory circular that promotes small hydro energy, and after that, the level of small hydro energy output increased. Furthermore, in an attempt to improve local investments in wind energy, the Regulation on the Construction and Management of Wind Farms was enacted by China. A study by Zhao *et al*. (2010), showed that the policy mechanisms effected are strongly correlated to renewable energy growth.

However, the lack of clarity on the applicability of the regulatory support issued by China has hindered the growth of renewable energy investments (Zhao *et al*., 2010). China has demonstrated its efforts to increase green energy and continues to commit to amending the renewable energy Acts that it already has in place to promote renewable energy (Zhao *et al.*, 2010). Moreover, it is committed to establishing a favourable regulatory framework and investment environment. The Vietnam government has also implemented key policies to encourage investment in renewable energy. An example of a policy in Vietnam is the Electricity Law 28 of 2004, which offers inducements relating to investment, electricity prices and taxation on renewable energy power plants (Nam *et al*., 2012). Indonesia enacted Regulation 12/2017 and 50/2017 to address the inadequacies of its feed-in tariff laws and encourage renewable energy investments (Bridle, Gass, Halimajaya, Lontoh, McCulloch, Petrofsky & Sanchez, 2018). Foreign direct expenditure on renewable energy was slowed down in 2002 when Egypt introduced new legislation that required private investors to fund projects in foreign currency as a means to curb the effects of the volatility of its exchange rate (Komendantova *et al.*, 2009). Based on the literature reviewed in this section, it is apparent that the quality of the regulatory framework enacted by government and the rule of law influence renewable energy generation.

The South African regulatory framework and the rule of law

As noted in the Background to this study (see Chapter 1, section 1:2), South Africa also enacted rules and regulations in an attempt to encourage renewable energy generation. Currently, the South African tax legislation also has a few sections that cater specifically to companies involved in the production of renewable energy. These sections of the Act are favourable to investors and thereby attempt to encourage green energy production. Renewable energy businesses are eligible for section 12B, which provides accelerated wear and tear allowance on machinery, plant, utensils and articles (Income Tax Act 58 of 1962). The allowance is claimable when the assets are used to generate electricity from wind power, solar energy, and hydropower that produces electricity which is 30 megawatts or less. Deduction is allowed if the asset is purchased by the taxpayer in an instalment sales agreement or owned and used for the first time by the taxpayer for trading. The research and development expenditures may be claimed as a deduction under section 11d (Income Tax Act 58 of 1962). In being eligible for the deduction, the expenses incurred shall be approved by the Department of Science and Technology of South Africa (Income Tax Act 58 of 1962). The deduction is either 150% of revenue expenditure or accelerated wear and tear for capital assets. No specific exemption applies to renewable energy investments in the VAT Act. This is an issue to be considered in the context of this study.

A tax exemption is allowed for any amount that is received or that accrues in respect of the disposal of any certified emission reduction resulting from the furtherance of a qualifying clean development mechanism project section 12K. Greenfield and Brownfield projects qualify for an additional allowance for used or unused assets used in a project that is eligible as an Industrial Policy Project as defined about assets employed in the manufacturing sector (Income Tax Act 58 of 1962). According to the Act a brownfield project is any existing project that makes use of new technology to improve energy efficiency and increase clean energy production in an industry within the Republic of South Africa (Income tax Act 58 of 1962). In qualifying, a Greenfield project should cost more than 50 million rands, and brownfield projects should cost more than 30 million rands, less than 50 million rands or 25% of expenditure on existing assets (Income Tax Act 58 of 1962). A Greenfield project is a new project that uses prevailing energy saving equipment and processes (Income tax Act 58 of 1962). Section 12L of the legislation allows the taxpayer to deduct an amount in respect of energy savings from their taxable income. The deduction is only allowed for energy generated from heat recovery and not renewable source generated energy (KPMG International, 2015). A further allowance is sanctioned/ permitted for the cost incurred to acquire new or unused environmental treatment and recycling assets or an environmental waste disposal asset that is used in manufacturing and is required by law to conserve the environment (Section 37B). Expenditures incurred to conserve or maintain land regarding a five-year biodiversity management agreement regarding the National Environmental Management Biodiversity Act shall be deemed to be incurred in the production of income, therefore, deductible (Section 37C). The deduction in the section may not create a loss when set off against the income from the land (KPMG International, 2015). Moreover, Dippenaar (2018), argues that the current tax rules do not motivate investors to participate in the renewable energy field and recommends the reformation of the currently available fiscal support to encourage participation in the field. Consequently, Dippenaar (2018), reported that none of the respondents in the study asserted that they consider the available tax incentives to be effective.

Government effectiveness in enforcing the rule of law

Kaufmann, Kraay and Mastruzzi (2010), define government effectiveness as the perceived quality of the policies that are created by the government and how well they are enforced. According to Puig and Morgan (2013), the principal driving force for the diffusion of renewable energy is supportive government policies. White *et al*. (2013), contends that the most significant challenge faced by investors in the renewable energy industry is inconsistent policies set by the government. Profits drive private investors. Therefore, actions taken by the government to incentivise investors to participate in the generation of renewable energy either through tax intervention, issuing of grants or the enactment of regulations has a direct impact on the investor's willingness to invest in renewable energy (White *et al*., 2013). Zhao *et al*. (2011), point out that a positive relationship exists between the promulgation of appropriate policies and the resulting degree of investment in renewable energy. The International Renewable Energy Agency (IRENA) (2015), asserts that comprehensive policies are required to achieve renewable energy targets and attract investors. The International Renewable Energy Agency (2018), highlighted that investors needed to be incentivised for the perceived or actual risk taken by investing in renewable energy generation technologies. Renewable technologies are also faced with other challenges such as high capital cost and lengthy periods before generating revenues and profits (Zhao *et al*., 2013). To make use of the potential that renewables have, adequate financial and non-financial inducements are necessary (Olz & Beerepoot, 2010).

Even though the deployment of sustainable energy technologies curtails carbon emissions and may result in energy security, these benefits are independent of power generators (Popp, Hascic & Medhi, 2011). Due to the high initial capital required to invest in renewable energy, stimulus through policy interference is required. Besides providing policy aid for renewable energy or penalising carbon emitters, investors have no rationale to participate in renewable energy generation (Popp *et al*., 2011). Burer and Wustenhagen (2009), opine that policy support is vital in encouraging investments in sustainable energy, arguing that policy alone is not enough motivation. Various countries use a variety of policy instruments to encourage solar power generation; these include the feed-in tariffs, subsidies, net metering, tax credits, green tags, tax concessions, government mandate and regulatory provision as well as renewable energy portfolios (REN21, 2011; Sovacool & Gilbert, 2013). Almost all countries stimulated investments in renewable energy through a combination of various support mechanisms. A combination of policies is usually adapted to directly influence the generation of a specific type of renewable energy technology (Popp *et al*., 2011). Governments mainly use feed-in-tariffs, tax incentives, and tradable green certificates to finance renewable energy development programs (Abolhosseini & Heshmati, 2014). These policies, however, do not always result in favourable outcomes due to their inconsistent application (Usha Rao & Kishore, 2010). Hafez (2014), claims that the use of consistent policies, which have a long-term view, is likely to reduce the risks associated with renewable energy production and induce investors' participation in its generation.

Spain, Ireland, China, USA, South Korea and Belgium all offer tax incentives to encourage renewable energy growth (Ogunlana & Goryunova, 2017). Producers are also given tax credits in the form of a deduction from the tax base or in a loan form at a fixed rate per kilowatt-hour by using renewable energy (Ogunlana & Goryunova, 2017). The production tax credits are applied against the income tax payments due to the state.

Developed countries

In 2006, a rapid increase in wind energy in Idaho, a state in the Western United States, was boosted by the enactment of the sales and a used tax rebate for alternative energy (Black *et al*., 2014). The significant increase in wind energy development which has been experienced by the United States (US) over the years is nearly at an average growth of 30% per year (Black *et al*., 2014). The sales and use rebate entitled the developer of a new alternative energy facility to a refund of the sales and use tax paid on machinery or equipment subject to the obtainment of a certificate for a refund (Black *et al*., 2014). An advantage of such a tax incentive is that the burden of providing additional infrastructure is lifted from the state. The sales and use program has expired, and it is anticipated that this will result in the loss of wind energy investments. A property tax exemption is also offered to the wind and geothermal energy producers. It applies to real estate, fixtures and assets used in the renewable energy production (Black *et al*., 2014). Utah, also a state in the US, was a late recipient of wind energy investments due to its lack of state incentives (Black *et al*., 2014).

The German government mainly uses a feed-in tariff, preferential tax policies, state loans, and loan guarantees to promote its PV industry (Zhi *et al*., 2014). This policy mix has resulted in the rapid growth of the German PV industry and is regarded as the best practice. Japan, too, with its scarce natural energy resource, uses policies such as feed-in tariffs, renewable energy portfolios, consumer subsidies, financial support and state mandates (Zhi *et al*., 2014). In some European countries, property tax deduction, which can be eliminated in its entirety for tax amounts on property, land and fixed assets, is used to encourage investment in renewable energy (Ogunlana &

Goryunova, 2017). Investments in capital intensive technologies used for wind power generation and solar energy conversion are stimulated by the reduction in property taxes (Ogunlana & Goryunova, 2017). This is because property taxes usually lead to a higher tax burden; its reduction creates tax equality between renewable energy and conventional technologies. Similarly, different incentives were used by various states in the US to attract investment in renewable energy. Policies in the form of tax exemptions, deductions and credits, as well as various subsidies and Renewable Portfolio Standards, have been used to attract wind power energy investments (Black, Holley, Solan & Bergloff, 2014). Previous studies concluded that these policies have a significant influence on new investments in wind power energy (Black *et al.,* 2014). A key tax incentive used in the US is the investment tax credit (Black *et al*., 2014). It reduces the tax on investment in the purchase of land, basic equipment, and power installation to produce renewable energy.

A study conducted by KPMG International (2015), revealed that feed-in-tariffs (FITs) and renewable portfolio standards were the most commonly used mechanisms for promoting renewable energy. In its 2014 study, KPMG found that most of the countries it studied use fiscal policies in combination with other policies to stimulate renewable energy investments (KPMG International, 2014). Feed in tariffs have proven to be a successful stimulant for renewable energy (Lu, Khan, Alvarez-Alvarado, Zhang, Huang, Imran, 2020). According to Müller, Claar, Neumann, Elsner (2020), African countries have promulgated various regulation to promote renewable energy generation. Globally, the frequently used incentives include Feed-in Tarrifs and Renewable Portfolio Standards (Wang, Jiang, Wang, & Wang, 2020). Taxes influence ownership structure, job creation, financing structure, and often the right decision to start a business. In a recent study, Hansson (2012) notes that the inability to incorporate a progressive tax system discourages risk-taking, hence reduces entrepreneurship, while neutral taxes (the proportional tax system) encourage risk-taking. Nadirov and Dehning (2020), argue that entrepreneurs consider marginal taxes when deciding whether to invest in an industry. Taxes reduce capital disposable to entrepreneurs and if high they can have drastic effects on the survival of a business (Giertz, 2018). Fossen, Rees, Rostam-Afschar and Steiner (2020), also argue that lower taxes can encourage entrepreneurship. It is evident from the literature that countries which are leaders in renewable energy production effectively use fiscal policies solely or in combination with other policies to stimulate investments in renewable energy.

Developing countries

Currently, the renewable energy procurement program in South Africa limits the renewable energy that can be purchased (Republic of South Africa, 2019). Due to its energy challenges and pollution caused by greenhouse gases (GHG) emissions, China is among the countries that implemented rules, mechanisms and regulations to encourage renewable energy investments (Zhao *et al*., 2010). Fiscal and tariff policies and research and development (R&D) incentives have been applied since the energy crisis of the 1970s. The phenomena of using different mechanisms at the national and local level to encourage the stimulation of renewable energy investments have been successfully applied in the past (Martinot, 2004). If renewable energy is to grow to a large proportion of the energy mix, the renewable energy technologies need to compete at the same level as the conventional fuels and receive priority to access to the grid. South Africa should increase its target to a level high enough to motivate the market to react. Sustainable energy can be made appealing by the state by encouraging the production and demand thereof (Sherzod, 2016). The effectiveness of support policies is, however, dependent on the number of policies as the benefit reduces as the policies increase (Zhao *et al*., 2013).

China facilitates the growth of its photovoltaic (PV) energy by providing product sales tax credits for its major industry participants and establishing joint research institutes with these companies. Moreover, China's renewable energy tax preference rules, thorough implementation guidelines, market-orientated operations and research and development incentives, encouraged renewable energy generation (KPMG International, 2015). China uses a policy mix which includes Research and Developments Grants, financial support for manufacturing, materials and duty-free equipment, tax concessions and investment subsidies (Zhi *et al*., 2014). China's primary policy is the preferential tax policies such as the exemption of PV products from import or export customs duty, VAT refund on sales of PV batteries and deductions of research expenditure up to 50% of total expenditure (Lo, 2014).

Moreover, Brazil was one of the nations which implemented fiscal policies in favour of renewable energy production among its other policies (Zhang Li, Cao, Zhao & Wu, 2011). In addition, India has various policies to stimulate investments in renewable energy such as differential tariff policies of import wind powered fans, depreciation and tax exemptions of electricity sales (Fang & Zeng, 2009). Moreover, the Vietnamese Decree 4 of 2009 offers preferential corporate tax rates, exemption from import tax on renewable equipment, facilities, and materials, and claims tax allowances on fixed assets 1.5 times faster than standard rates (Nam *et al*., 2012). Incentives are also offered through favourable income tax rates, loss transfer and preferential land rights. Furthermore, the tax rates are relaxed in the nascent years of the business. Investors get preferential treatment as an incentive for investing in renewable energy. Additionally, renewable energy companies are exempted from import tax on equipment, tools, materials and purchases of machines in the first four years (Nam *et al*., 2012). Furthermore, an exemption from VAT for the purchase of investment equipment and 0% VAT for renewable energy projects is provided (Nam *et al*., 2012). The tax rate for newly established renewable enterprises is 10% for the first 15 years, but if the project uses advanced technology or is large, the period can be extended to 30 years (Nam *et al*., 2012). The standard corporate income tax is 25%, while companies in the oil and gas industry pay their taxes on a sliding scale from 32.5% to 50% depending on location. Indonesia also allows net income tax reductions of 5% of the investment value each year over six years to its renewable energy investors as well as for accelerated wear and tear ranging from 2-10 years depending on the asset type (Damuri & Atje, 2012). Furthermore, foreign investors in Indonesia pay a 10% dividend tax, which is lower than the standard rate. It compensates its foreign investor losses subject to specific criteria and exempts these enterprises from import duty and VAT on capital goods and machinery (Damuri & Atje, 2012). Hence, it is clear from the above-mentioned that many countries make use of tax incentives to stimulate investments in renewable energy.

Likewise, Zambia uses investment incentives to encourage investment in renewable energy (Waliwimpi, 2012). Its incentives comprise financial incentives, fiscal incentives and other incentives. The tax incentives offered are tax exemptions and reduction of dividends, import duties, -added value tax and general corporate taxes. Dividends are taxed at 15%, but in the case of investors into renewable energy, tax is levied at 0% for the first five years for investments over USD10 million (Waliwimpi, 2012). The import duty and VAT exemption apply to investments of USD10 million or USD500 000 (Waliwimpi, 2012). Corporate taxes are usually payable at 35%, but investments above USD10 million or USD500 000 pay no tax for the first five years (Waliwimpi, 2012). From year six to eight, only 50% of the benefits are taxable, and from year nine to ten, only 75% of the benefits are taxable (Waliwimpi, 2012). Small and micro investors are exempt from tax for three years in urban areas and five years if in the countryside (United Nations Conference on Trade and Development, 2011).

Argentina as well uses fiscal policies in addition to other policies to encourage investments in renewable energy (IRENA, 2015b). Its fiscal policies are contained within its Law 26190 and permit the deferral of tax payments for 15 years during which the tax debt cannot be modified or changed in any form (IRENA, 2015a). The depreciation of its assets is hastened, and VAT refunds are available after three years. National laws request provinces to abide by the national legislation and develop their incentives. Provinces can establish fiscal inducements such as exemptions from revenue tax, property tax, as well as local and administrative fees.

Despite the fact that the attempts by South Africa to encourage investments in renewable energy by revising its regulatory legislation, little or insignificant attempts have been made to measure the impact the mix of support policies has on companies investing in renewable energy. Furthermore, based on the above literature, it is clear that various factors influence renewable energy, and as such, it is necessary to investigate and identify its enablers.

2.7 Economic factors

The Development Indicators Report states that indicators of economic development and transformation include GDP, infrastructure development through public-private partnerships, and foreign direct investment (FDI), among others (Republic of South Africa, 2012). Burke (2010), argues that GDP positively influences the production of renewable energy. According to Ohler and Fetters (2014), GDP and green energy production have a bidirectional relationship. Doytch and Narayan (2016), for instance, found that FDI has a favourable effect on renewable energy generation while an opposite relationship existed for non-renewable energy. Sahoo, Dash and Nataraj (2010), opine that investing in infrastructure results in cost savings on projects, improved competition and sustainable economic development. According to Lee, Han, Gaspar and Alano (2018), the level of investment made by PPPs is an indicator of economic development.

GDP per capita

Pohl and Mulder (2013), submit that the level of education, economic growth, governance and economic policies stimulate renewable energy deployment. Additionally, Popp *et al*. (2011), found that economic growth is positively correlated to renewable energy production. This suggests that there is a positive cause and effect relationship between GDP per capita and renewable energy generation (York & McGee, 2017). Ayres and Voudouris (2014), state that economic growth requires the provision of sufficient and reasonably priced quantities of useful energy. As such, energy resources are critical drivers of economic advancement. This notion has been studied, and different results drawn. For instance, Lee and Chang (2008), argue that energy consumption causes economic growth, while Kraft and Kraft (1978), argue that the opposite is true. A bi-directional causal relationship was found between energy use and economic growth (Lee & Lee, 2010). Likewise, Marinaş, Dinu, Socol and Socol (2018), found a bi-directional relationship between GDP and renewable energy output.

Furthermore, expenditure on renewable energy promotes an increase in capital investments in the economy (Maradin et al., 2017). In China, renewable energy produced is greatly influenced by the level of economic growth (Perticas *et al*., 2017). Similarly, it has been proven that economic growth is strongly and positively correlated to the renewable energy generated (Perticas et al., 2017). Alkar (2016), opined that green energy development is affected by economic growth, among other factors. Furthermore, the expansion of economies requires a similar expansion in energy (Saidi & Hammami, 2015). According Can and Korkmaz (2019), a negative relationship exists between economic growth and renewable energy output. Marinaş et al. (2018), found a bi-directional relationship between economic growth and renewable energy. A positive cause and effect relationship was found between economic growth and renewable energy production (Grabara, Tleppayev, Dabylova, Mihardjo, Dacko-Pikiewicz, 2021).

Foreign direct investment (FDI)

An investment in infrastructure exceeding three trillion dollars needs to be made globally to meet growth targets set by developing countries and emerging markets (Mckinsey Company & Bernal, 2016). Foreign expenditure has played a significant role in the progression of Pakistan and other developing countries (Latief & Lefen, 2019). According to Ilaria and Rolland (2015), investments in renewable energy infrastructure can be enhanced by foreign expenditure. The Department of Energy (2015), states that there is the prospect for South Africa to use foreign investment to increase renewable energy production and curb CO_2 emissions. Despite the state providing a significant level of investments made in the renewable sector in North Africa, continued reliance on state investments is not sustainable (Komendantova *et al.*, 2009). The direct foreign expenditure in North Africa has been declining, and this has posed a challenge to the realisation of the renewable energy targets it set to address climate change (Komendantova *et al.*, 2009).

In contrast, Pakistan received significant foreign investments in its power and energy sector due to its favourable renewable energy policies that encouraged investment (Latief & Lefen, 2019). In 2015, Pakistan implemented a renewable energy policy with various mechanisms that will induce investors to invest in green energy (Latief & Lefen, 2019). According to Grabara, Tleppayev, Dabylova, Mihardjo, Dacko-Pikiewicz (2021), FDI and renewable energy output have a positive relationship. FDI is relatively low in Africa when compared to expenditure throughout the globe. Significant investments in green energy are required to achieve renewable energy targets set by economies; therefore, there is a need for FDI (Komendantova *et al.*, 2009). Similarly, the

Department of Energy (2015), submits that foreign investment, among other factors, will influence the level of renewable energy that will be produced within the next ten years.

Public-private partnership (PPPs) investment in energy

Despite efforts by governments to invest in energy most citizens in Africa do not have access to electricity (World Bank Group, 2017). To overcome this challenge, additional investments and reformed business models that encourage private expenditure will be necessary (World Bank Group, 2017). The involvement of the private sector in energy infrastructure development has played a vital role in improving service delivery and ensuring efficient use of energy facilities (World Bank, 2020). South Africa's inclusion of the private sector in the energy sector through the Independent Power Producer programme resulted in the addition of 4 gigawatts of renewable energy output (Baker & Wlokas, 2015). The investment made by the private sector in the wind and solar energy in South Africa amounted to $4.8 billion in 2013, a significant increase from a few hundred million dollars in 2011 (UNEP, 2014). According to Aitken (2014), many opportunities exist in the energy sector for the private sector to participate. Furthermore, private sector involvement in the energy industry will help resolve funding challenges and project backlogs faced by the industry (Aitken, 2014). Financing provided by private entities through PPPs benefits the energy sector significantly (Nel, 2018). Additionally, Nel (2018), argues that PPPs are essential in transforming the energy industry, reforming the current energy mix and improving the energy infrastructure. Private sector participation in the energy sector is expected to transform the industry towards sustainable energy (David & Venkatachalam, 2018). Due to the contractual nature of PPPs projects, they yield benefits such as efficient and timely completion of projects (Rakic & Radjenovic, 2011). Public-private partnerships in energy consist of funding arrangements for building infrastructure that supports energy projects, which are for the benefit of the public (World Bank, 2020). In a public-private partnership, the private entity usually assumes most of the risk related to the investment (David & Venkatachalam, 2018).

Among other causes, deficiency in required funding and the disinclination by financiers to invest have resulted in inadequate diffusion of renewable energy (Wustenhagen & Menichetti, 2012). Investors regard renewable energy projects to be very risky, unexplored ventures, and as such, they are less likely to fund them (Anbumozhi & Rakhmah 2018). In spite, having made substantive progress, renewable energy technologies nonetheless struggle technically and financially (Scarlat, Dallemand, Monforti-Ferrario, Banja & Motola, 2015). This is because renewable energy requires a higher initial investment as compared to conventional sources (Hidayatullah, Blagojce & Kalam, 2011; Giraldo, Mojica-Nava & Quijano, 2014; Nasirov, Silva & Agostini 2015). Likewise, Meltzer (2016), argues that renewable energy projects require high upfront costs. Notwithstanding the high investment required for renewable energy projects the cost of production has been decreasing remarkably (IRENA, 2019). Despite, plans to transition to renewable energy, which is more sustainable and desirable, the majority of governments cannot finance this transition due to their constrained budgets (Mabel and Fernandez, 2008; Webber, 2010; Saidur et al., 2010; Zahedi, 2010). Most developing countries have little or no funds to finance the high cost of renewable energy infrastructure because they have low tax bases and poor tax collection (David & Venkatachalam, 2018). The world requires trillions of dollars on an annual basis for water, healthcare, and energy infrastructure (OECD, 2017). The level of investment required for green projects is very high (David & Venkatachalam, 2018). The sole electricity distributor in South Africa, Eskom, is cash strapped, behind schedule, and experiencing significant cost overruns on its projects that are intended to extend capacity (Baker & Wlokas, 2015; Gerner, 2019).

Additionally, Eskom requires a capital injection of ZAR149 million by 2022 to enable it to bolster its distribution networks and enhance its substations (Roelf, 2015). The burden faced by Eskom is due to its reluctance to introduce private investors into the energy market (Boulle, Boyd & Cunliffe, 2015). The budget constraints faced by governments can be overcome through the inclusion of the private sector in renewable energy projects (David & Venkatachalam, 2018). India, as well as other developing economies, are transitioning towards the inclusion of the private sector to enhance their green energy sector (David & Venkatachalam, 2018). David and Venkatachalam (2018), state that India facilitated PPPs through the provision of land for sustainable energy projects, and it also bridged the gap between private entities and the consumers. Other countries that have actively encouraged investments by the private sector in medium and large-scale renewable energy projects include Brazil and China (International Finance Corporation, 2010). As evidenced above, public-private partnerships have a role to play in enhancing the renewable energy sector.

2.8 Environmental factor

The Organisation of Economic Development (2008), contends that the assessment of environmental factors provides a platform for monitoring the ecological state of nations and forms a basis for policymaking. Among the key environmental policies identified is climate change which comprises of CO_2 and greenhouse gas emission intensities (OECD, 2008). According to Zhao and Chen (2018), environmental pollution, global warming and energy sustainability are the principal factors that have influenced the shift towards increased renewable energy generation in China.

The level of total greenhouse gas emissions

According to Komendantova *et al*. (2009), globally, the reduction of the effect of greenhouse gas emissions on the climate should be considered when devising means to meet the energy demands of economies. The generation of renewable energy is a reliable means of mitigating global warming and addressing energy security (Pao, Li & Fu 2014). Emissions need to be halved by 2050 to circumvent the disastrous changes wrought by CO_2 emissions, such as, threats to food security, rising sea levels and water pollution in economies (UNEP, 2008). Globally, none of the countries has a feasible plan on how to achieve the low levels of emissions required to prevent the dire consequences of CO_2 emissions (Bruce, 2013). Walz, Slowinski and Alfano (2016), contend that environmental policies affect the prospects of the renewable energy industry. Conventional exhaustible sources of energy have been adjudged to provide most of the energy required worldwide. South Africa produces a large proportion of carbon emissions through its coal-fired plants used to generate electricity. Among the world-leading economies in renewable energy generation and installation is China, which started experiencing significant growth in renewables since 2006 because of its renewable energy policy framework (Schuman & Lin, 2012). The increases in renewable energy generated can be attributed to the high level of GHG emissions experienced by China (Zhao *et al*., 2010). According to IPCC (2018), two thirds of emissions in 2018 emanated from the energy sector and a shift towards renewable energy would reduce CO_2 emissions. Likewise a study by IRENA (2019), revealed that the reduction of emissions is a key driver for transitioning to green energy. ÓhAiseadha, Quinn, Connolly, Connolly and Soon (2020), concur that CO_2 emissions influence renewable energy generation positively. Contrarily, Twumasi (2017), found that no relationship exists between renewable energy and CO_2 emissions. South Africa is among the top 20 emitters of greenhouse gas emissions globally, and also ranked as a significant emitter in Africa (Dippenaar, 2018). A significant portion of the energy needs of South Africa is catered for through coal-generated electricity, a trend that is expected to continue. The high level of carbon dioxide emissions faced by South Africa is due to its use of coal which is considered a significant contributor to greenhouse gases that cause climate change (Dippenaar, 2018). According to the report issued by REN21 in 2017, even if the renewable energy targets set in the Paris Agreement on Climate Change are met, greenhouse gas emissions will not be able to meet the goals set to reduce the emissions to an acceptable level. However, because of investments in green energy made between 2005 and 2016, greenhouse gas emissions are expected to reduce in 2020 by 0.6 gigatons of carbon dioxide (REN21, 2017). In mitigating the effects of GHG emissions, the South African government introduced the Independent Power Producer Procurement Program to encourage investments in renewable energy (Republic of South Africa, 2012). On the other hand, Bruce (2013), argues that greenhouse emissions may be reduced through the enactment of regulation that is favourable.

2. 9 Social factor

Carley and Bustelo (1986), aver that social indicators assist in measuring the effect of past and future policies as well as highlighting the need for specific policies. Similarly, the Organisation of Economic Development (2013), argues that social indicators enable policymakers to identify critical areas of focus, thereby guiding policy formulation. Furthermore, the Organisation of Economic Co-operation and Development (2001), argues that policymakers should take into consideration the impact of social indicators when formulating policies to enable sustainable economic growth. The level of education can have a direct or indirect impact on a phenomenon being investigated (Estes, 2005).

Education- Gross enrolment ratio of upper secondary pupils

According to White et al. (2013), green energy development often receives state support in the form of education and funding. Education is crucial for the development of the economy (United Nations, 2015). In accomplishing the desired renewable energy production, skills training relevant to the industry will need to be provided (IRENA, 2013). Renewable energy is in its infant stages; however, it is expanding swiftly (Malamatenios, 2016). Given the exponential growth expected in the renewable energy industry, the job growth rate is expected to increase and consequentially result in a skills shortage (Yoeurp, 2017). The International Labour Office (2011), identified the lack of green collar skills required in the green industry as a significant challenge of renewable energy production. Likewise, IRENA (2013), opined that the lack of skills is a significant obstacle for renewable energy generation. The lack of the appropriate human resource skills has caused terminations of projects, excessive spending above budgets, as well as deferment of projects and, has subsequently constrained renewable energy investments in various countries (International Labour Office, 2011). Moreover, the absence of the experienced workforce can hinder investor confidence in the potential of the green energy industry (IRENA, 2013). Nations must commit to providing training because the transition to a decarbonised economy depends on it, and the renewable energy sector lacks personnel with the required skills (International Labour Office, 2011). Contrary to previous researchers, Muhammad, Muhammad, Avik, Tuhin and Quande. (2020), contend that a bi-directional relationship exists between education and renewable energy produced. On the other hand, Ozcicek and Agpak (2017), argue that a positive causal relationship exists between education and renewable energy generation.

According to the Department of Energy (2015), renewable energy output can be enhanced indirectly by improving the standard of renewable energy education and training accredited by the South African Qualifications Authority (SAQA). The workforce in the renewable energy sector in Spain consists of fifty percent university graduates (International Labour Office (2011), reinforcing the fact that most of the workforce in other parts of the globe earn better wages. A significant portion of the jobs available in the South African renewable energy industry requires highly skilled employees with qualifications above matriculation (Grade 12) (Cobenefits, 2019). Likewise, IRENA (2011), argued that the critical jobs in the renewable energy industry require qualified personnel. In their study Lehr, Lutz, Khoroshun, Edler, O'Sulllivan and Nitsch (2011), concluded that employment in the renewable energy field generally requires the workforce to be experienced. Possession of a university qualification is a requisite to become an engineer, meteorologist or project developer in the field (IRENA, 2011). According to Malamatenios (2016), students do not usually study engineering, and as a result, there is a lack of engineers and technicians in the renewable energy industry, and this phenomenon is prevalent in developing nations (Malamatenios, 2016). Due to the high skills base required in the green energy production field, it is difficult to fill positions (IRENA, 2013). In countering the skills shortage problem in the field, China has established renewable energy training centres such as the China Wind Power Center (CWPC). Training that specifically addresses the skills shortage in the renewable energy industry is necessary.

2. 10 Summary of the chapter

From the above review, it is evident that various enablers and factors that influence renewable energy generation are invested. Moreover, the combination of fiscal or financial policies and other mechanisms such as the priority to grid access and direct public financing applied, influence the generation of renewable energy. Additionally, the amount invested has a causal relationship with the output generated. The in-depth review of the related literature reinforces the objectives of this study and has raised the hypotheses that this study intends to answer in the context of the South African renewable energy industry. Existing literature has been explored, and it is evident that a negligible amount of research has been conducted in the South African context to address the research hypothesis raised in this study. The next chapter outlines the overall research approach used in this study. Furthermore, it discusses the research paradigm, the research design, the research method, the data collection approach, the data analysis approach, the population and sample size, the reliability and validity of the method and data as well the ethical considerations relevant to this study.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

The preceding chapter outlined the theoretical framework on which this study is based, and presented the literature that supports this study. The purpose of this study is to examine the effect of the dollar investment in renewable energy on renewable energy generated in developing economies. Additionally, the study investigated the effect that proxies for governance, economic, environmental, and social factors have on renewable energy output in selected developing countries. Proxies that were used to measure the impact of these factors include the control of corruption, GDP per capita, FDI, the quality of the regulatory framework, the level of greenhouse gas emissions, the level of education as measured by the gross enrolment ratio of upper secondary pupils, the rule of law, PPP investment in energy, and government effectiveness. This chapter discusses the overall research approach used in this study. It explains the research paradigm, the research design, the research method, the data collection approach, the data analysis approach, the population and sample size, the reliability and validity of the method and data as well the ethical considerations in this study. The research approach is defined as a way to solve the research problem systematically. It considers the research methods and the reasoning for using a specific method for a research study instead of other methods available (Kothari, 2004**).** Section 3.2 explains the research paradigm, Section 3.3 outlines the research design, and the discussion of the research method follows it. It describes the data collection approach and considers the data analysis approach in Section 3.4. The variables are described in Section 3.5.The model applied to explain the relationship between the variables is presented in Section 3.6 while Section 3.7 explains the research variables. Section 3.8 discusses the population and the sample considered in the study. The reliability and validity of the study and the ethical consideration are explained in Section 3.9

and Section 3.10 respectively. Finally, Section 3.11 discusses the summary of the study. This was done according to the prescriptions of the research literature indicated below.

According to Langos (2014), the methodology of a study outlines the research method, strategy, and approach, methods of data collection, selection of the sample, research process and type of data analysis, the ethical considerations and research limitations of the project. It is how researchers describe, explain, and predict phenomena through procedures they perform (Rajasekar, Philominathan & Chinnathambi, 2013). It is the science of studying how the research will be done. Myers (2009), described it as a strategic investigation which transforms the underlying expectations to research design and data collection.

3. 2 Research paradigm

A positivist research paradigm was adopted in this study. This study applied quantitative measures to answer the research hypothesis; therefore, a positivist approach was determined to be the most appropriate paradigm. This research tested the relationship between proxies for governance, economic, environmental, social factors, and renewable energy generated (output) in selected developing countries. The data for the variables tested was available in numeric format. Abuhamda, Ismail and Bsharat (2021), when a quantitative approach is followed the relationships between variables is tested, likewise this research examined the relationship between the selected variable thus it adopted a quantitative approach. According to Hayes, Bonner and Douglas (2013), a quantitative study involves the gathering of numeral data for analysis, hence this is a quantitative study. In addition, the study examined the relationship between the dollar investment in renewable energy and renewable energy generated (output) in selected developing countries. This study tested whether a causal relationship exists between the selected variables. Kumar (2019), argues that the positivist paradigm is a scientific paradigm that aims to provide evidence of whether a specific premise exists, as such it can be deduced that this is the appropriate paradigm for this study.

A panel data regression model has been applied in the study. Kumar (2019), asserts that research results under the positivist paradigm are derived through the objective use of statistical and scientific methods (Kumar, 2019).This research can be classified as requiring the application of a positivist paradigm, it employs a statistical method to derive results. In a positivist approach, the scholar objectively investigates theories by using sizeable samples (Doyle *et al*., 2009). Data for a sample of developing countries has been tested, once more it is apparent that a positivist approach is the most appropriate selection.

From the above discussions, it is evident that this study required the application of the positivist paradigm. A cause and effect relationship between the dollar investment in renewable energy, the proxies for governance, economic, environmental as well as social factors and renewable energy generated in developing economies is explored.

3. 3 Research design and method

A research design is a plan that guides the conditions for the collection and analysis of data in a manner that aims to combine relevance to the research purpose with the economy in progress (Sellitz, Jahoda, Duetsch & Cook, 1965, Kumar 2019). According to Rajasekar, Philominathan and Chinnathambi (2013), a research design is the various schemes, procedures and algorithms used in the research to collect data, samples, and solve the problem. It focuses on all the steps to be taken to reach the desired outcome. Moreover, it is a plan of how the researcher will collect and analyse the data that is needed to answer the research problem (Bertram & Christiansen, 2014).

To curb the perpetual electricity crisis in South Africa and to demonstrate South Africa's commitment to the Kyoto Protocol which requires a reduction in greenhouse gases, the investment in renewable energy and the proportion of renewable energy in the energy mix has been continuously increased. Consequently, this motivated the need to investigate if a causal relationship exists between the amount invested, the various variables as identified above, and the resulting renewable energy produced in South Africa and other selected developing countries. The investigation of the type of relationship that exists represents the quantitative part of this study.

Creswell (2009), opines that the choice of the research method depends on the research topic, the research questions and the objectives of the study. According to Kivunja and Kuyini (2017), the paradigm and methodology of a study are closely linked. Moreover, the choice of paradigm has implications on the research method chosen, the way data is collected and how the data is analysed.

3. 4 Data collection and analysis approach

A panel data analysis was performed to investigate the type of relationship that exists between the amount invested in renewable energy, the proxies for governance, economic, environmental as well as social factors, and the output thereof. As indicated earlier, proxies used in this study include the control of corruption, GDP per capita, FDI, the quality of the regulatory framework, the level of greenhouse gas emissions, the level of education as measured by the gross enrolment ratio of upper secondary pupils, the rule of law, PPP investment in energy and government effectiveness. Panel data analysis is increasingly being used by researchers (Fitriantoa & Musakkala, 2016). The data required for the quantitative research was collected from reputable databases. Panel data is defined as a method of analysing data that combines time series and cross-sectional data (Baltagi, 2013). According to Brüderl and Ludwig (2015), panel data measures two components of data which comprise time series and cross-sections. Falk, Marohn, Michel, Hofmann, Macke, Spachmann, and Englert (2012), describe time series data as outcomes that are grouped according to the period of occurrence. A cross-sectional study is a prevalent study that estimates the effect of various factors at a point in time (Kesmodel, 2018). Hurlin (2010), argues that panel data can reveal any complex relationships that exist within the data. A sampling unit with data sets consisting of various observations is panel data as defined. The use of cross-sectional data in a panel data analysis is a benefit because multiple data sets are analysed over time (Fitriantoa & Musakkala, 2016).

Furthermore, panel data is recommended for studies that explore if a relationship exists in data that is disaggregated (Fitriantoa & Musakkala, 2016). The advantage of panel data is that it allows the researcher to use large samples of various data sets and reduces the multi-collinearity of the sample units (Vijayamohanan, 2016). Besides, longitudinal data analysis can evaluate social phenomena that cannot be addressed by time series data individually (Hurlin, 2010). The application of panel data also strengthens the measurement of the relationship between the independent and dependent variables (Gil-Garcia & Puro-Cid, 2013). According to Gujarati (2003), the use of panel data analysis improves the results that may be drawn from a study. Panel data comprises various models such as the fixed-effect model and the random effect model (Wooldridge, 2012). The fixed-effect method analyses the outcome of the traits of the independent variables over time whereas the random effect model assumes that any unobservable variables are reflected by the error term (Gil-Garcia & Puro-Cid, 2013). The Hausman test is applied to interpret the results of fixed and random effects methods (Woolridge, 2002). The Hausman test assumes that the fixed-effect and random effect model yield similar estimators; thus, if the null hypothesis is rejected, the fixed-effect results are appropriate (Hausman, 1978). The probability value explains whether the model is significant. A probability value of less than 5% means that the independent variable has a significant effect on the response variable. Studies testing hypotheses usually analyse the effect of variables on each other by applying the probability values (P-values) statistical test (Saunders *et al*., 2009). According to De Smith (2015), descriptive data in the panel data analysis illustrates the mean values of the subset of the population. The descriptive statistics in this study show the central tendencies of the data being investigated. Data were obtained from the World Bank and the British Petroleum (BP) Statistics databases (World Bank, 2018; BP, 2018). Collected data include investment and output data of renewable energy which includes hydro and non-hydro power. Non-hydro power is defined as a combination of wind, bioenergy, photovoltaic and concentrated solar energy.

3.5 Description of key variables

Refer to Table 3.1 that identifies the databases from which each variable was obtained. Analysis established if an increase in investment is correlated to the units of renewable energy produced, especially in South Africa. Besides that, the study used proxies such as the control of corruption, GDP per capita, FDI, the quality of the regulatory framework, the level of greenhouse gas emissions, the level of education as measured by the gross enrolment ratio of upper secondary pupils, the rule of law, PPP investment in energy, *and* government effectiveness to establish the effect they have on renewable energy generated in selected developing countries.

Table 3:1 Databases of key variables

No.	*Proxy / Variable*	*Type*	*Measure*	*Database*
1	Amount invested in renewable energy	Independent	(US$ - million)	BP statistics
2	Renewable energy output (hydro & non-hydro)	Dependent	Terawatts	BP statistics
3	Control of corruption	Independent	Mean value	The World Bank
4	GDP per capita	Independent	(US$ - million)	The World Bank
5	FDI	Independent	% of GDP (US$ - million)	The World Bank
6	Quality of the regulatory framework	Independent	Mean value	The World Bank
7	Total greenhouse gas emissions	Independent	(Million tonnes of carbon dioxide - kt of CO2 equivalent)	The World Bank
8	Education as measured by the gross enrolment ratio of upper secondary pupils	Independent	Percentage	The World Bank
9	Rule of law	Independent	Mean value	The World Bank

10	PPP investment in energy	Independent	(US$)	The World Bank
11	Government effectiveness	Independent	Mean value	The World Bank

Source: Author

Gathering data through various ways enhances reliability and dependability (Zohrabi, 2013). Data collection instruments allow the researcher to gather the information to assess the study's objectives. This study comprises complex data and is characterised by multiple observations (272) and covers a period of 17 years from 2000 to 2016. The observations consist of one dependent variable as constituted by renewable energy output generated in selected developing countries. The proxies for the explanatory variables comprise the amount invested, the control of corruption, GDP per capita, FDI, the quality of the regulatory framework, greenhouse gases, the level of education as measured by the gross enrolment ratio of upper secondary pupils, the rule of law, PPP investment in energy, and government effectiveness in selected developing countries. Panel data is, therefore, the most appropriate approach to investigate the effect that the explanatory factors identified above have on the renewable energy that is produced in the selected developing countries. Numerous studies relating to the renewable energy field in various developing countries have employed panel data analysis (Zhao *et al*., 2013; Polzin *et al*., 2015; Gul Akar, 2016; da Silva *et al*., 2018). The researcher employed a similar approach to previous studies that have applied panel data analysis.

3.6 Model Specification

The researcher used STATA 15 software to analyse the quantitative results from the panel data of investments in the renewable energy sector. Data analysis was described by Wahyuni (2012), as a process of interpretation and derivation of conclusions from unprocessed data. The Stata software is a tool used to analyse time-series data, panel data or survival data (Rabe-Hesketh & Everitt, 2004).

The following generalised panel data regression model is proposed:

$$y_{it} = \propto + \beta X_{it} + \alpha_i + \mu_{it} \dots \dots \dots + \varepsilon_{it}$$

Where, y = the dependent variable with *i* countries and *t* time period,

X_{it} = independent variable that varies over time;

α = the unknown intercept for each variable

μ_{it} = the error associated with variables that occur between countries

ε_{it} = the error term associated with variables within each variable.

Therefore:

$$Hp_{it} = \propto_{it} + \alpha_i country\ id + \varepsilon_{it} \qquad (1)$$

Where: Hp_{it} = hydro renewable energy output; α_I = total selected developing countries; ε_{it} = error term.

The following fixed-effects equation model was applied:

$$y_{it} = \propto + \beta X_{it} + \alpha_i + \mu_{it}$$

Where, y = the dependent variable with i countries and t time period;

X_{it} = independent variable that varies over time;

α = the unknown intercept for each variable

μ_{it} = the error associated with the fixed-effects model.

Therefore:

$$Hp_{it} = \propto_{it} + \alpha_i country\ id \quad (2)$$

Where: Hpit = hydro renewable energy output; αI = total selected developing countries.

3.7 Research variables

Research variables identified in this study are explained below:

3.7.1 Dependent variable

The renewable energy produced (output) was used as the dependent variable. As demonstrated in Chapter 2, most countries continue to increase their expenditure in their effort to increase their renewable energy production. Furthermore, it is evident from the literature review in Chapter 2 that indirect measures of governance, economic, environmental and social factors such as the control of corruption, GDP per capita, FDI, the quality of the regulatory framework, the level of greenhouse gases, the level of education as measured by the gross enrolment ratio of upper secondary pupils, the rule of law, PPP investment in energy, and government effectiveness influence renewable energy output generated. Hence, it was necessary to use renewable energy output as the dependent variable to encourage countries to increase expenditure in renewable energy in the long run and motivate the consideration of appropriate enablers to stimulate the output.

3.7.2 Independent variables

Increasing the investment in renewable energy has become the key method that most countries use to respond to their commitment to the Kyoto Protocol and to reduce the greenhouse gas emissions. Other techniques that have been applied to increase renewable energy output include actively considering the impact of social, economic, governance, and environmental factors. Proxies taken into account include the control of corruption, increment in GDP per capita, openness to FDI, monitoring the quality of the regulatory framework, managing the level of CO_2 emissions, PPP investment in energy, and government effectiveness. Moreover, other nations have ensured that the level of education and the rule of law are enough to stimulate high green energy production. This motivated the researcher to investigate whether renewable energy output in selected developing countries was impacted by the amount invested as well as by indirect measures of governance, social, economic, and environmental factors.

3. 8 Population and sample size

Developing countries involved in the production of renewable energy were used as the population; they represent the total population from which a sample was drawn. Developing countries are defined by applying their economic state such as the gross national income and the level of fuel exports as a basis of measurement (World Economic Situation and Prospects, 2014). According to Polit and Hungler (1999), a population is the total or all subjects, members or objects that conform to a set of requirements. Furthermore, to be eligible, participating countries must possess the required characteristics to be included in the study being conducted. Polit and Beck (2004), defined the population as the whole or entire sum of all things conforming to a described set of requirements. The population was thus described as the total elements from which the sample was drawn.

The sample of the selected countries investigated was drawn from a population of developing countries as defined by the World Economic Situation and Prospects in 2014. The study sample consisted specifically of all developing countries which produce renewable energy that can be classified as hydro and non-hydro and for which the required data was available. The data chosen for investigation included the amount invested and proxy data such as the control of corruption, GDP per capita, FDI, the quality of the regulatory framework, the level of greenhouse gases, the level of education as measured by the gross enrolment ratio of upper secondary pupils, the rule of law, PPP investment in energy and government effectiveness. The data for countries investing in renewable energy generation is available on the World Bank website and the British Petroleum (BP) website. The data required to conduct the panel data analysis was obtained directly from the World Bank website and the British Petroleum (BP) website. This was done to narrow the research to focus on the applicability of the research problem to this sector.

A sample is the selection of a group of items or people from a large population that represents the total population (Scott & Morrison, 2006). Besides, a sample is a subgroup of a population participating in the investigation (Uys & Basson, 1991; Polit & Beck, 2004). Purposive sampling was applied in this study. Purposeful sampling allows the researcher to identify and select research subjects that will provide the best evidence. Palinkas, Horwitz, Green, Wisdom, Duan, and Hoagwood (2015), define purposive sampling as a non-probability sampling technique. According to Morse and Niehaus (2009), probability and purposive sampling methods serve the same purpose, which is to enhance the reliability of the study. Purposive sampling aims to select a sample that addresses the research problem and can be extrapolated from the population precisely (Charles & Fen, 2007). The result of selecting information-rich cases is that a comprehensive understanding of the research problem is derived from the research (Charles & Fen, 2007).

Onwuegbuzie and Collins (2007), argue that the level of extrapolation a researcher wants to apply should influence the type of sampling method chosen (Patton, 2002). It allows the researcher to choose participants with the highest level of knowledge of the research problem (Cresswell & Clark, 2011). The study strives to investigate the effect that selected enablers have on renewable energy generated by developing countries. Therefore, its sample was purposefully chosen to include only developing countries in the renewable energy sector with the desired data during the period 2000 and 2016 for the independent variables chosen. The countries selected for the purposes of this study are included in Table 3.2. Furthermore, the availability of research data for renewable investments is limited, necessitating the application of purposeful sampling.

Table 3:2 Sample of developing countries selected

Algeria	Colombia	Mexico	The Philippines
Brazil	Egypt	Morocco	South Africa
Chile	India	Pakistan	Thailand
China	Iran	Peru	Turkey

3. 9 Reliability and validity of the method and data

The data collected and the data interpretations from the perspectives of the quantitative method are viewed as valid and reliable. The data used in the study is secondary data obtained from reputable websites. Thus, it can be assumed to be reliable. The data used in the research was obtained from the World Bank database and the British Petroleum (BP) database. Data from other databases such as the International Renewable Energy Agency (IRENA) and BMI research were considered; however, the data provided in these databases was not sufficient for this study.

Reliability outlines the magnitude with which a study produces the same conclusions when replicated (Carmines & Zeller, 1979). According to Zohrabi (2013), it is necessary for the findings and data of a study to be reliable. Reliability is concerned with the dependability and whether the study may be redone, and the same results are obtained (Nunan, 1999). Data collection, which is reasonably free from error, is considered to be reliable (Fink, 2010). Validity is the reflection of the actual reality of the state of affairs. The study should correspond with reality to be viewed as reliable (Nunan, 1999). Furthermore, the results of the study should be consistent and reliable. Burns (1999), opines that the value of the study is derived from its legitimacy. Moreover, the participants and researcher need to be reliable and honest for the research to be valid (Zohrabi, 2013). Given that the researcher used secondary data that is unaltered, the data in this study can be viewed as reliable and valid.

3. 10 Ethical considerations

This study used data obtained from the websites of various institutes that publish data of countries that invest in renewable energy. The data used in the research was obtained from the World Bank database and the British Petroleum (BP) database. The data was used without alteration so that the results are reflective of the existing state. The information required for the panel data analysis was readily and publicly available on Internet websites. Hence, the researcher did not require ethical clearance from the Turfloop Research Ethics Committee (TREC).

3.11 Summary of the chapter

This chapter discussed the methodology used in this study. The primary aim of this study is to examine the impact of governance, economic, environmental, and social factors on the level of renewable energy that is produced in the selected developing countries. Panel data for the sixteen developing countries selected were tested for the period 2000 to 2016. Therefore, the quantitative method was employed to analyse the data and examine the research hypothesis. Sixteen developing countries were selected due to the unavailability of consistent renewable energy data. Lastly, panel data regression analysis was used to analyse data. The next chapter presents descriptive statistics, the correlation matrix of variables, random and fixed-effects models, and the Hausman test.

CHAPTER FOUR: DATA ANALYSIS AND INTERPRETATION

4.1 Introduction

The preceding chapter discussed the research methodology on which this study is based. This chapter outlines the analysis of the data collected to respond to the research problem and the research hypothesis presented in Chapter One. Additionally, the chapter discusses the statistical and non-statistical approaches used to analyse the data. According to the researcher's knowledge based on literature reviewed, there is insufficient evidence of prior studies that examine the relationship between the amount invested in and the renewable energy output that is generated in the South African context. Furthermore, the effect of proxies for governance, economic, environmental and social factors such as the control of corruption, the level of GDP per capita, the level of FDI, the quality of the regulatory framework, the level of greenhouse gases, the level of education as measured by the gross enrolment ratio of upper secondary pupils, the rule of law, PPP investment in energy and government effectiveness has been inadequately explored. This study seeks to hopefully contribute to the knowledge that exists on this subject. Section 4.2 describes the descriptive statistics and Section 4.3 explains the empirical evidence from the study. Lastly, Section 4.4 presents the results drawn from the study followed by Section 4.5 which summarises this chapter.

4. 2 Descriptive Statistics

The study relies on the dataset from sixteen selected developing countries to investigate influencing factors and enablers in renewable energy generation. The dataset was standardised, and the key variables include: hydropower, non-hydro renewable energy, investment in hydropower, investment in non-hydro renewable energy, GDP, PPP investment in energy, girls-boys' enrolment ratio for upper secondary school, total carbon-dioxide emissions, FDI, control of corruption, regulation quality, government effectiveness and the rule of law. The dataset was panelised as strongly balanced, and the scope is 2000 to 2016.

Table 4.1 reports the earlier mentioned key variables: observations, means, standard deviations and their range (minimum and maximum).

Table 4. 1: Descriptive statistics of key variables (2000-2016)

Variable	Obs	Mean	Std. Dev.	Min	Max
Hp	272	81.84552	179.2095	0.054	1153.269
Nhe	272	10.16419	36.17637	0	360.8918
Ih	272	81.84552	179.2095	0.054	1153.269
Inhre	272	11.59835	36.0009	0	360.8918
lgdp	272	8.146101	0.828086	6.084191	9.676675
PPPIE	272	1.71e+09	4.00e+09	0	2.96e+10
GBRr	272	27.13583	38.35581	0	120.2819
TCDE	272	709.8426	1733.261	24.12565	9206.508
FDI	272	2.634623	1.982801	-.3240121	11.34033
Coc	272	-0.2650656	0.5373774	-1.087391	1.592268
Rq	272	-0.058713	0.6526462	-1.72011	1.538509
Ge	272	0.009697	0.4505273	-.963841	1.275488
Rle	272	-0.2490185	0.5309316	-1.211336	1.43314

Source: Author

Note: Hp = hydropower, Nhe = non- hydro renewable energy, Ih = Investment in hydropower, Inhre = investment in non-hydro renewable energy, lgdp = log GDP, PPPIE = public private partnership investment in energy, GBRr = girls-boys' enrolment ratio for upper secondary school, TCDE = total carbon-dioxide emission, FDI = foreign direct investment, Coc = control of corruption, Rq = regulation quality, Ge = government effectiveness, Rle = rule of law.

The descriptive statistics in Table 4.1 consist of 272 observations for the period 2000 to 2016 in the sixteen developing countries selected. As illustrated in Table 4.1 above, on average, 81% of the total renewable energy produced consists of hydropower. A significant portion of the countries included in the sample generate hydropower, and, as such, the significantly high mean value is within the researcher's expectation. The mean value of non-hydroelectricity is 10%, which is significantly low. The average investments in hydroelectricity and the level of greenhouse gas emissions are significantly higher. This implies that most of the countries in the sample have high levels of greenhouse gas emissions and invest in hydro renewable energy. Generally, the selected developing countries have considerable negative effects on the level of investment in non-hydro renewable energy, GDP, the level of PPP investments in energy, girls' and boys' enrolment ratio for higher secondary school, the level of foreign direct investment, control of corruption, regulatory quality government effectiveness and the rule of law. The standard deviation measures dispersion from the mean value. Hydropower, the level of total greenhouse gas emissions, FDI, and the level of investment in hydropower is significantly dispersed from the mean value. The countries selected, therefore, have significantly varying levels of investment in hydropower, FDI and total greenhouse gas emissions.

On the other hand, non-hydro power, the related investment in non-hydro power, girls-boys' enrolment ratio for upper secondary school, control of corruption, regulatory quality, government effectiveness, and the rule of law are closely related to the central tendency. The minimum values within the data range are as low as 0 and range up to a maximum value of 9206. As outlined in the literature review, this study seeks to explore the effect that various factors have on renewable energy.

4. 3 Empirical Evidence

First, the estimation focuses on selected developing countries; the analysis distinguishes between hydropower and non-hydro renewable energy. The developing countries have a significant negative impact on both hydropower and non-hydro renewable at the 99 percent confidence level of significance.

Table 4. 2: Overview of countries with hydro and non-hydro power

	(1)	(2)
	Hp	Nhe
VARIABLES	Hp	Nhe
country_id	-14.65***	-1.85***
	(2.19)	(0.46)
Constant	206.39***	25.85***
	(21.14)	(4.48)
Observations	272	272
R-squared	0.14	0.06

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4.2 reveals that overall, for the selected developing countries, there is a highly significant negative impact on hydropower and non-hydro renewable energy output. The portion of hydropower is significantly high (2.19) while non-hydro renewable energy is (0.46) relatively small. The results in the table have a p-value of less than 1%. Thus, the level of hydropower and non-hydro power is significantly affected by the state of the countries.

Table 4. 3: Hydro and non-hydro power - Standard regression, fixed-effects and random effects

	(1)	(2)	(3)	(4)
	beta_Nhe	fe_Nhe	re_Hp	re_Nhe
Variables	Nhe	Nhe	Hp	Nhe
Ih	0.01**	0.00		0.00
	(0.00)	(0.01)		(0.00)
Inhre	0.98***	1.00***	1.46***	0.99***
	(0.01)	(0.01)	(0.06)	(0.01)
Lgdp	-0.37	0.26	8.57**	0.19
	(0.30)	(0.36)	(4.17)	(0.32)
PPPIE	-0.00	-0.00	0.00**	-0.00

	(0.00)	(0.00)	(0.00)	(0.00)
GBRr	-0.01	-0.02***	-0.15***	-0.02***
	(0.01)	(0.00)	(0.05)	(0.00)
TCDE	0.00	0.00	0.07***	0.00
	(0.00)	(0.00)	(0.00)	(0.00)
FDI	0.25**	0.01	-2.07**	0.06
	(0.11)	(0.08)	(0.96)	(0.08)
Coc	3.25***	0.05	11.47	0.87
	(0.74)	(0.76)	(8.87)	(0.71)
Rq	-2.72***	-1.69**	8.83	-1.94***
	(0.47)	(0.73)	(8.46)	(0.62)
Ge	-3.44***	-0.89	-10.95	-1.43
	(0.90)	(0.93)	(10.86)	(0.89)
Rle	2.76***	2.18***	23.11**	2.43***
	(0.86)	(0.79)	(9.14)	(0.74)
Constant	2.19	-2.87	-36.84	-2.23
	(2.40)	(2.75)	(35.52)	(2.49)
Observations	272	272	272	272
R-squared	0.99	1.00		
Number of country_id		16	16	16

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Second, Table 4.3 presents estimation results using Standardised regression, fixed and random effects models. For a standardised regression result, the effect of covariates on hydroelectric power reveals different results. In this result, the researcher is interested in the determinant of hydropower and non-hydro renewable energy. In Column 1, the principal argument is that some factors such as the GDP, girls-boys' enrolment ratio for upper secondary school, PPP investment in energy, regulation quality, and government effectiveness have a negative impact. In contrast, other mentioned factors have a positive impact on non-hydro renewable energy using standardised ordinary least squares. Among the factors that negatively influence the production of renewable energy, regulatory quality, and government effectiveness have a highly significant impact, with a 99% confidence level that the independent variable will affect the dependant variable.

Investment in non-hydro renewable energy, the rule of law and control of corruption have a positive impact with a p-value less than 0.01 on the production of clean energy. Investment in hydroelectricity and FDI have a p-value of less than 0.05, which has a less significant effect on non-hydro renewable energy. The other factors too have an insignificant correlation to non-hydro renewable energy output. In contrast to investments in renewable energy, investments in non-hydro power and FDI, the unit change in the production of non-hydro power is significantly lower than the unit change that occurs when there is a change in the control of corruption (3.25%) and the rule of law (2.76%). A unit change in the rule of law, however, causes a 23.11% change in the hydropower that is generated. Comparably, a unit change in GDP causes an 8.57% change in the production of hydropower.

In using fixed-effects and random effects techniques, factors such as investment in non-hydro renewable energy, GDP, PPP investment in energy, total carbon dioxide emissions, and the rule of law have a positive impact on hydropower and non-hydro renewable energy. The results in Column 2 reveal that investments in non-hydro renewable energy and the rule of law have a considerably high correlation to the non-hydro renewable energy that is generated. This is supported by the significant P-value that is less than 0.01. Conversely, the girls-boys' enrolment ratio for upper secondary school and regulatory quality negatively impacts the production thereof.

This relationship between the girls-boys' enrolment ratio for upper secondary school as well as regulatory quality of renewable energy and the energy output produced is statistically significant with p-values less than 0.01 and 0.05, respectively.

Column 3 discusses the random effect results of the effect of the selected independent variables on hydropower. Factors such as girls-boys' enrolment ratio for upper secondary school and FDI have a considerable negative impact on hydropower using the random effects technique. The girls-boys' enrolment ratio for upper secondary school has a substantially significant influence on hydro renewable energy generated at a p-value less than 0.01. Regulatory quality strongly influences the production of hydropower at a significant level lower than 0.05. In contrast, the rule of law, total carbon dioxide emissions, PPP investment in energy, GDP, and investments in non-hydro renewable energy positively affect the production of hydropower. The p-values for these variables reflect the existence of a significant relationship. Total carbon dioxide emissions and investments in renewable energy have a p-value that is less than 0.01.

Column 4 shows the random effect of the selected independent variables on the generation of non-hydro renewable energy. Investments in non-hydro renewable energy and the rule of law have a significant positive influence on the production of non-hydro renewable energy at more than the 99% confidence level. In contrast, regulatory quality and the girls-boys' enrolment ratio for upper secondary school is negatively correlated to the generation of non-hydro renewable energy. The relationship between the variables is considerably higher at a p-value less than 0.01.

A standardised regression model, fixed-effects and random effects models were used to ensure the robustness of the results of the relationship between the independent variables and non-hydro power. In some instances, the models produced mixed correlation results and differing levels for the significance of the relationship between variables. The researcher considered the results with the same correlation results among the three models to be the most appropriate.

The correlation matrix is presented in table 4.4.

Table 4. 4: Correlation matrix

	Ih	Inhre	Rle	Ge	Rq	Coc	FDI	TCDE	GBRr	PPPIE
Ih	1									
Inhre	0.8303	1								
Rle	-0.053	0.0095	1							
Ge	0.0393	0.0831	0.8613	1						
Rq	-0.0335	0.0374	0.7579	0.7892	1					
Coc	-0.0183	0.0266	0.8585	0.7958	0.7683	1				
FDI	0.0847	0.0005	0.5118	0.5063	0.5957	0.5666	1			
TCDE	0.8644	0.7255	-0.0905	0.054	0.1102	-0.0956	0.0347	1		
GBRr	0.1818	0.3088	0.085	0.1838	0.1441	0.048	0.0759	0.1341	1	
PPPIE	0.3284	0.2429	0.0724	-0.0109	0.018	-0.0075	-0.0028	0.1073	0.1823	1
lgdp	*0.1424*	*0.1484*	*0.2916*	*0.4418*	*0.4497*	*0.4788*	*0.3301*	*-0.0011*	*0.4833*	*0.0951*

The analysis reveals that most variables have an insignificant relationship with one another. On the other hand, the rule of law is strongly correlated to government effectiveness, control of corruption and regulatory quality. Similarly, government effectiveness is significantly interrelated with regulatory quality and the control of corruption. Regulatory quality is also strongly correlated to the control of corruption. The correlation between these factors is expected; they are all measured with a mean value in the data set. Total carbon dioxide emissions are also strongly correlated investments that are made in hydro and non-hydroelectricity.

Table 4. 5: Hydro and non-hydro power - Random effects

VARIABLES	(1) Hp_re Hp	(2) Nhe_re Nhe
Inhre	2.41***	0.99***
	(0.08)	(0.01)
Lgdp	12.90**	-0.93***
	(5.23)	(0.25)
Ih		0.01**
		(0.00)
Constant	-51.16	5.73***
	(44.51)	(2.13)
Observations	272	272
Number of country_id	16	16

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4.5 above shows a random effect technique. It shows that some selected variables, such as investment in hydro renewable energy, have a significant positive effect on hydropower and non-hydro renewable energy. The GDP has a positive influence on hydropower and a negative effect on non-hydro renewable energy. The positive effect is significant at a p-value of less than 0.05, while the negative impact is significantly high, with a p-value of less than 0.01. A unit change in investments in non-hydropower will result in a 2.41% and 0.99% change in the hydro and non-hydro power produced, respectively. Investments in non-hydroelectricity are positively linked to both non-hydro and hydroelectricity generation at a p-value of 0.01; this shows that these variables have a significant influence on the dependent variable.

Similarly, investments in hydropower have a substantial positive effect on the production of non-renewable energy with a p-value that is significant and less than 0.05. On the other hand, GDP causes a 12.90% and -0.93% change in hydropower and non-hydro power, respectively, when there is a change in one unit. The change in non-hydro power is, however, very minimal whenever there is a change in investments in hydropower.

Table 4. 6: Hydro and non-hydro - Fixed effects

VARIABLES	(1) Hp_fe_1 Hp	(2) Nhe_fe_1 Nhe
Inhre		1.00***
		(0.00)
Lgdp	81.91***	-0.87***
	(9.38)	(0.26)
Constant	-585.43***	5.61***
	(76.51)	(2.11)
Observations	272	272
R-squared	0.23	1.00
Number of country_id	16	16

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4.6 above shows a fixed-effect technique. Using some specific variables, it is evident that an investment in hydro renewable energy has a significant positive effect on non-hydro renewable energy. The GDP has a positive influence on hydropower and a negative effect on non-hydro renewable energy. All independent variables are substantially correlated to hydropower and non-hydro power with a confidence level that is more than 99%. The change per unit of GDP causes an 81.91% change in the hydropower that is produced, GDP thus, significantly influences hydropower production. Despite the positive relationship between investments in renewable energy and non-hydro power, a change in the investment has a minimal effect on the output of non-hydro power. A unit change in GDP, however, results in a 0.87% negative change in the non-hydro power that is generated.

Table 4. 7: GDP analysis of hydro and non-hydro power

VARIABLES	(1) Hp_1 Hp	(2) Nhe_1 Nhe	(3) Hp_c Hp	(4) Nhe_c Nhe
Lgdp			81.91***	
			(9.38)	
Algeria	-44.21	-1.13	59.24**	-1.13
	(27.04)	(10.08)	(25.53)	(10.08)
Brazil	311.90***	29.07***	361.40***	29.07***
	(27.04)	(10.08)	(23.98)	(10.08)
Chile	-21.97	2.86		2.86
	(27.04)	(10.08)		(10.08)
China	572.42***	86.26***	686.48***	86.26***
	(27.04)	(10.08)	(26.00)	(10.08)
Colombia	-3.19	-0.28	79.79***	-0.28
	(27.04)	(10.08)	(24.77)	(10.08)
Egypt	-30.92	-0.14	119.00***	-0.14
	(27.04)	(10.08)	(27.92)	(10.08)
India	62.26**	29.03***	272.90***	29.03***
	(27.04)	(10.08)	(32.12)	(10.08)
Iran	-33.03	-0.96	57.64**	-0.96
	(27.04)	(10.08)	(25.03)	(10.08)
Mexico	-14.04	0.99	15.27	0.99
	(27.04)	(10.08)	(23.78)	(10.08)
Morocco	-42.87	-0.98	93.89***	-0.98
	(27.04)	(10.08)	(27.16)	(10.08)
Pakistan	-16.57	-0.86	197.39***	-0.86
	(27.04)	(10.08)	(32.37)	(10.08)
Peru	-24.45	-1.00	71.81***	-1.00
	(27.04)	(10.08)	(25.24)	(10.08)
The Philippines	-35.69	1.26	125.84***	1.26
	(27.04)	(10.08)	(28.64)	(10.08)
South Africa	-42.89	0.23	28.90	0.23
	(27.04)	(10.08)	(24.44)	(10.08)
Thailand	-38.10	-0.26	57.80**	-0.26
	(27.04)	(10.08)	(25.23)	(10.08)
Turkey			35.59	
			(23.82)	
Constant	44.43**	1.16	-726.87***	1.16
	(19.12)	(7.13)	(87.41)	(7.13)
Observations	272	272	272	272
R-squared	0.82	0.38	0.86	0.38

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4.7 above shows the analysis of GDP on hydropower and non-hydro renewable energy. The study generate country dummy variables, as mentioned earlier the GDP has a positive influence on hydropower for some selected countries such as Brazil, China, and India. Dummy variables highlight the effect of categorical variables on research (Yip & Tsang, 2014). A change in one unit of GDP results in significant changes in the level of hydro energy that is produced in Brazil, China, and India. On a country-specific basis, the GDP has a significant positive effect on hydropower produced in countries such as Algeria, Egypt, China, Colombia, Egypt, India, Iran, Morocco, Pakistan, Peru, the Philippines, and Thailand. Similarly, GDP has a positive impact on the non-hydro power produced in selected countries such as Brazil, China, and India. The influence of GDP is considerably strong in most of the countries mentioned above; the p-values reflect a strong correlation at a confidence level that is greater than 99% ($p<0.01$). Furthermore, on a country by country basis, the results show that China's hydropower experiences a tremendous change amounting to 686.48% when there is a change in one unit of GDP. Likewise, the remaining countries with significant relationships between the GDP and hydropower have been identified. Thus, the change in the output per unit ranges from a lower end of 59.24% to as high as 361.40%.

In contrast, the movement in GDP for each country has a significantly lower effect on non-hydro energy output. For every unit change in GDP, the effect on the output ranges from a minimum of 29.03% to a maximum of 86.26%. Nevertheless, again, a movement in the GDP of China has the most significant impact on the non-hydro power produced, output increases by 86.26% when GDP changes by one unit. The non-hydro power output for Brazil and India is affected similarly by a move in GDP; a unit change causes a positive movement in the non-hydro electricity output that amounts to 29.07% and 29.03%, respectively.

Table 4. 8: Hydro and non-hydro power - Random effects

Variables	(1) Hp_re_1 Hp	(2) Nhe_re_1 Nhe
Inhre	1.45***	1.00***
	(0.06)	(0.01)
Lgdp	8.33**	0.26
	(4.24)	(0.36)
PPPIE	0.00*	-0.00
	(0.00)	(0.00)
GBRr	-0.15***	-0.02***
	(0.05)	(0.00)
TCDE	0.07***	0.00
	(0.00)	(0.00)
FDI	-2.10**	0.01
	(0.95)	(0.08)
Coc	11.59	0.05
	(8.91)	(0.76)
Rq	8.46	-1.69**
	(8.60)	(0.73)
Ge	-8.05	-0.89
	(10.86)	(0.93)
Rle	25.01***	2.18***
	(9.17)	(0.79)
Algeria	8.76	2.91***
	(13.07)	(1.11)
Brazil	270.58***	3.70**
	(8.48)	(1.64)
Chile	-46.55***	3.94***
	(17.53)	(1.51)
China	16.35	2.17
	(24.48)	(2.09)
Colombia	40.22***	4.82***
	(9.00)	(0.80)
Egypt	15.71	4.22***
	(11.84)	(1.01)
India	-42.37***	2.71**
	(14.37)	(1.25)
Iran	0.11	2.38*
	(15.89)	(1.35)
Mexico	-15.96*	-2.41***
	(8.36)	(0.72)
Morocco	-5.04	2.56***
	(9.01)	(0.77)
Pakistan	46.37***	2.75**

	(15.57)	(1.35)
Peru	23.05**	4.54***
	(10.61)	(0.91)
The Philippines	0.30	-3.74***
	(10.74)	(0.92)
South Africa	-48.56***	5.33***
	(7.64)	(0.70)
Thailand	-20.25**	1.27*
	(7.88)	(0.68)
Turkey	-	-
Ih		0.00
		(0.01)
Constant	-49.60	-5.19*
	(36.63)	(3.13)
Observations	272	272
Number of country_id	16	16

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Computed by the Author

Table 4.8 above shows the analysis of investments in non-hydro power, GDP, PPPs investment, girls-boys' enrolment ratio for upper secondary school, the level of total greenhouse gas emissions, FDI, control of corruption, regulatory quality, government effectiveness and the rule of law on hydropower and non-hydro renewable energy using random effect techniques. The table further explores the aggregate effect of the variables noted above on the generation of hydropower and non-hydro power for all the selected developing countries. Investments in non-hydro power, the level of total carbon dioxide emissions, and the rule of law have a significantly high positive effect on the generation of hydropower. Likewise, the GDP has a material positive impact on the generation of hydropower. The analysis reveals that the relationship that exists between PPPs investment and investments made in hydropower is immaterial. The girls-boys' enrolment ratio for upper secondary school and FDI have a direct significant negative effect on the generation of hydropower at confidence levels greater than 99% and 95%, respectively. The aggregate effect of the independent variables on the production of hydropower is positive and significant for Brazil, Columbia, and Pakistan. Conversely, the aggregate variables have a strong negative correlation with hydropower generation in Chile, India, and South Africa. The results for Mexico, on the other hand, show that these independent variables do not affect the level of hydropower that it produces. The p-value for Mexico is more significant than 0.05 and, therefore, shows an insignificant relationship. The predictors are positively linked to the generation of hydropower in Thailand. The relationship is significant at a confidence level greater than 95%. Non-hydroelectricity is influenced positively by investments in non-hydro renewable energy and the rule of law. A unit change in the rule of law and investments in non-hydro power is expected to result in a 1% and 2.18% change in the non-hydroelectricity, respectively. While, on the contrary, girls-boys' enrolment ratio for upper secondary school and regulatory quality have a significant negative impact on the production of non-hydroelectricity. The p-values reflect a significant relationship at the 99% and 95% confidence level for girls-boys' enrolment ratio for upper secondary school and regulatory quality, respectively. The predicted values have a positive effect on non-hydro electricity generated in all the selected countries, except for Iran, Mexico, the Philippines, and Thailand. The correlation between the independent and dependant variables is negative and material at a confidence level greater than 99% for the Philippines and Mexico. An insignificant positive relationship exists between the variables when applied to Thailand and Iran. The p-value of Thailand and Iran is less than 0.01 and therefore has an immaterial effect on non-hydro power.

4.4 Discussion of Results

The above section outlines the descriptive statistics, model specifications, empirical evidence, in addition to the analysis of the results. This section discusses the applicability of the empirical evidence derived to the hypotheses being tested in the study:

H_1: Dollar amount invested influences the volume of renewable energy output generated in selected developing countries.

The regression results of this study for both fixed-effects and random effects indicate that there is a positive, highly significant relationship between the amount invested and the output of hydro and non-hydro energy that is produced. The random effect results further reveal that investments in hydropower significantly and positively influence the non-hydro energy that is generated at the 95% confidence level. Similar studies previously conducted argue that a positive relationship exists (Konstantinos & Kolybiris, 2012; Liebreich, 2012; Michi & Takashi, 2013; REN21, 2015; UNEP, 2016; Liebreich, 2017). Likewise, Brunnschweiler (2010), opines that the availability of funding influences the production of renewable energy. Furthermore, the study by Wustenhagen and Menichetti (2012), revealed that the lack of funding has a negative influence on the generation of renewable energy. This implies that the majority of the funding necessary in a renewable energy project is required at the beginning of the project, and after that, the cost drops (McDaid, 2016). This means that once the initial investment is made, the funds invested after that yield output.

Bheket and Harun (2017), in contrast, posit that there is a positive relationship between the output and the amount invested that is bilateral. In agreement with the results drawn in this study, Scarlat *et al*. (2015), opine that renewable energy technologies are not progressing because they lack the necessary financial and technical assistance. Nations worldwide have or intend to increase their investments in renewable energy in meeting their clean energy targets and thereby reduce greenhouse gas emissions and counter the electricity crisis faced (IRENA, 2014). The pressure to curb the emissions and resolve the electricity crisis is motivating nations to produce as much as possible with every investment made in renewable energy. Thus, H_1 is accepted, hence, the study concludes that there is a relationship between the amount invested in renewable energy and the output thereof in the selected developing countries.

H_2: Governance factors influence the volume of renewable energy output generated in selected developing countries

Control of corruption

The results of this study reveal that a significant positive relationship exists between control of corruption and non-hydro power output. This finding is consistent with the conclusions drawn by other researchers (Bellakhal *et al*., 2017; Mahmud *et al*., 2018). In support of this finding McEwan (2017), contends that the South African REIPPPP was successful because it was free of corruption. Corruption reduces the attractiveness of a project, thereby lowering investments (Davoodi & Tanzi, 2000; Sumah, 2018) while renewable energy projects require significant start-up capital (McDaid, 2016). Corruption can thus reduce investments in renewable energy which subsequently affects the output produced. In support of the results of this study, Fouinhas and Marques (2013), argue that the significant difficulty faced by the energy sector is corruption. Mahmud, Jamasb and Llorca (2018), found similar results that indicate that control of corruption influences the rate that renewable energy is produced. The results further suggest that an insignificant positive relationship depicted by a confidence level of below 90% exists between the control of corruption and the production of hydropower. This finding is also consistent with the results of previous studies. Accordingly, the study accepts this hypothesis that control of corruption influences the production of renewable energy.

Regulatory quality

Results derived in this study illustrate that regulatory quality has a strong negative effect on the production of non-hydro power. Besides, Komendantova (2009), contends that robust regulations are necessary for the advancement of renewable projects. Zhao *et al*. (2010), found that a positive causal relationship exists between regulations that are enacted and the level of renewable energy produced. Barradale (2010), contends that constant changes to regulations render renewable energy projects infeasible. China continues to revise its renewable energy regulations in an attempt to improve the production of clean energy and improve the viability of its projects (Zhao et al., 2010). South Africa improved the production of renewable energy through the enactment of REIPPPP (Walwyn & Brent, 2015). Despite its success, the REIPPPP legislation has also been criticised for containing clauses that slow down the growth of green energy production (Msimang & Sebitotsi, 2014; Eberhard, 2014). On the contrary, there is weak positive evidence that regulatory quality influences the production of hydropower. According to the results, H_5 is accepted. Hence, the conclusion is that the quality of regulation influences the amount of non-hydropower produced.

The rule of law

Results of this study indicate a strong positive correlation between the rule of law and the production of hydropower and non-hydro power. The correlation is at a 95% and 99% confidence level for hydropower and non-hydro power, respectively. South Africa enacted various Acts in a bid to improve its renewable energy; however, most of them failed due to the failure to sign contracts or enforce them (Eberhard, 2014). On the other hand, the REIPPPP Act successfully increased the level of renewable energy produced as contracts signed were honoured by a majority of the Independent Power Producers. China, the leading renewable energy producer, has made green energy development a national priority and has enacted various legislations to support the initiation and execution of renewable energy production contracts (Zhao *et al.*, 2010; Kurkoti, 2016). This study, therefore, accepts H_8 and concludes that there is a positive correlation between the rule of law and hydropower output.

The effectiveness of governance by government

The outcome of this study indicates that a significant negative relationship exists between the effectiveness of governance by government and the production of non-hydro power output. Contrary to the results of this study, Puig and Morgan (2013), contend that supportive government policies are the key drivers of renewable energy production. Likewise, Zhao *et al*. (2011), opine that the enactment of adequate policies is positively correlated to the investment that is made in renewable energy. China continuously monitors its policies and amends them to ensure that they continue to stimulate renewable energy production (Zhao et al., 2010). Renewable energy production was impacted when the government of Norway significantly reduced its support policies (White et al., 2013). The researcher, therefore, accepts H_9 and concludes that government effectiveness influences the production of non-hydro power. Additionally, further research should be conducted, as previous studies (Martinot, 2004; Black *et al*., 2014; Sherzod, 2016) have identified contradictory evidence.

H_3: Economic factors influence renewable energy output generated in selected developing countries

Gross domestic product (GDP) per capita

The random effect results of the study show that there is a significant positive relationship at the 95 per cent confidence level between the value of the GDP and hydropower output. On the other hand, the GDP has a significant negative relationship with non-hydro power at the 99 percent confidence level. The fixed-effects analysis shows similar results to the random-effects model except for the relationship between hydropower and GDP that is identified as significant at the 99 percent confidence level. On a country by country basis, the GDP has been identified as a significant positive driver of hydropower generation in all the selected countries, except for Chile, Mexico, South Africa and Turkey. GDP only has a significant positive effect on the production of non-hydro power in Brazil, China and India. Likewise, Popp, Hascic and Medhi (2011), argue that GDP has a positive cause and effect relationship with renewable energy production.

Similarly, Perticas *et al*. (2017), argue that the level of renewable energy in China is significantly influenced by economic growth. Pohl and Mulder (2013), supplement this argument by noting that economic growth, as measured by GDP, promotes the generation of renewable energy. York and McGee (2017), also contend that a positive correlation exists between the GDP per capita and renewable energy produced. According to Ayres and Voudouris (2014), sufficient energy is required to enable economic growth. In support of this argument, Lee and Lee (2010), contend that a bidirectional relationship exists between GDP and renewable energy. The researcher, therefore, accepts this hypothesis that the GDP influences the production of renewable energy in the selected developing countries.

The amount of foreign direct investment

The outcomes of this study show that FDI has a significant positive effect on the generation of non-hydro power. The results further show that FDI negatively impacts the production of hydropower at the 95 percent confidence level. Ilaria and Roland (2015), argue that foreign investment stimulates the generation of both non-hydro power and hydropower. Likewise, the Department of Energy (2015), contends that foreign expenditure can be used to promote the generation of renewable energy. Results obtained by the Department of Energy (2015) and Ilaria and Roland (2015), support the finding in this study that foreign investments have a positive cause and effect relationship on the generation of non-hydro power.

On the other hand, the results of this study that indicate that there is a negative causality between direct foreign expenditure and hydropower production are not justified by the arguments made in previous studies. According to Latief and Lefen (2019), Pakistan implemented different stimulants within its energy policy to influence the level of foreign investment in the renewable energy sector. The choice of the type of renewable energy to invest in is influenced by the policy mechanisms as well. Therefore, the researcher accepts H_4 and concludes that the amount of FDI significantly influences the non-hydro power generation positively and has a negative impact on hydropower generation.

The results of both proxies for economic factors examined indicate that economic indicators influence the output of renewable energy in the selected developing countries. Policymakers are, therefore, encouraged to consider the effect of GDP and FDI when making policies relating to energy sustainability.

H_4: Environmental factors influence renewable energy output generated in selected developing countries.

The level of total greenhouse gas emissions

The random-effects model applied in this study finds a strong positive relationship between the level of the total carbon dioxide emissions and the hydropower generated. Zhao *et al.* (2010), contend that excessive greenhouse gas emissions in China were a key driver in the progression of renewable energy production. According to REN21 (2017), global warming, which is mainly caused by greenhouse gas emissions, can be reduced by the increment of renewable energy production and usage. Despite South Africa being part of the top 20 emitters of greenhouse gases, a significant portion of its energy needs are still met through coal-generated electricity (Dippenaar, 2018). In response to the Kyoto Protocol, most countries, including South Africa, are increasing their renewable energy generation to reduce greenhouse gases (Begg, van der Woerd & Levy, 2005). Previous research has demonstrated that an increase in CO_2 emissions is likely to increase renewable energy produced.

Thus, H_4 is accepted, and the study concludes that the level of greenhouse gas emissions, an indirect measure of the effect of environmental factors, influences hydropower production.

H_5: Social factors influence renewable energy output generated in developing countries.

The level of education as measured by the gross enrolment ratio of upper secondary pupils

The results of this study are inconsistent with conclusions reached by other researchers. The outcome of the study shows that a significant negative causal relationship between the level of education as measured by the gross enrolment ratio of upper secondary pupils and hydropower, as well as non-hydro power output, exists. According to the International Labour Office (2011), the transition to a green economy depends on the energy sector committing to improve the skills base in the renewable energy sector. The Department of Energy (2015), contends that renewable energy generation can be enhanced by improving the standard of education. Similarly, a report by IRENA (2011), opined that critical jobs in the renewable energy sector required specialised skills.

The hypothesis is, therefore, accepted; however, further studies need to be conducted as previous studies (see Chapter 2, section 2.9:p54) have proven that a differing relationship exists between social factors as measured by the proxy above and renewable energy output.

4.5 Summary of the chapter

This chapter outlined the results of the study. The results showed that in addition to the level of the amount invested, other considerations such as governance, economic, environmental, and social factors have an impact on the level of renewable energy that is produced in the selected developing countries. Proxies tested demonstrated that governance, economic, environmental, and social factors may have a positive or negative impact on renewable energy generation that is significant or insignificant in other instances. The objectives of the study have, therefore, been achieved: a relationship exists. The next chapter presents the summary, conclusions, and recommendations based on this study. It discusses the objective of the study and how the objective is addressed.

CHAPTER FIVE: SUMMARY, CONCLUSIONS AND RECOMMENDATION

5.1 Introduction

The previous chapter discussed the statistical and non-statistical approaches used to analyse the research data. The chapter also discussed the data analysis and the results of the study. This chapter outlines the summary, conclusions, and recommendations based on this study. It states the objective of the study and explains how the objective is addressed. Section 5.2 summarises of the study; Section 5.3 outlines the conclusions reached based on the results of the study, and Section 5.4 discusses the limitations of the study, followed by an outline of limitations of the study. A summary of the study's contributions follows in Section 5.4 and Section 5.5 gives recommendations. Section 5.7 discusses the anticipated future research before ending with concluding remarks (section 5.8).

5. 2 Summary of the study

The objective of this study was to establish what type of relationship exists between the dollar amount invested and the renewable energy generated (output) in selected developing economies. Furthermore, the study examined if social factors, economic factors, governance factors, and environmental factors influence the renewable energy output in selected developing countries. The study found that the dollar amount invested in addition to social, environmental, economic and governance factors impact on the production of hydropower and non-hydro power. Proxies used to measure these factors include the control of corruption, GDP per capita, FDI, the quality of the regulatory framework, the level of greenhouse gas emissions level, the level of education as measured by the gross enrolment ratio of upper secondary pupils, the rule of law, PPP investment in energy and government effectiveness. Panel data comprising multiple observations (272) for sixteen selected developing countries for 17 years from 2000 to 2016 were used in this study.

Amount of dollars invested.

The results of the panel data analysis conducted show that the dollar amount invested positively influences the level of hydropower and non-hydro power produced. The results imply that an increase in the dollar amount invested is crucial for improving renewable energy output. Similarly, UNEP (2017), found that an increase in the amount invested has an incremental effect on the renewable energy output. Bheket and Harun (2017), however found that a bi-directional relationship exists between capital invested and renewable generated. South Africa also experienced substantial growth in its renewable energy sector due to the increased investment (Greencape, 2019). Efforts by nations to increase the target amount of dollar invested are, therefore, commendable as they are likely to yield improved renewable energy output.

Economic factors

The study found that economic factors may have a negative or positive effect on renewable energy generation. The study achieved its objective: a relationship does exist between economic indicators and renewable output. Policymakers are therefore encouraged to consider the effects of these factors when deciding on which stimulants to apply. The results showed that the GDP, an economic measure, had a positive association with hydropower while it had a negative correlation to non-hydro power production. This evidence shows that the GDP affects both non-hydro power and hydropower in a contrary manner. York and Mcgee (2017), found a positive relationship between GDP and renewable energy produced. Likewise, Grabara, Tleppayev, Dabylova, Mihardjo, Dacko-Pikiewicz (2021), found that economic growth positively impacts renewable energy production. Contarily, Can and Korkmaz (2019), argue that there is a negative relationship between economic and renewable energy. A bi-directional relationship was found between GDP and renewable energy (Marinaş *et al*., 2018). This provides evidence that during different periods of economic growth the specific growth period determines whether hydropower or non-hydro power should be produced. Another economic factor considered was foreign domestic investment: the relationship with non-hydro power production is positive; however, the link with hydropower output is negative. These results indicate that an increase in FDI boosts non-hydro power generation, however, causes hydropower production to decrease. Besides, results indicate that depending on the movement in FDI, investment in either hydropower or non-hydro power should be considered. Illaria and Rolland (2015), contend that renewable energy infrastructure that enables the production of renewable energy can be enhanced by FDI. According to Grabara, Tleppayev, Dabylova, Mihardjo, Dacko-Pikiewicz (2021), a positive relationship exists between FDI and renewable energy output. Additionally, a negative causal relationship was identified between PPPs investment and non-hydro power output, while the impact on hydropower is significantly positive. According to Nel (2018), PPPs have a positive effect on the transformation of the renewable energy sector. These results reflect the exclusion of the private sector by governments in the energy sector. The World Bank (2020), states that the inclusion of the private sector played a key role in boosting the renewable energy sector. Considering the lack of financing faced by many governments, it is advisable to consider the inclusion of the private sector to accelerate the transition to sustainable energy systems. Similarly, David and Venkatachalam, (2018), PPPs can play a crucial role in transforming the energy mix to accommodate renewable energy.

Governance factors

Similarly, the research found that governance factors have varying effects on the production of renewable energy; the objective of the study was, therefore achieved. Further tests conducted to test the effect of governance factors revealed that a positive link existed between control of corruption and non-hydro power output. On the other hand, an insignificant positive relationship was identified between control of corruption and hydropower. This outcome of the study indicates that control of corruption has a positive bearing on the quantity of non-hydro power that is produced. However, regulatory quality negatively impacts the generation of non-hydro power. Similarly a positive causal relationship was found between control of corruption and renewable energy generation (Department for International Development (DFID), 2015; McEwan, 2017). Contrary to these findings, Sobjak (2018), argues that a negative relationship exists between control of corruption and renewable energy generation.

Contrary to other studies, an increase in regulatory quality results in lower production of non-hydro power. On the other hand, a positive link exists between the rule of law and hydropower and non-hydro power output. The outcome of this hypothesis shows that as the rule of law improves the renewable output will increase. The enforcement of contracts is, therefore, key in the renewable energy sector. Government effectiveness has a negative relationship with hydropower generation. Accordingly, as the perceived quality of the policies that are created by the government and how well they are enforced increases, a reduction in hydropower generated is experienced. Past research has revealed that a positive relationship exists between government effectiveness and renewable energy output (IRENA, 2015; IRENA, 2018). The termination of feed-in tariffs and limitations imposed on prices of renewable energy are a constraint on renewable energy generation (Bridle, Gass, Halimajaya, Lontoh, McCulloch, Petrofsky & Sanchez, 2018). According to Hua, Oliphant and Hu (2016), laws and regulations can be used to impact renewable energy generation. It is evident that the rule of law has an impact on green energy production

Environmental factor

Results of this research indicate that the selected environmental factor, total carbon dioxide emissions, influences the production of renewable energy in the developing countries chosen for the analysis. The goal of the study was fulfilled; a cause and effect relationship has been identified. Total carbon dioxide emissions are positively associated with hydropower and non-hydro power production. This outcome of the study indicates that as TCDE increases, hydropower and non-hydro power generation accelerates. Similarly, ÓhAiseadha, Quinn, Connolly, Connolly and Soon (2020), maintain that a positive relationship exists between TCDE and renewable energy output. Contrary to this study Twumasi (2017), argues that no relationship exists between CO_2 emissions and renewable energy. This is consistent with the Kyoto principle that states that renewable energy can be used to counter the production of greenhouse gases (Dippenaar, 2018).

Social factor

The results of this study indicated that social factors have an impact on renewable energy generation. The aim of the study has been accomplished; a causal relationship was identified between the selected social factor and renewable energy output. A negative relationship was found between the gross enrolment ratio of upper secondary pupils and hydropower as well as non-hydro power. The evidence in this study is contradictory to previous studies; it implies that an increase in the level of education has a negative impact on renewable energy production. Contradictory to results of this study, Ozcicek and Agpak (2017), found that education positively influences renewable energy output. Other researchers have found that the lower the level of education, the lower output of renewable energy is generated (IRENA, 2013; Yoeurp, 2017; Cobenefits, 2019). This argument was based on the premise that the generation of renewable requires specialised knowledge. The study by Muhammad, Muhammad, Avik, Tuhin and Quande. (2020), revealed that a bidirectional relationship exists between education and renewable energy generated. Further studies should be conducted on this variable because the limited available data may have influenced the results in this study.

5.3 Conclusion

The study provides significant insight regarding identifying enablers and influencers of renewable energy production in selected developing countries. Furthermore, it also addresses these issues in a South African context. The results of this study sought to address the ever-increasing energy crisis faced by many developing nations, including South Africa, and reduce greenhouse gas emissions. The identification of key influencers and enablers that governments should focus on to increase renewable energy output is expected to address these challenges. The growth in renewable energy will have a sustainable impact on future generations.

The study showed that the independent variables selected have an impact on hydropower and non-hydro power generation. The predictor variables explored in this study are the dollar amount invested, social factors, economic factors, governance factors, and environmental factors. This shows that hydro and non-hydro power react differently to the predictor variables; therefore, careful consideration should be given when selecting enablers and influencers. Furthermore, the study provides a guide that can be used by policymakers in formulating solutions for budgetary constraints on renewable energy projects. The outcome of the study supports how China used a combination of mechanisms such as tax regulation, dollar amount invested, and general regulation to boost renewable energy production.

The following section discusses the limitations of this study.

5.4 Limitations of the study

Purposive sampling was applied due to the limitations faced in obtaining the relevant data for the selected developing countries. Due to the scarcity of consistent renewable energy data, the study used a combination of panel data and pooled regression to overcome this limitation. The study is limited to a small sample of developing countries for which the data required for analysis was available on reputable websites for the period chosen (2000 -2016). Other websites such as the International Renewable Energy Agency database, the International Energy Agency and the Renewable Energy Data and Information Services were considered however the data available was either insufficient to fulfil the objectives of the research or unavailable. In instances where data was found on the alternative websites mentioned above, the data missed some years and sometimes the data was not compatible with the level of breakdown the researcher intended. The specific definition of a developing country as provided by the World Economic Situation and Prospects report (2014), was used as a criterion for selection given that many definitions of the term exist. Independent variables tested were chosen based on the availability of data and their applicability to the research.

The following section discusses the contributions of this study:

5.5 Contributions of the study

In contrast to previous studies, this research attempted to investigate the research topic with a particular focus on a selected set of developing countries. The study, therefore, narrowed the applicability of its results down to specific developing nations, including South Africa. The study offered a unique opportunity for the researcher to explore which factors and enablers can be applied to improve renewable energy output. An opportunity exists to narrow down the study to focus mainly on South Africa as data becomes available. An investigation concentrated on South

Africa will bring much-needed solutions for the energy crisis faced by the country. The energy industry in developing countries, including South Africa, has consistently been faced with severe energy shortages.

This study highlights the need for scrutiny to be applied when renewable energy enablers and influencers are chosen. The empirical evidence from the study revealed that hydropower and non-hydro power react differently to enablers and influencers. This study shows that there has been minimal progress in transitioning to renewable energy in South Africa and other developing countries. Bottlenecks identified include lack of funding, minimal effort to control corruption which in turn discourages FDI, attitudes towards renewable energy, and allowing private sector participation, as well as lack of adequate regulations and stimulants. The study emphasizes that the energy crisis can be overcome if the bottlenecks identified in this study are given due consideration. The use of public-private partnerships in the energy sector is expected to improve efficiencies, expedite the transition to green energy, and bridge the funding gap. Evidence from this study and prior studies shows that an increase in investment results in increased renewable energy output. Improved governance will improve FDI which in turn will increase GDP and boost renewable energy output. As the output of renewable energy output increases, total greenhouse carbon emissions are likely to decrease. The application of the results of this research is, therefore, expected to provide great insight into the selection of enablers and influencers of green energy production. Consequently, this study will indirectly provide sustainable solutions for the ongoing energy crisis and cap greenhouse gas emissions. The literature review and the outcome of this study showed that governments play a vital role in the energy industry. The effectiveness of the rules and regulations affect the generation of renewable energy. The results of this study can be used to influence the structure of energy regulations and policies, encourage investment in renewable energy, and provide sustainable energy solutions.

The application of the results of the study is expected to yield increased renewable output. Policymakers should consider the results of this study when formulating job creation policies as well as any other policies that impact the quality of lives of the citizens of South Africa. This will improve living conditions as more electricity will be available to communities. Additionally, the increment in renewable energy is expected to boost production in the economy, thereby creating employment. Greenhouse gases will be reduced, and fewer quantities of non-renewable energy will be necessary. As a result of the reduction, societies will be exposed to less pollution and the effects of global warming, which stems mainly from greenhouse gas emissions.

5.6 Recommendations

The selected developing countries explored in this study are encouraged to review their current pool of enablers to ensure that they do not hinder green energy production. Particular attention should be given to variables which nations can easily influence and that have a positive effect on renewable energy. These variables include the dollar amount invested, control of corruption, GDP, total carbon dioxide emissions, and the rule of law. Furthermore, based on the available influencers, the study provides governments with insight about which combination of renewable energy technologies to focus on.

The suggestions above can be applied in the South African context to improve renewable energy output and counter the ever-increasing energy crisis. This will enable South Africa to also fulfil its commitments to the Kyoto principles. Other considerations would be to use non-financial means such as favourable tax laws, or focus on robust contract enforcement for Independent Power

Producer contracts. A review of the requirement to pay tax based on revenue, (imposed on renewable energy projects), as opposed to profits, may also promote growth. This research has highlighted the fact that various means can be deployed to encourage renewable energy production, means which South Africa has not yet considered. Therefore, the results of this study will serve as a challenge to governments to consider them as a basis for building a sustainable energy system.

5.7 Future research

There will be further opportunities to explore this study on a country by country basis as data becomes available. Future researchers can also include a qualitative element in the study, by applying mixed methods which may yield more vibrant and in-depth results. Additionally, the effect of predictor variables can be applied to the individual renewable technologies to obtain more in-depth information of how each technology reacts. Narrowly focused studies will help governments implement appropriate enablers to improve renewable energy output.

5.8 Concluding remarks

The results of this study have exposed the factors that contribute to the generation of renewable energy in the selected developing countries. Moreover, the results of the study have highlighted factors that are applicable in the South African context that policymakers need to consider in their efforts to transition towards a sustainable energy system and curb the energy crisis that has struck the country for many years.

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