ASSESSMENT OF RISKS ASSOCIATED WITH RENEWABLE ENERGY INVESTMENT IN GHANA: A CASE STUDY OF VOLTA RIVER AUTHORITY

By

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DECLARATION

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the award of any other degree or diploma at Kwame Nkrumah University of Science and Technology, Kumasi or any other educational institution, except where due acknowledgment is made in the thesis.

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ABSTRACT

This study assessed the risk associated with renewable energy investment at Volta River Authority, a semi-structured interview and questionnaire were used to access data from Management and staff of the Volta River Authority (VRA). The study reveals that the company recognizes various risks associated with renewable energy investment, risk identification is very crucial to plan appropriate intervention directed at fostering flow of capital into the RE sector. The researcher gathered that most of the respondents agreed on the impact of risks in the renewable investments in order to achieve corporate objectives. The responses gathered further reveals that most of the respondents identify the various barriers to deployment and mitigation for risks associated with Renewable Energy Investment (REI). It was recommended that Volta River Authority should explore the development of strategic alliance with complimentary players in the value chain component suppliers, utilities and financial institutions to create risk resilient consortium then hedging the significant risks associated to the disconnected across the value chain steps. The company should also explore the use of bank guarantees and/or insurances to secure engineering, procurement construction (EPC) and components suppliers to honor their contractual quality and services obligations. Competence of staff is a necessity to increase efficiencies in processes resulting in performance of renewable energy projects. It was further recommended that a systematic approach to risk management that uses a meaningful risk break down structure (RBS) and risk management plan. These aid better risk identification and minimization.

Keywords: Renewable, Energy, Investment, Ghana, Volta River Authority

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DEDICATION

This dissertation is dedicated to God almighty and my family.

ABBREVIATIONS

DCE (E&0)	:	Deputy Chief Executive, Engineering and Operations
EGS	:	Enhanced Geothermal System
EPC	:	Energy Procurement Construction
FiT	:	Feed-in-Tariff

FiAHs	:	Feed-in-Approval Holders
GDP	:	Gross Domestic Product
IPP	:	Independent Power Producer
PPA	:	Power Purchase Agreement
PURC	:	Power Utility Regulatory Authority
RE	:	Renewable Energy
RES	:	Renewable Energy Source
R&D	:	Research and Development
VRA	:	Volta River Authority

CHAPTER ONE

GENERAL INTRODUCTION

1.1 BACKGROUND OF STUDY

Increasing the demand of access of energy in least developed and developed countries in Sub-Saharan Africa and beyond needs the infrastructure of that country to be developed. If done properly, it would be considered to account for a vital and critical share of every country's resources; usually estimated at an average of 4% of regional GDP (Gross Domestic Product) to a level greater than 10% of the GDP in some few countries (Rosnes and Vennemo, 2009). According to Institutional Investors (2013), high investment needs of every country is typically and usually combined with very low level of private capital penetration.

This is liable of increasing the risk occurrences and uses effort to minimize these emissions in countries in order to support certain renewable energy technologies (Frisari et al., 2013). The risk mitigation tool provided in this context is as a result of finance development institutions proving an efficient way of minimizing private cost with regards to meeting energy demands. IEG (2009) asserted that the provisions of energy tools are below expectation with many barriers or constraints spreading.

According to Eydeland and K.Wolyniec (2003) energy sector is known for being complex and uncertain Energy market is changing continuously, appearing new products, tools, processes and policies. Because of this, the risk is inherent and companies must take into consideration many factors and variables to decide which projects they are going to invest. Especially important is risk management in renewable energy projects where the horizon is larger and the amortization of the projects is a key factor (Zhong, 2014).

Energy sector is ruled for the premise: safe and sustainable production. To archive this goal renewable energy is fundamental because it reduces environmental and human risks and carbon oxide emissions.

Renewable energy is termed as “energy that is collected from renewable resources, which are naturally replenished on a human timescale, such as sunlight, wind, rain, tides, waves, and geothermal heat”. *Ellabban et al* (2014). Renewable energy often provides energy in four important areas: electricity generation, air and water heating/cooling, transportation, and rural (off-grid) energy services (International Renewable Energy Agency, IRENA 2014). Renewable energy resources and significant opportunities for energy efficiency exist over wide geographical areas, in contrast to other energy sources, which are concentrated in a limited number of countries (Holburn, 2012).

According to Jacobson *et al. (2015),* renewable energy would reduce environmental pollution such as air pollution caused by burning of fossil fuels and improve public health, reduce premature mortalities due to pollution and save associated health costs that amount to several hundred billion dollars annually only in the United States. Just like every other form of power, renewable energy can be vulnerable to natural disasters (although considering the alternatives, the fallout is less dangerous) Emilio (2017). Renewable energy policy has been recognized as a major incentive to the growth of renewable energy and market. In particular, in the last decade, renewable energy sources are considerably increased due to the supportive renewable energy policy worldwide.

1.2 PROBLEM STATEMENT

As indicated by Godoy (2017) in recent years, the use of renewable technologies to generate power has increased at an exponential rate. This growing focus on new sources of energy has seen increased investment in renewable technologies across the globe. Investment in renewable energy is increasing in both developed and developing countries.

"In contrast to investments in conventional electricity generation, investments in renewable energy sources (RES), such as wind and solar power, require large upfront investments, but low working/operating capital. Most investments are to be made upfront, before the system becomes operational. From an investor's perspective, this means that the overall investment risks increase. To compensate for this risk, investors require a higher rate of return on their investments, leading to increased cost of capital for RES investments (Hussain,2013).

Burgherr and Hirschberg (2014) stated clearly that risk in relation to investments in renewable energy projects can be described by the negative impact, which uncertain future events may have on the financial value of a project or investment. According to (Hussain,2013), Risks form the counterpart of the upward potential: the increase in value due to future events. It is important to note that risk is not identical to uncertainty. Uncertainty of the financial value of a project can be both positive and negative in comparison with the expected value. The term 'risk', however, "relates exclusively to the events, which might occur and would lower the expected financial value. Events that may take place and would increase the expected value form the 'upward potential". It is then imperative to consider Volta River Authority (VRA) in terms accessing the renewable energy investment".

1.3 RESEARCH QUESTIONS

1. What are the risks identified with renewable energy investment in VRA?
2. What are the identified barriers deployed with renewable energy investment risk in VRA?
3. What are the specific measures that Volta River Authority is taken to mitigate renewable energy investments risks?

1.4 AIM OF STUDY

The aim of this study was to assess the risks associated with renewable energy investments in Ghana with a focus on Volta River Authority.

In order to achieve the stated aim of the study, the following specific objectives have been formulated:

1.4.1 Study objectives

- To identify risks associated with renewable energy investments in Volta River Authority;
- To identify barriers to deployment of renewable energy investments in Volta River Authority; and
- To identify specific measures/ strategies to mitigate risks and barriers associated with renewable energy investments in VRA.

1.5 SIGNIFICANCE/JUSTIFICATION OF STUDY

Human activity is overloading our atmosphere with carbon dioxide and other global warming emissions. These gases act like a blanket, trapping heat. The result was a web of significant and harmful impacts, from stronger, more frequent storms, to drought, sea level rise, and extinction (Hussain, 2013). Most renewable energy sources produce little to no global warming emissions. Even when including “life cycle” emissions of clean energy (i.e., the emissions from each stage of a technology’s life—manufacturing, installation, operation, decommissioning), the global warming emissions associated with renewable energy are minimal.

“Energy is the golden thread that connects economic growth, increases social equity and an environment that allows the world to thrive. Development is not possible without energy and sustainable development is not possible without sustainable energy. Renewable energy sources provide an opportunity for developing countries and countries with economies in transition to embrace a low carbon pathway powered by innovative, smart and locally relevant energy solutions. Renewable energy has a great potential to help countries become less dependent on energy imports, create jobs and mitigate climate change while contributing to prosperity.

According to Hussain (2013), Renewable energy sources are even larger than the traditional fossil fuels and in theory can easily supply the world’s energy needs. 89 PW of solar power falls on the planet’s surface. While it is not possible to capture all, or even most, of this energy, capturing less than 0.02 per cent would be enough to meet the current energy needs. “Barriers to further solar generation include the high price of making solar cells and reliance on weather patterns to generate electricity (Hussain, 2013). As investments in renewable energy plants grow, so too do the risks inherent in owning, building and operating such plants. In particular, political and regulatory risk and financial risk are becoming acute, as the macroeconomic outlook for many countries deteriorates. In addition, weather-related volume risk is particularly acute as investments in wind farms continue to expand" (Crotty, 1998:3).

1.6 METHODOLOGY/RESEARCH DESIGN

"Methodology refers to 'the strategy, plan of action, process or design lying behind the choice and use of particular methods and linking the choice and use of methods to the desired outcomes" (Crotty, 1998:3). Methodology can refer to theory, philosophy or more practical decision making that underpins the research. "Interview and questionnaires were used to elicit information from management and staff of VRA" (Hussain, 2013). The study was conducted within a specified time-period and will focus on hundred (100) VRA staff at the Engineering Services Department, Environment & Sustainability Development Department, Finance Departments, Technical Services, Investment Department and Audit Department. The researcher focused on wind and solar projects by Volta River Authority. With the help of SPSS, the tables and frequencies would be generated to give an in-dept explanations.

1.7 RESEARCH SCOPE

The study was limited to the Volta River Authority by obtaining information from Management and staff in six (6) department. Volta River Authority represent the largest power producing company in Ghana. The researcher chose Volta River Authority because of his acquaintance with the organization and for that matter makes data collection easier from respondents. Furthermore, the cost involved in collecting data was reduced because of the proximity of the area to the researcher.

1.8 STRUCTURE OF THE RESEARCH

This research was structured into five unified chapters. The first chapter spoke about the main introduction which include the background, problem statement, aim and objectives, research questions, scope of the study, research methodology. The second chapter, encompassed literature on preceding work done around the subject area. It also includes data and several interpretations linked to this study by other authors which aided as a footing for this study. Chapter three postulates a methodical approach as to how this research was conducted. It also covered how the questionnaire was established and how data was collected from respondents. Chapter four talks about discussions of the findings of the study through data presentation and analysis. Finally, the last chapter presented and discussed the conclusions of this study and its contribution to the knowledge gap and also enhancing research in this study area.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter reviews literature on assessment of risk associated with renewable energy investment and the basic theoretical framework of the concepts of risk management. It also reviews the literature on risk reduction in renewable energy projects, renewable energy in different countries, energy sector investment landscape, as well as previous works on the in deploying renewable energy in organizations.

2.2 DEFINITION OF RENEWABLE ENERGY

"Renewable energy is energy that is collected from renewable resources, which are naturally replenished on a human timescale, such as sunlight, wind, rain, tides, waves, and geothermal heat" (Ellabban et al., 2014). Jackson (1993) stated that "renewed attention is now given to the development and utilization of renewable sources of energy, in response to growing concerns about climate change, acidification, and urban air pollution, and interest in secure and affordable supplies of energy for economic and social development, which was the dominating rationale behind the interest of the 1970s. The growing aspirations of an expanding world population are expected to increase world energy demand, even if strong efforts are made to improve energy efficiency".

2.3 TYPES OF RENEWABLE ENERGY

2.3.1 Hydropower

According to Jackson (1993), “Hydropower is a vital energy source derived from water moving from higher to lower altitude, primarily to turn turbines and generate electricity. Hydropower projects include Dam project with reservoirs, run-of-river and in-stream projects and cover a range in project scale. Hydropower technologies are technically mature and its projects exploit a resource that vary temporarily”. “The primary energy is provided by gravity and the height the water falls down on to the turbine. The potential energy of the stored water is the mass of the water, the gravity factor (g = 9.81 ms-2) and the head defined as the difference between the dam level and the tail water level. The reservoir level to some extent changes downwards when water is released and accordingly influences electricity production. Turbines are constructed for an optional flow of water
(Forsund, 2015).

2.3.2 Bioenergy

One advantage of biomass energy-based electricity is that fuel is often a by-product, residue or waste product from the above sources. Significantly, it does not create a competition between land for food and land for fuel” (Urban and Mitchell, 2011; Ajanovic,
2011). “The annual biodiesel consumption in the United States was 15 billion litres in 2006. It has been growing at a rate of 30–50% per year to achieve an annual target of 30 billion litres at the end of year 2012” (Ayoub and Abdullah, 2012).

2.3.3 Direct Solar Energy

The word “direct” solar energy refers to the energy base for those renewable energy source technologies that draw on the Sun’s energy directly, according to Jackson (1993). “Solar energy technology is obtained from solar irradiance to generate electricity using photovoltaic (PV)" (Asumadu-Sarkodie & Owusu, 2016) and "concentrating solar power (CSP), to produce thermal energy, to meet direct lighting needs and, potentially, to produce fuels that might be used for transport and other purposes" as said by (Edenhofer et al., 2011). According to the World Energy Council (2013), "the total energy from solar radiation falling on the earth was more than 7,500 times the World's total annual primary energy consumption of 450 EJ".

2.3.4 Geothermal Energy

According to Jackson (1993), "Geothermal energy is obtained naturally from the earth's interior as heat energy source. The origin of the heat is linked with the internal structure of the planet and the physical processes occurring there. Although heat is present in the earth's crust in huge quantities, not to mention the deepest parts, it is unevenly distributed, rarely concentrated, and often at depths too great to be exploited mechanically. Geothermal gradient averages about 30 °C/km. There are areas of the earth's interior which are accessible by drilling, and where the gradient is well above the average gradient (Barbier, 2002). Heat is mined from geothermal reservoirs using wells and other means. Reservoirs that are naturally adequately hot and permeable are called hydrothermal reservoirs, while reservoirs that are satisfactorily hot but are improved with hydraulic stimulation are called enhanced geothermal systems (ESG). Once drawn to the surface, fluids of various temperatures can be used to generate electricity and other purposes that require the use of heat energy" (Edenhofer et al., 2011).

2.3.5 Wind Energy

"The emergence of wind as an important source of the World's energy has taken a commanding lead among renewable sources. Wind exists everywhere in the world, in some places with considerable energy density" (Manwell et al., 2010). "Wind energy harnesses kinetic energy from moving air. The primary application of the importance to climate change mitigation is to produce electricity from large turbines located onshore (land) or offshore (in sea or fresh water)" (Asumadu-Sarkodie and Owusu, 2016). "Onshore wind energy technologies are already being manufactured and deployed on large scale" (Edenhofer et al., 2011).

2.3.6 Ocean Energy (Tide and Wave)

"Surface waves are created when wind passes over water (Ocean). The faster the wind speed, the longer the wind is sustained, the greater distance the wind travels, the greater the wave height, and the greater the wave energy produced" (Jacobson and Delucchi, 2011). "The ocean stores enough energy to meet the total worldwide demand for power many times over in the form of waves, tide, currents and heat". The year 2008 saw the beginning of the first generation of commercial Ocean energy devices, with the first units being installed in the UK-SeaGen and Portugal-Pelamis. "There are presently four ways of obtaining energy from sea areas, namely from Wind, Tides, Waves and Thermal differences between deep and shallow Sea water" (Esteban & Leary, 2012).

2.4 RISK ASSOCIATED WITH RENEWABLE ENERGY INVESTMENT

2.4.1 Risks

International investment flows into renewable energy (RE) have improved fast, with RE investments outshining investments in thermal energy internationally in 2017. However, these investments are focused in selected markets, particularly in the event of emerging countries, with Brazil, China and India accounting for about 80 per cent of RE investment flows into emerging countries in the past three years. Despite the fact that business case for RE investments has become considerably dynamic in a limited geography resulting in investment focus in these regions, the deployment of RE still meets various degrees and types of risk in most emerging countries, which holds back the flow of RE investments. In order to fast-track the international transition to clean energy, it is significant to thoroughly identify the risks associated with RE implementation and tackle these risks through an amalgamation of policy and market-based interventions. Reinforcing the business case for RE technologies in emerging nations will facilitate a stable flow of investments into this sector. Frankfurt School-UNEP Centre (2018)

Creating an understanding of the risks hindering RE investment is crucial to plan appropriate interventions directed at fostering the flow of private capital into the RE sector. Planned de-risking could help propel investment flows by alleviating non-project-specific risks. Encouraging investor assurance by addressing exaggerated risk perceptions that are beyond actual risks is essential for increasing private sector investments in RE deployments at the international scale. Policies geared towards risk mitigation present a more effective means of using limited public capital, as they can increase RE investment flows regarding direct lending.

Direct investments undoubtedly contribute to RE deployments, planned risk mitigation could greatly improve investment flows by enticing more risk-averse investors. (Griffith-Jones et al., 2011)

2.4.2 Demand Risk

Electricity designing in any country does not consider the existing electricity demand but also considers the requisite demand to have the economy growing at a significant pace in the short, medium, and long term. Predictions with reference to expected demand also update the judgements of the whole energy ecosystem, including power generators, transmission companies, and capital goods manufacturers. The contrast between the planned and actual electricity demand is what is important, and not the total adjustment in electricity demand. (Chawla et al., 2018)

2.4.3 Transmission and Evacuation risk.

Transmission and evacuation risk is of two types, pre-and post-connectivity risk. Preconnectivity risk means that RE generators are not able to connect their plants to the designated substation within a predictable time period and at predictable prices. Postconnectivity risk means that RE generators are not able to inject all the electricity that their plants could have produced. This phenomenon is called "curtailment" (Chawla et al., 2018)

2.4.4 Macro risk

Macro risks comprise all economy-wide risks that are not specific to the RE and power sector. In this case, Ghana's macro risks may include: credit rating downgrade; sudden changes in the economic landscape; sharp movements in the Ghana currency, political risks such as the government imposing capital controls or nationalizing assets; and potential uncertainty arising from future trade disputes. (Chawla et al., 2018)

2.4.5 Political risk

Political risks, including currency inconvertibility, post-hoc changes to tariffs, and changes in the regulatory and tax regimes, can derail RE projects in Ghana. Some level of comfort is provided by the government involvement in power projects through a contract called the power purchase agreement (PPA), which is signed between the government and the IPP. The PPA guarantees the payment of any sum due from VRA to the IPP as an energy payment or otherwise, as defined in the PPA. The PPA also determines the contractual obligations of the IPP in terms of risk regarding development obligations, since failure to comply will result in penalties and, eventually, termination in the case of prolonged noncompliance. (Chawla et al., 2018)

2.4.7 Land acquisition risk

Land acquisition in Ghana has traditionally been a challenge for infrastructure projects. Land records are often unclear as to ownership, particularly in rural areas, which complicates land acquisition, as do lengthy legal processes and opposition from local communities. The 1992 Constitution, Article 267 Clause (1) All stool lands in Ghana shall vest in the appropriate stool on behalf of, and in trust for the subjects of the stool in accordance with customary law and usage. However, "Indeterminate boundaries of stool lands as a result of lack of reliable maps/plans, and use of unapproved, old or inaccurate maps and also the use of quack surveyors leading to land conflicts and litigations between stools and other land owning groups" (Gyamera et al., 2018). For instance, land acquisition for the 75MW at Goy and 75MW at Anloga wind plant, has been rescheduled as a result of disputes between the chiefs and the investor "VRA".

2.5 RENEWABLE ENERGY INVESTMENT

2.5.1 Energy Sector Investment Landscape, Trends And Performance

As the energy sector is closely associated with economic growth and development, the investment of the sector is closely analyzed to ensure steady improvement in global prosperity, and to ensure that the demand for energy is fulfilled. Specifically, for electricity demand, Figure 1 shows that renewable energy resource is projected to surpass electricity generation from coal, nuclear and petroleum in the year 2035 (EIA, 2018). The EIA report uses two difference scenarios based on its own reference case and reference with the Clean Power Plan, which is a US-based policy aiming to reduce CO_2 emission from power generation (Ramseur & McCarthy, 2016). Regardless of the scenarios, the projected power generation from different energy sources follow similar trends. The projected total increase of renewable energy resources for power generation is 139%, which is significantly higher than coal, nuclear and petroleum power generation in 2050 (EIA, 2018).

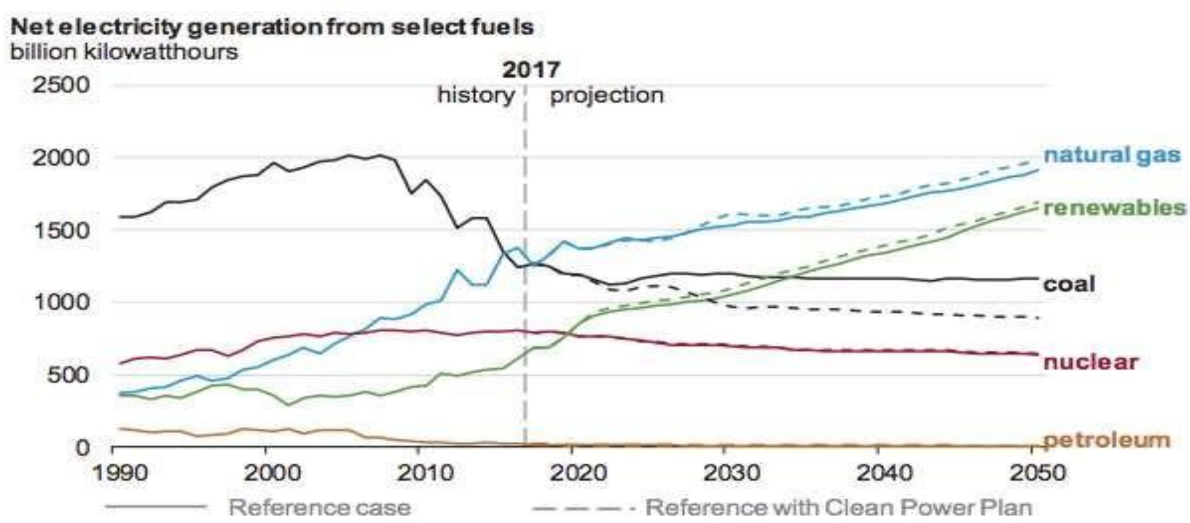


Figure 2.1: Net electricity generation from selected fuels

(EIA, 2018, p. 89)

The increasing maturity of the renewable energy, or the alternative energy technologies allows the sector to be more cost-competitive to the conventional energy sector (IRENA, 2014; Lazard, 2017). According to him the alternative energy technologies, namely solar photovoltaic for utility scale, micro turbine, geothermal, biomass direct and wind, are cost competitive to conventional energy technologies such as natural gas, coal and gas combined cycle. The increased in the market competitiveness of the alternative energy sector is a result of improved technologies, effective policy and regulations, and overall input cost reductions (IRENA, 2014).

2.5.2 Application of Real Option To Renewable Energy Investment

According to Jackson (1993), "Research and development (R&D) and project investment are two important stages of developing renewable energy. The focus will be on the analysis of R&D investment and project investment".

2.5.3 Research and Development in Investment of Renewable Energy

(Fernandes B, et al 2011) stated that "developing and commercializing renewable energy requires huge initial investments cost. R&D is proved to be an important way to reduce initial investment cost. Many countries and enterprises are aggressively investing in related R&D programs". Nevertheless, since R&D investment is considered high risk and it includes various of options in the decision-making process such as delay, abandon, and expansion, it is important to consider uncertainties and these options simultaneously when evaluating economic values and selecting the optimal timing to deploy the results of R&D.

2.5.4 Project Investment of Renewable Energy

The studies on renewable energy project investment started in the early 21st century (Hussain, 2013). These studies may differ in the emphasis which is placed on certain aspects of evaluation. Some scholars focused on analyzing the investment value and investment timing, while others put more attention to the impact of uncertain factors or the uncertainty value. The investment value, optimal investment timing and the trigger point for investment is the research focus of many studies (Hussain, 2013). (Bockman et al. 2008) proposed "a real options-based model for assessing small hydropower projects which are subject to uncertain electricity price".

2.5.5 Renewable Energy in Ghana

In a bid to create an enabling investment climate for renewable energy, the government of Ghana put in place several policies and regulatory measures, including the Renewable Energy Act 2011 (Act 832). The Clause (4):

a) Recommend the exemption from customs, levies and other duties, equipment and machinery necessary for the development, production and utilization of renewable sources;

b) Consultation with Public Utilities Regulatory Commission (PURC) recommend financial incentive necessary for the development, production and utilization of renewable sources;"

The above provisions are made to make the renewable energy sector attractive for investors. According to a research by the Embassy of Netherland in Accra, the Ghana government has created a conducive environment for business in the Renewable Energy (RE) sector by putting the following in place;

- Explicit Feed-in Tariffs (FITs) for energy generated by renewable sources.
- Ghana Investment Promotion Centre, which is a one stop shop for all investment enquiries and assistance.

The market exists, is growing and there is plenty of scope for new players. When it comes to Renewable Energy investments and trade, yes, Ghana is ready for business as indicated" by Energy Commission (2015).

2.5.6 Renewable Energy Investment in Malaysia

Rising concern over climate change and pollution is promoting many policy makers to pass regulation to encourage renewable energy (RE) generation. It is expected that the RE sector will be the fastest growing component of world primary energy demand with an annual growth rate of 6.7% (Sadorsky, 2012).

Malaysia, in particular, established a comprehensive National RE Policy and Action Plan in the year 2009 leading to a proposal to introduce a Feed-in-Tariff (FiT) system. In June 2011, the system received the royal consent and it is currently managed by the Sustainable Energy Development Authority (SEDA). The FiT system offers RE investors in Malaysia, commonly known as the Feed-in-Approval Holders (FiAHs), a return set at a FiT rate for each unit of electricity fed into the grid, and obliges the Distribution Licensees i.e. there are registered power companies to buy the electricity from FiAHs for specific duration (Muhammad-Sukki et al., 2014)

It is reported that the current capacity mix of RE in Malaysia is less than 1 % of total capacity mix of Malaysia electricity generation [Ajzen, 2013]. The low percentage could be contributed to the fact that Malaysia is implementing a controlled FiT system where there is a quota being set for RE investment. According to Masini & Menichetti (2013) with these targets, it is expected that the RE quota will keep on increase and massive private investment is expected to be made. To encourage RE investment, Malaysia has also crafted its 'National RE Policy and Action Plan which is accompanied by five strategic thrusts

(ST) including ST 2: Provide Conducive Business Environment for RE. Among initiatives being stipulated under ST2 is to promote RE businesses among small-medium enterprises (SMEs) and manufacturing companies, providing long term low interest financing, and developing a standard evaluation process.

2.5.7 Renewable Energy Investment in Japan

According to Sheldrick and Kato (2015), "Japan's Ministry of Economy, Trade and Industry will scrap a system in which solar and wind energy from major power companies is purchased at a predetermined price". The government set favorable prices for energy from wind and solar operators, but the higher rates are passed on to consumers via electricity bills (Jackson, 1993, Teruyuki, 2015; McNell, (2015). "Solar and other forms of renewable power have gained in Japan, by 2019, they are expected to amount to about 3.6 trillion yen ($33.2 billion), with about 2.4 trillion yen being passed on to households and businesses. Policymakers decided reforms are needed as the corporate side has been reluctant to move ahead with cost reduction as indicated" (Martin, 2015).

2.6 BREAKING BARRIERS IN DEPLOYMENT OF RENEWABLE ENERGY

"The world's population is growing at an unprecedented rate and that has necessitated a dramatic increase in energy demand globally. Matching supply with this surging demand is a principal and critical challenge for countries around the world. Presently, this demand is being met through the increased use of fossil fuels", according to Jackson (1993). The research institute known as International Energy Outlook (2013) asserted that, "global energy demand will be increased by 56 per cent between 2010 and 2040", as it was also supported by (Azad et al., 2014) when researched on similar issues. "Currently, the majority of the world's energy consumption is satisfied by consuming energy created using fossil fuels. To satisfy the ever-increasing energy demand and to protect the climate, breakthrough advancements have been made in the past to design technologies that can control and harness power from alternative energy sources".

2.6.1 Inadequate fiscal incentives

According to (Zhang et al., 2014), "There have not been enough measures by governments to remove tax on imports of the equipment and parts required for renewable energy plants". "Feed-in tariffs are the measures by which governments aim to subsidize renewable energy sources to make them cost-competitive with fossil fuel-based technologies, but the absence of these adequate financial incentives results in high costs that hinder the industry's development, operation and maintenance, and stagnate the future" (Sun and Nie, 2015).

2.6.2 Public awareness and information barriers:

"Sustainable development stems from the satisfaction of human desires, through socially recognized technological systems and suitable policies and regulatory tools" (Paravantis et al., 2014; Nasirov et al., 2015). "Loss of other/alternative income: A major issue with renewable plants (especially solar and wind farms) is the vast area of land required to produce an amount of energy equivalent to that which can be produced from a small coal fire power plant" (Chauhan and Saini, 2015)

2.6.3 Lack of experienced professionals:

"Universal transition from fossil fuels to renewable energy sources requires the solid foundation of a skilled labour force. There is huge demand for skilled professionals to design, build, operate and maintain a renewable energy plant.

Incompetent technical professionals and lack of training institutes prevent renewable energy technologies from scaling new heights" (Ansari et al., 2016)."The shortage of trained workforce to design, finance, build, operate and maintain renewable energy projects is considered a major obstacle to the wide penetration of renewable energy" (Karakaya and Sriwannawit, 2015).

2.6.4 Limited availability of infrastructure and facilities

"There is limited availability of advanced technologies required for renewable energy, especially in developing countries, which acts as a factor preventing penetration of renewable energy. Even if this technology is available, the cost of procuring it is very high" (Dulal et al., 2013). "Since renewable energy power plants are mostly placed in remote locations, they require additional transmission lines to connect to the main grid. Since most of the existing grids are not designed to integrate with renewable energy, these existing grids need to be upgraded or modified" (Izadbakhsh et al., 2015).

2.6.5 Impractical government commitments

"There is a gap between the policy targets set by governments and the actual results executed by implementation" (Goldsmiths, 2015). "There is a lack of understanding of a realistic target and loopholes in the implementation process itself" (Sen and Bhattacharyya, 2014).. "The responsibility for overcoming these commitment issues lies with governments. Policies should be devised that can offer clear insight into important legislation and regulatory issues so that the industry can be promoted as stable and offering growth. Governments can fix this mismatch by becoming more responsive and reactive" (Hussain, 2013).

2.6.6 Lack of research and development (R&D) capabilities

"Investment in research and development (R&D) is insufficient to make renewable energies commercially competitive with fossil fuel. Both governments and energy firms shy away from spending on R&D as renewable energy is in its development stage and risks related to this technology are high" (Cho et al., 2013)

2.6.7 Lack of standards and certifications

According to (Zhang et al., 2014), "Standards and certificates are required to ensure that the equipment and parts manufactured or procured from overseas are in alignment with the standards of the importing company". "These certifications make sure that companies are operating the plant in compliance with local law. Absence of such standards creates confusion and energy producers have to face unnecessary difficulties" (Emodi et al., 2014).

2.6.8 Lack of operation and maintenance culture

"Since renewable energy technology is comparatively new and not optimally developed, there is a lack of knowledge about operation and maintenance". "Efficiency cannot be achieved if a plant is not optimally operated and if maintenance is not carried out regularly" (Sen and Bhattacharyya, 2014). "Lack of availability of equipment, components and spare parts will require a substantial increase in the production costs, as these items need to be imported from other countries, therefore being procured at high prices and so increasing the overall cost" (Bhandari et al., 2015)

2.6.9 Technological barriers

"There are a number of legitimate technological barriers to the widespread deployment of renewable energy, including limited availability of infrastructure, inefficient knowledge of operations and maintenance, insufficient research and development initiatives, and technical complexities like energy storage and unavailability of standards" (Zhao et al., 2016).

2.6.10 Regulatory barriers

"Factors like lack of national policies, bureaucratic and administrative hurdles, inadequate incentives, impractical government targets, and lack of standards and certifications have prevented renewable energy from expanding dramatically" (Stokes, 2013)

2.7 MEASURES TO IMPROVE RENEWABLE ENERGY INVESTMENT RISKS

2.7.1 Six Steps of Risk Reduction in Renewable Energy investment

Zhang et al. (2014) explained diligence to consist of commercial, legal and technical considerations. Developing a full understanding of a proposed project comes with risk discovery which may affects the success of it. Hussain (2013) considered renewable energy projects to include solar farm, wind farm, hydro scheme, and other emerging options, which may include and explore total energy yield, project uncertainties, technology choices and also non-financial goals.

2.7.2 Quantify Energy Yield and Uncertainties

According to Bennet (2018), renewable energy projects do not deal with risks of variable of fuel costs. "To avoid lower-than-expected revenue generation, the project needs to be able to export power into the electricity grid without constraint. This makes the grid connection arrangements and understanding the risks associated with the eventual operational regime critical to the success or failure of a project" (Hussain, 2013).

2.7.3 Justify Technology Choices

"Project lenders require confidence in the capability and reliability of the proposed technology for the project. For wind farms and hydropower projects using equipment from a supplier with a long operational history or large install base, this is less likely to pose hurdles than for emerging renewable energy options such as hybrid systems using batteries" (Sen and Bhattacharyya, 2014). "Absence of information is likely to result in conservative assumptions for financing purposes, so efforts to extract and justify all parameters is typically well worthwhile" (Sen and Bhattacharyya, 2014).

2.7.4 Ensure Social Acceptance and Environmental Reputation

"Renewable energy projects operate within communities. There will be a range of attitudes towards any project and many stakeholder relationships to manage. The relationship established with the project's community can make a substantial difference to the success of the project" (Hussain, 2013).

2.7.5 Take Care with Contracts

According Bennet (2018), "Land-owner agreements; connection applications; engineering, procurement and construction contracts; supply and installation contracts; and operations and maintenance contracts of various forms will be required to develop, construct and operate the project. While a legal adviser will need to comb through these, many technical aspects can vary significantly in their favorability to a purchaser or investor. Identifying and quantifying these items will need input from a technical advisor" (Hussain, 2013).

2.7.6 Understand Markets, Policies and Regulation

Bennet (2018) said "Renewable energy projects are often supported by government policies that recognise the environmental benefits of clean energy generation. It is essential to understand both the commercial market for the energy and the policy environment in order to negotiate power purchase agreements or to manage merchant risk if the energy is being sold on the spot market. Another potential risk – or opportunity – is change in the market, both short term and longer term. Consider how foreseeable or unforeseeable market movements (such as changes in industrial loads or shifting levels or patterns of demand) may affect performance and viability of the project over its life" (Hussain, 2013).

2.7.7 Assess the business case and other goals

According to Bennet (2018), "The ultimate motivations and goals of the investor will influence the assessment of risk. The project may not simply be all about financial return, but also a desire to limit carbon exposure or to increase corporate social responsibility. Understanding the goals of the project will provide a clearer perspective for the due diligence investigation". "Technical viability and environmental benefits won't be enough to get projects over the line if they cannot demonstrate their long-term financial soundness and ability to weather the competitive pressures of the market" (Hussain, 2013)

"Businesses are likely to gain substantial benefits from making structured and systematic efforts to foresee and quantify risks across the spectrum of commercial, technical, social and environmental issues" (Jones et al., 2012). "The more detailed a due diligence process is, the more accurately risks can be quantified, and the less likely it is that potential risks will be overlooked. A thorough due diligence will take time and expertise, but it is a critical investment in the success and resilience of every renewable energy development" (Chawla et al., 2018).

CHAPTER THREE

METHODOLOGY

3.1 INTRODUCTION

This chapter outlines the methodology used in gathering the relevant data for the research. The chapter involves a detailed discussion of the data sources, population, sampling technique, sample size, research instruments, data analysis and profile of the organization.

3.2 STUDY AREA

As already indicated, to augment the purposes of risk associated with renewable energy Investment, it is important not to overlook the involvement of the Volta River authority who happens to be leader in the energy production. The study thus confined it scope to the Volta River Authority by sourcing information from Six (6) departments involved in renewable energy investment. Volta River Authority represent the largest power producing company in Ghana. The researcher chose Volta River Authority because of his acquaintance with the organization and for that matter makes data collection easier from respondents. Furthermore, the cost involved in collecting data was reduced because of the proximity of the area to the researcher.

3.3 RESEARCH DESIGN

"The research design determines which established convention was chosen for conducting a piece of research. The choice of research design was based on the research problems and questions of a study. Various approaches can be used to study a problem (Agyed et al., 1999; Saunders et al., 2007; Saunders et al., 2007). In the case of this research an exploratory design was adopted to assess the risk associated with renewable energy investment at the Volta River Authority". Qualitative data was then taken from the staff of VRA.

3.4 RESEARCH STRATEGY

The request for information of research objective is simply the research strategy as Naoum (2012) define. There are three (3) main types of research strategy according to Naoum (2002) professed. They are qualitative, quantitative and triangulation. Nevertheless, the one to utilize in any research counts on the target of the study, type, as well as the accessibility of information for the study (Naoum, 2012). In operation, the study exploited the qualitative and qualitative research approach. According to Frechtling and Sharp (1997) questionnaire verified and represented on database is the common data collection technique used in quantitative research technique. This study deployed qualitative and qualitative to examine the objectives and identified the risks associated with renewable energy in Ghana with a focus on Volta River Authority. Subsequently, the views of Management and staff from the survey were tested empirically to augment findings. The quantitative method was adopted to gather factual data so that the researcher can study the relationships between facts in accordance with theory. The procedure for the study took the form of literature review and survey using the structured questionnaire approach.

3.5 RESEARCH APPROACH

3.5.1 Deductive Research Approach

According to Baxter and Jack (2008), deductive approach is often referred to as quantitative method or design. A key distinguishing approach is that theories need to be deployed in a way that measures quantitatively. Henceforward, with deductive approach, the principle of reductionism is followed (Saunders *et al.*, 2012). According to Saunders *et al.* (2009), deductive research approach be in debt to the empiricism approach exclusively attached to diverse research philosophies

3.5.2 Inductive Research Approach

The inductive research approach embroils the incident where the researcher gathers information for the purpose of developing a theory (Saunders *et al.*, 2012). As a result, this approach embroils theory development as well as conjecturing broad analyses from precise lexicalisation (Neuman, 2002). Inductive research approach is to propagate meanings with respect to statistics gathered to characterise affiliations and patterns to build a theory. Henceforward, this approach is predominantly tied to the framework in which the study's background is placed (Saunders, *et al.*, 2012).

3.6 POPULATION

According to Kumekpor (2002), "the population of a study may be considered as the number of all units of the phenomenon to be investigated that exists in the area of investigation". Also, Bell (2005) indicated that "the population is the total collection of elements about which some inferences can be made". Sekaran (2003) on the other hand asserted that population is the aggregate of all cases that conform to some designated set of specifications. The population for the research was employees and management of Volta River Authority.

Table 3.1: Population Size

Department	**No of Staff**
Engineering Services	**42**
Environment & Sustainable Development	**77**

Finance	**99**
Technical Services	**53**
Investment	**6**
Audit	**22**
Total	**299**

Source; Field Survey, 2019

The study focused on staff from the Engineering Services, Environment & Sustainable Development, Finance, Technical Services, Investment and the Audit Departments as well as the Deputy Chief Executive (Engineering & Organizational Branch) of the organization. The researcher interviewed the Directors of listed Departments for information pertaining on the assessment of the risk associated with renewable energy investment at VRA. The Directors were selected because of the role that they play in the Authority's renewable energy operations. The DCE (E&O) was also selected because he is the branch head of the charge of power generation.

3.7 SAMPLING SIZE AND TECHNIQUE

Robson (2002) defined a sample as a subset of some part of a larger population, a population being any complete group of people or companies that share some set of characteristics. Kumekpor (2002) emphasized that a sample of a population consists of that proportion of the number of units selected for investigation also supported by Cooper and Schindler (2003). On the other hand, states that "sampling is the deliberate choice of a number of people who are to provide the data from which conclusions about those people can be drawn" (Kumekpor, 2002). "As a result of the cost related to covering the entire population, it was relevant for the researcher to draw a sample for the study. The sample size was drawn because of the greater need for accuracy of results and the greater speed of data collection. A sample representative of the population provides a higher accuracy and speed of data collection compared to the total population" (Kumekpor, 2002).

The six (6) department of VRA was engaged in the study, with the objective of selecting the staff and assessing them based on the role that they play in the assessment of renewable energy in the Authority operational areas. The total number of staff was 299 and so there was the need to take a sample of respondents from which basic generalizations could be deduced.

Saunders *et al*. (2007) defined a sample as a subset of some part of a larger population. Stratified random sampling was adopted to achieve a sample size of 100 staff. This made the researcher to obtain accuracy by the using each area or field.

Table 3.2: Sample size distribution

Strata	Department	No of Staff	Sample size
1	Engineering Services	**42**	**36**
2	Environment & Sustainable Development	**77**	**20**
3	Finance	**99**	**15**
4	Technical Services	**53**	**20**
5	Investment	**6**	**4**
6	Audit	**22**	**5**
	Total	**299**	**100**

Source; Field Survey, 2019

3.8 SOURCES OF DATA

To assess assessment of the risk associated with renewable energy investment at the Volta River Authority, the study used both primary and secondary data.

3.8.1 Primary Sources

"The primary sources of data refer to data collected expressly for specific purpose" (Zikmund and Babin, 2007). "The primary source of data was gathered from interviews with management of VRA and also questionnaires administered to staff of six selected departments of the organization" (Kumekpor, 2002).

3.8.2 Secondary Sources

"The secondary data apply to that already collected and compiled for other purposes (Gravetter and Forzano, 2012)". "Secondary data was obtained through both published and unpublished materials including articles, reports and papers. The collection of secondary data is important since it provided in-depth and foundational knowledge on the research topic and area" (Kumekpor, 2002).

3.9 INSTRUMENTS FOR DATA COLLECTION

Interview and questionnaires were used to elicit information from management and staff of VRA. The questionnaires administered to staff sought to assess staff background, staff perception of renewable energy investment risks incorporated into the long-term strategic plan and the importance the company attaches to identification of renewable energy investment risks. The interview with DCE (E&O) and the Directors was also centered on the risk associated with renewable energy investment and measures to improve renewable energy investment risks for achievement of corporate objectives of the company.

The questionnaire administration method provided immense opportunities for the researcher because it also produced valuable data and provided insight into issues that otherwise would have been difficult to gather using other methods(Kumekpor, 2002).

3.10 DATA ANALYSIS AND PRESENTATION

Tables were used to show the analysed data. The data was analysed to address the aim and objectives of the study, using Statistical Package for Social Systems to interpret the data, as well as showing them on a tabular manner including graphs and charts in examining the relationships among variables.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS AND DISCUSSIONS

4.1 INTRODUCTION

The results drawn from the data analysis conducted and interpretation was discussed in this section. The discussions are aimed at meeting the researcher's objectives; assessing the risks associated with renewable energy investment in Volta River Authority (VRA). "This chapter therefore involves the data analysis, discussion and presentation of primary and secondary data collected from the staff of the six (6) departments and Deputy Chief Executive (Branch Head, Engineering & Organization). The chapter also focuses on the implications of the findings".

4.2 RESPONSES RATE OF STAFF

The questionnaires were randomly administered to hundred (100) staff from the six (6) departments selected for the research. Out of these, eighteen (18) questionnaires were not returned. Data analysis was there conducted on the eighty-two (82) usable questionnaires, representing eighty-two percent (82%) response rate. An interview was conducted with the Directors and as well as DCE (E&O)

4.3 CHARACTERISTICS OF THE RESPONDENTS

Table 4.1 below displays the characteristics of staff of the six (6) departments of VRA. The table describes the sex, age, Department, length of time that a staff had worked with VRA and highest education attained by individual.

The data revealed that 71% of the respondents were male and 39% were female. From table

4.1 below it was realized that 22% of the respondents were between the 21-30 years. Whilst 27% were between the 31-40 years, 17% were between the ages of 41-50 years. On the other hand, 34% of the respondents were between 51-60 years.

The results indicated that 39% of the respondents were from Engineering Services Department, 22% of the respondents were from the Environment & Sustainable Development Department. Finance Department had 15% respondents, whilst 17% respondents were from the Technical Services Department. The data gathered also shown that 5% of the respondents were Investment Department staff and 2% from the Audit Department.

The data gathered from the respondents indicated that 2% of the respondents were Professional Certificate holders, another 2% of the respondents had attained Doctor of Philosophy. The results also shown that 22% of them had Master's degree, whilst 59% of them had Bachelor's degree. 15% of the respondents had Diploma certificates.

The results also indicated that 5% of the respondents had worked with the organization for 1-5 years. Whilst 24% of the respondents had worked with the organization between 6-10 years, 43% had worked with the organization between 11-15 years. On the other hand, 28% of the respondents had worked with the organization for over five years. It could be inferred from the responses that a large number of the respondents had worked with the organization for quite some time.

Table 4.1 Characteristic s of Staff

Item	Frequency	Percentage (%)
Sex		
Male	58	71
Female	24	39
Total	**82**	**100**
Age		
Below 20 years	0	0
21-30 years	18	22
31-40 years	22	27
41-50 years	14	17
51-60 years	28	34
Total	**82**	**100**
Department		
Engineering Services	32	39
Environment & Sustain Dev.	18	22
Finance	12	15
Technical Service	14	17
Investment	4	5
Audit	2	2
Total	**82**	**100**
Educational Level		
Professional Certificate	2	2
Doctor of Philosophy (PhD)	2	2
Master's Degree	18	22
Bachelor's Degree	48	59
Diploma	12	15
Total	**82**	**100**
Years as a Staff		
1 -5 years	4	5
6 -10 years	20	24
11-15 years	43	43
Over 15 years	23	28
Total	**82**	**100**

4.4 RISK ASSOCIATED WITH RENEWABLE ENERGY INVESTMENT (REI)

According to Sadorsky (2012), "a key challenge in obtaining financing at a reasonable cost is the ability to quantify and manage the different element of risk (organizational, political, technical, commercial) associated with renewable energy projects". "Any RE project risk management approach should be structured and apply a conscious approach to risk identification, risk appraisal, risk managing and risk review" (Ellahbban et al 2014). Recognizing the risk impeding RE investment is important for appropriate interventions pre, during and post project execution. Table 4.2 depicts staff perception of risk associated with renewable energy investment.

Please indicate how you agree or disagree with statements listed below

Table 4.2 Risk associated with Renewable Energy Investment (REI)

Statement	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
1.The company identifies demand risks associated with renewable energy investment	0 (0)	0 (0)	6 (7)	48 (59)	26 (34)
2.The company identifies macro risks associated with renewable energy investment	0 (0)	0 (0)	0 (0)	22 (27)	60 (73)
3. The company identifies transmission and evacuation risk associated with renewable	0 (0)	0 (0)	0 (0)	11 (13)	71 (87)
4. The company identifies political risk associated with renewable energy investment	0 (0)	0 (0)	3 (4)	13 (16)	66 (80)
5.The company identifies land acquisition risk associated with renewable energy investment	0 (0)	0 (0)	4 (5)	12 (15)	66 (80)

Source: Field Survey, 2019

With the issue of whether the company identifies demand risk associated with renewable energy investment, 93% of the respondents stated that demand risk is associated with renewable energy investment. The study revealed that 7% of the respondents were neutral in responses that demand risk is associated with renewable energy investment.

The results revealed that 100% of the respondents agreed that the company identifies macro risk is associated with renewable energy investment

The study again revealed that 100% of the respondents agreed that the company identifies transmission and evacuation risk are associated with renewable energy investment. From the responses gathered 96% of the respondents agreed that political risk is associated with renewable energy investment, whilst 4% of the respondents were neutral in their responses that political risk is associated with renewable energy investment.

When the respondents were asked to state whether the company identifies land acquisition risk associated with renewable energy investment, 95% were positive that land acquisition risk is associated with renewable energy investment on the other hand 5% were neutral in their responses.

Table 4.3 Barriers to deployment with Renewable Energy Investment (REI)

Statement	Strongly Disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly Agree (%)
1.There are limited financial instruments to organizations for renewable projects financing.	2 (3)	3 (4)	5 (6)	66 (80)	6 (7)
2. Inadequate awareness of renewable energy information is the basis for the public resistance	10 (12)	6 (7)	8 (10)	24 (29)	34 (42)
3. The lack of experience professionals is a major obstacle for wider penetration of renewable energy	0 (0)	6 (8)	0 (0)	20 (24)	56 (68)
4. High initial capital influences investment for renewable energy technology infrastructure and facilities	0 (0)	1 (1)	2 (3)	48 (59)	31 (38)
5.The amount government subsidies for conventional energy is higher than those awarded to renewable energy	5 (6)	6 (7)	8 (10)	30 (37)	33 (40)

6.The lack of research and development (R&D) capabilities	0 (0)	2 (3)	0 (0)	36 (44)	44 (53)
7.The lack of standards and certifications for equipment and manufactured parts	4 (5)	2 (3)	7 (9)	45 (54)	24 (29)
8.Lack of operation and maintenance culture	0 (0)	0 (0)	6 (8)	56 (68)	20 (24)
9.Technological barriers are widespread deployment of renewable energy	4 (5)	0 (0)	0 (0)	45 (55)	33 (40)
10.Regulatory barriers have prevented renewable energy from expanding dramatically	0 (0)	0 (0)	5 (6)	51 (62)	26 (32)

Source: Field Survey, 2019

When the respondents were asked to state whether they identify limited financial instruments to organizations for renewable projects financing. 87% of the respondent were positive that the company identifies that there are limited financial instruments to organizations for renewable projects financing. The results gathered revealed that 6% of the respondents were neutral whilst 7% disagree that there are limited financial instruments to organizations for renewable projects financing as a barrier to the deployment of renewable energy investment.

With the issue of whether or not inadequate awareness of renewable energy information is the basis for the public resistance, 71% of the respondents stated that they agreed inadequate awareness of renewable energy information is the basis for the public resistance. Whilst 9% of the respondents were neutral in their responses, 19% of the respondents disagree that inadequate awareness of renewable energy information is the basis for the public resistance as a barrier to the deployment of renewable energy investment.

Anasari et al (2016) stated that lack of experience professionals is a major obstacle for wider penetration of renewable energy. With the issue of whether the company identifies lack of experience professionals as a major obstacle for wider penetration of renewable energy, 92% of the respondents indicated that lack of experience professionals is a major obstacle for wider penetration of renewable energy. On the other hand, 8% of the respondents disagreed lack of experience professionals is a major obstacle for wider penetration of renewable energy. The responses gathered therefore indicate that lack of experience professionals is a major obstacle for wider penetration of renewable energy. The results gathered also revealed that they identify high initial capital influences investment for renewable energy technology infrastructure and facilities. 96% of the respondents emphasized that high initial capital influences investment for renewable energy technology infrastructure and facilities, whilst 3% respondents were neutral in their responses, 1% of the respondent disagree that that high initial capital influences investment for renewable energy technology infrastructure and facilities as a barrier to the deployment of renewable energy investment.

With the issue of whether or not the company identifies that the amount government subsidies for conventional energy is higher than those awarded to renewable energy, 77% of the respondents indicated the amount government subsidies for conventional energy is higher than those awarded to renewable energy. Whilst 10% of the respondents were neutral in their responses, 13% of the respondents on the other hand disagreed that the amount government subsidies for conventional energy is higher than those awarded to renewable energy.

Cho et al., (2013) stressed the insufficient investment in research and development in the renewable industry. From the responses gathered 97% of the respondents agreed that the company identifies lack of research and development (R&D) capabilities as a barrier to the deployment of renewable energy investment, whilst 3% of the respondents were neutral in their responses that lack of research and development (R&D) capabilities is a barrier to the deployment of renewable energy investment.

83% of the respondents agreed that lack of standards and certifications for equipment and manufactured parts is a barrier to the deployment of renewable energy investment. The results further shown that 9% of the respondents were neutral whilst 8% disagree that lack of standards and certifications for equipment and manufactured parts is a barrier to the deployment of renewable energy investment.

In respect to the responses on lack of operation and maintenance culture as a barrier to the deployment of renewable energy investment 92% agreed, whilst 8% of the respondents were neutral.

The results again revealed that 95% of the respondents agreed that technological barriers are widespread deployment of renewable energy investment, whilst 5% disagreed with the statement.

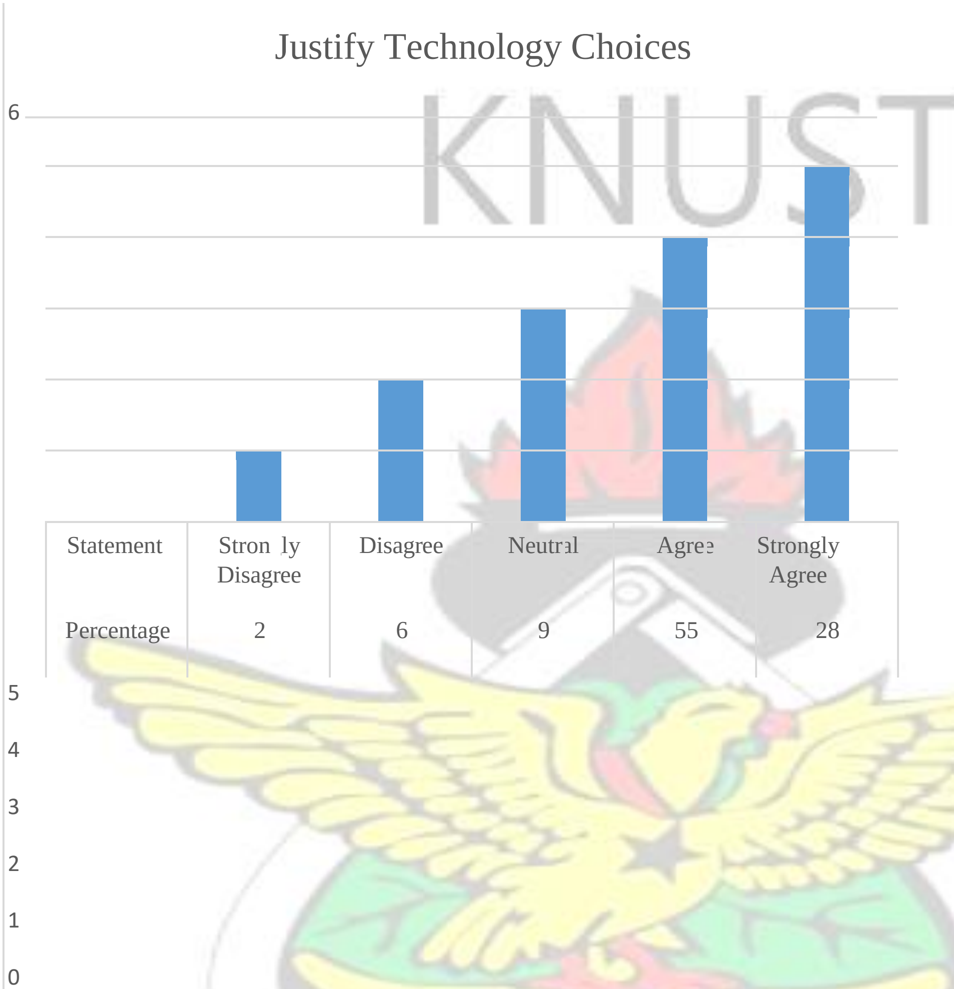
With the issue of whether or not the respondents identify regulatory barriers have prevented renewable energy from expanding dramatically, the results revealed that 94% of the respondents agreed, whilst 6% of the respondents were neutral that regulatory barriers have prevented renewable energy from expanding dramatically,

Table 4.4 Mitigation of Risks and Barriers to deployment with Renewable Energy Investment (REI)

Statement	Strongly Disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly Agree (%)
1.Quantify energy yield and uncertainties analysis are critical to the successful of an RE investment	8 (10)	6 (7)	13 (16)	12 (15)	43 (52)
2.Justify technology choices attract investment	2 (2)	5 (6)	7 (9)	45 (55)	23 (28)
3.Ensure social acceptance and environmental reputation during construction and operation stages can boost REI projects	4 (5)	10 (12)	0 (0)	30 (37)	38 (46)
4.Take care with contracts to curtail risks associated with RE contractual agreements	8 (10)	14 (12)	10 (17)	18 (22)	32 (39)
5. Have high caliber of staff to understand RE markets, policies and regulation trends	0 (0)	4 (5)	0 (0)	33 (40)	45 (55)
6. Assess to business case and other goals such as social responsibility	0 (0)	0 (0)	3 (4)	13 (16)	66 (80)

Source: Field Survey, 2019

The results gathered revealed that 67% of the respondents agreed that quantify energy yield and uncertainties analysis are critical to the success of RE investment. It was also realized that 16% of the respondents were neutral in their responses and 17% disagree that quantify energy yield and uncertainties analysis are critical to the success of RE investment With the issue of whether the company identifies that justify technology choices attract investment 83% of the respondents agreed, whilst 9% of the respondents were neutral and 8% disagreed with the statement that justify technology choices attract investment.



Source: Field Survey, 2019

Figure 4.1 Justify Technology Choices Attract Investors

The results gathered from the study further revealed, to ensure social acceptance and environmental reputation during construction and operation stages can boost REI projects. 83% of the respondents agreed to ensure social acceptance and environmental reputation during construction and operation stages can boost REI projects, while 17% of the respondents disagreed.

61% of the respondents agreed that to take care with contracts to curtail risks associated with RE contractual agreements, 17% of the respondents were neutral and the rest 22% disagree that Take care with contracts to curtail risks associated with RE contractual agreements.

The responses gathered also revealed that 95% of the respondents agreed to have high caliber of staff to understand RE markets, policies and regulation trends and 5% disagreed with the statement to have high caliber of staff to understand RE markets, policies and regulation trends.

From the responses gathered 96% of the respondents agreed that assess to business case and otK2her goals such as social responsibility, whilst 4% of the respondents were neutral in their responses that assess to business case and other goals such as social responsibility. (Chawla et al, 2018) explained that risk identification should be conducted to achieve corporate objectives. “Risk identification in a renewable energy project is to ensure that all the key topics are considered and lessons learnt are incorporated in new projects. In practice, this process is improved by the use of the Risk Breakdown Structure (using a structured Kapproached to list the risk that could be encountered) the use of facilitated workshop and the drawing from ‘risk libraries’ based on past experience” (Goldsmith, 2015).

When respondents were asked to state whether they can identify the types of risks that are associated with renewable energy investment more than three-quarters of the respondents ascertain that the various risks. These was collaborated by the researcher’s interview with Management, the followings risks were identified; cumbersome land acquisition system, unavailability of technical competence in renewable energy and uncertainty of investors to invest in the renewable energy projects.

According to Goldsmith (2015) the transition from conventional energy to renewable energy have encountered public resistance and opposition. VRA have operated hydroenergy and thermal for a long time that have under gone several research and development, in respect to renewable energy, few barriers were recognized. Renewable energy projects are competing in the money market with projects which are easier to predict return on investment. Land for renewable energy projects (solar and wind) are in challenge with other projects i.e. the Navrongo Solar project, vast area of land is required. VRA agreed that they have not been able to educate the public on the ecological and financial benefits on renewable energy. Insufficient government subsidy on renewable energy production makes it unattractive for private investors was another reason given for barriers to deployment of renewable energy investment by management.

(Brynes et al, 2013) emphasized that deployment of renewable energy is crucial not only to meet energy demands but also to address concerns about climate change. Management supported the concept, that government must provide renewable energy infrastructure fund to mitigate entry and exit investment in a policy form, which investors can access government loans and grants for RE projects. Capacity building for technical and nontechnical staff have been strengthened, in readiness for new RE projects. Management understands that the requisite knowledge in the field is critical for the investment.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

This chapter is organized into three parts. Part one presents the summary drawn from the findings, part two deals with the conclusion and part three discusses the recommendations based on the findings of the study.

5.2 SUMMARY OF FINDINGS

5.2.1 Risk associated with Renewable Energy Investment (REI)

The responses gathered revealed that more than three-quarters of the respondents indicated that the company identifies demand risk is associated with renewable energy investment. All the respondents emphasized that macro risk is associated with renewable energy investment. The study portrayed that more than three-quarters of the participants identifies transmission and evacuation risk is associated with renewable energy investment. All the respondents agreed that the company identifies political risk associated with renewable energy investment.

The study again discovered that all the participants identifies land acquisition risk associated with renewable energy investment. Management buttress the risk identification process by the use of risk register to record all potential risk with project objectives. The responses gathered indicated that the company recognizes identification of risk management in its renewable energy activities as necessary for its operations.

5.2. 2 Barriers to deployment of Renewable Energy Investment (REI)

Renewable energy is crucial to the energy mix of countries globally, however, barriers exist, which prevent its development and penetration. It was realized from the results gathered that majority of the respondents indicated that there are limited financial instruments to organizations for renewable projects financing to the company, these emphasized a barrier to deployment of renewable energy investment. The data gathered further revealed that less than one-fifth of the respondents stated inadequate awareness of renewable energy information is the basis for the public resistance which implies that much work need to be done to sensitize the public on the benefit of renewable energy source. More than two-thirds emphasize that lack of experience professionals is a major obstacle for wider penetration of renewable energy. It was also revealed that more than half felt that high initial capital influences investment for renewable energy technology infrastructure and facilities as a barrier to the deployment of renewable energy investment. It was realized from the results gathered that majority of the respondents agreed that the amount government subsidies for conventional energy is higher than those awarded to renewable energy. The data gathered further revealed that minority of the respondents disagreed with the view that the amount government subsidies for conventional energy is higher than those awarded to renewable energy. The results indicate that the government invest less in renewable energy as compared to conventional energy. During the analysis it was realized that three quarters of the respondents indicated that lack of research and development (R&D) capabilities is a barrier to deployment of renewable energy investment. Consequently, majority of the respondents stated that lack of standards and certifications for equipment and manufactured part is a barrier to deployment of renewable energy investment and majority indicated that lack of operation and maintenance culture may bar investors into the renewable energy industry. More than three quarters of the employees were of the view that technological barriers are widespread deployment of renewable energy. On barriers to deployment of renewable energy, regulatory barriers were identified as a factor that prevented renewable energy from expanding dramatically.

5.2.3 Mitigation of Risk and Barriers to deployment with Renewable Energy Investment (REI)

During the analysis it was realized that more than half of the respondents indicated that quantify energy yield and uncertainties analysis are critical to the success of RE investment Consequently majority stated that justify technology choices attract investment which serves as a mitigation to risk and barriers to deployment with renewable energy investment. While more than three quarters agreed that to ensure social acceptance and environmental reputation during construction and operation stages can boost REI projects and mitigate barriers and risk to investment.

The study further revealed that more than half of the respondents and management emphasize that need to take care with contracts to curtail risk associated with RE contractual agreements as a mitigation step for barriers and risk to RE investment. While, more than three quarters of the respondents agreed that company need to have high caliber of staff to understand RE markets, policies and regulation trends as a crucial factor for risk and barriers mitigation approach for RE investment.

Majority of the respondents indicated that assess to business case and other goals such as social responsibility is essential to the mitigation of risks and barriers to deployment with renewable energy investment. An investor may be influence to invest in a project with a crave for a limit carbon exposure. A corporate objective from the interview gathered from management indicated that VRA's energy mix production will appreciate 15% by 2025 from renewables.

5.3 CONCLUSIONS

Many years of research and development have a number of renewable energy technologies to a stage where there are technologically matured and ready for a more widespread market introduction. However, “perceptions of the associated risk have constrained the progress of renewable energy; as a consequence, there is a gap between the Renewable Energy System (RES) promoters and the financing organizations” (PwC 2017). The risk involved in financing conventional energy is lower than that of renewable energy, thus, investors have the opportunity cost of investing in a project that have a lower risk identification. Unlike conventional fossil fuel plants or hydro electrical plants that have evolved and developed over the years, the risk involved are well understood through experience, design specifications or statistical records. Certain risk might not have been encountered due to the short track record of RES, for instance risk that may occurred at the end of a lifetime of RE project might not be visible yet.

Renewable energy has always been associated with frontier technology risk, outside the realm of feasibility for traditional investors. Even where the technology is accessible, the cost of equipment and parts are very expensive (Dulal et al., 2013). Disruptive technology risk (also present during construction) expose private partners to the unexpected displacement of current technology. For instance, new technologies might be able to reduce power-generation costs but the private partner is not allowed to make the change under the current Power Utilities Regulatory Authority (PURC) arrangement. Working through partnership with the private banks (i.e. Energy Bank and other Commercial Banks), the public sector can provide low-level finance to support technology which do not have the necessary track record performance.

investments in renewable energy sources are regarded with increasing interest as an effective means toward energy independence and stimulate economic growth. Numerous policies, therefore, are implemented to promote renewable sources investments in renewable energy sources are regarded with increasing interest as an effective means toward energy independence and stimulate economic growth. Numerous policies, therefore, are implemented to promote renewable sources investments in renewable energy sources are regarded with increasing interest as an effective means toward energy independence and stimulate economic growth. Numerous policies, therefore, are implemented to promote renewable sources

Deployment of renewable energy projects typically needs to enjoy government backed financial support schemes (investment subsidies, feed-in-tariffs, Government financial guarantees, preferential credit lines, tax incentives). Investments in renewable energy sources are regarded with increasing interest as an effective means toward energy independence and stimulate economic growth in developed and developing countries. Therefore, explicit policy needs to be formulated and implemented to promote renewable energy sources.

5.4 RECOMMENDATIONS

Energy is a requirement in our everyday life as a way of improving human development leading to economic growth and productivity. The return-to renewables will help mitigate climate change is an excellent way, however, depending on the investor's risk appetite, exposure to risk can be manage through the contractual agreement with the developer, equipment suppliers, construction contractors and government agencies. A regular assessment of risk in project management is essential for sustaining organizational health and growth. The need for such assessment is even greater in renewable energy projects due to limitation of investors in this business venture. It is recommended that the Volta River Authority institutionalize a risk unit as part of it corporate strategy in order to proactively identify weakness for continuous improvement supply of reliable electricity to satisfy customers' and stakeholders' expectations.

- It is recommended that the Volta River Authority explore the development of strategic alliance with complimentary players in the value chain component suppliers, utilities and financial institutions to create risk resilient consortium then hedging the significant risks associated to the disconnected across the value chain steps.
- Government to enact laws that promote the use of renewable energy sources and provide financial incentives to the major stakeholders in the RE industry to mitigate the risk that have been tagged with it.
- A systematic approach to risk management that uses a meaningful risk break down structure (RBS) and risk management plan. These aid better risk identification and minimization.
- Building and nurturing of staff in renewable energy skills in both technical and non-technical staff to increase efficiencies in processes resulting in performance
- A deliberate/conscious effort for Ministry of Energy to sensitize the public on renewable energy benefits.

5.5 RECOMMENDATION FOR FURTHER STUDIES

A research can be conducted on risk in renewable energy economics of developing countries, with the aim of identifying the risk in economy of renewable energy.

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APPENDIX

QUESTIONNAIRE TOPIC: An assessment of risks associated with Renewable

Energy Investment in Ghana: A Case Study of Volta River Authority

Dear Sir/Madam,

This questionnaire is part of a study being conducted at the KNUST, Kumasi. The main objective of the study is to *assess the risks associated with renewable energy investment in Ghana* **All information collected will be confidential and used only for academic purposes.** Please, we would be grateful if you could answer this questionnaire to aid this study. Thank you for your time and valid contribution in advance.

Yours faithfully, T.

K. Ewusie.

APPENDIX 1

QUESTIONNAIRE FOR STAFF

Please tick (√) where appropriate and provide details where necessary. Thank you.

SECTION A: RESPONDENTS BACKROUND

1. Sex

a) Male []

b) Female []

2. Age

a) Below 20 []

b) 21-30 years []

c) 31-40 years []

d) 41-50 years []

e) 51-60 years []

3. Department

a) Engineering Services []

b) Environment & Sustainable Dev. []

c) Finance []

d) Technical Service []

e) Investment []

f) Audit []

4. Educational Level

a) Professional Certificate []

b) Doctor of Philosophy (PhD) []

c) Master's Degree []

d) Bachelor's Degree []\

e) Diploma []

5. How long you have been working with VRA?

a) 1 to 5 years []

b) 6 to 10 years []

c) 11 to 15 years []

d) Over 15 years []

SECTION B: (1) RISK ASSOCIATED WITH RENEWABLE ENERGY INVESTMENT (REI)

Please indicate how you agree or disagree with statements listed below

Statement	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
1.The company identifies demand risks associated with renewable energy investment					
2.The company identifies macro risks associated with renewable energy investment					

3. The company identifies transmission and evacuation risk associated with renewable					
4. The company identifies political risk associated with renewable energy investment					
5.The company identifies land acquisition risk associated with renewable energy investment					

(II) BARRIERS TO DEPLOYMENT OF RENEWABLE ENERGY INVESTMENT (REI)

Please indicate how you agree or disagree with statements listed below

Statement	Strongly Disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly Agree (%)
1.There are limited financial instruments to organizations for renewable projects financing.					
2. Inadequate awareness of renewable energy information is the basis for the public resistance					

3. The lack of experience professionals is a major obstacle for wider penetration of renewable energy					
4. High initial capital influences investment for renewable energy technology infrastructure and facilities					
5.The amount government subsidies for conventional energy					
is higher than those awarded to renewable energy					
6.The lack of research and development (R&D) capabilities					
7.The lack of standards and certifications for equipment and manufactured parts					
8.Lack of operation and maintenance culture					
9.Technological barriers are widespread deployment of renewable energy					

10.Regulatory barriers have prevented renewable energy from expanding dramatically					

(III) MEASURES TO MITIGATE RISKS AND BARRIERS TO DEPLOYMENT OF RENEWABLE ENERGY INVESTMENT (REI)

Please indicate how you agree or disagree with statements listed below

Statement	Strongly Disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly Agree (%)
1.Quantify energy yield and uncertainties analysis are critical to the successful of an RE investment					
2.Justify technology choices attract investment					
3.Ensure social acceptance and environmental reputation during construction and operation stages can boost REI projects					
4.Take care with contracts to curtail risks associated with RE contractual agreements					
5. Have high caliber of staff to understand RE markets, policies and regulation trends					
6. Assess to business case and other goals such as social responsibility					

Any further comments can kindly be indicated below:

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

Thank you

APPENDIX II

INTERVIEW GUIDE FOR DCE (E&O) AND DIRECTORS

1. How has the company enlightened staff on benefits of renewable energy?
2. Is risk management an investment strategy of VRA
3. Do management provide reasons for the solar and wind projects undertaken by the company?
4. How do the VRA collaborate with other Government agencies on energy prediction on strategy term?
5. As a source of clean energy, how is the company ensuring the development of new energy in a sustainable manner?
6. What's VRA vision improve technology and infrastructure in the area of Renewable Energy.
7. What is Authority's public-private partnership policy on renewable energy investment?
8. Is insufficient information a source of public opposition renewable energy projects?
9. Do VRA have the requisite manpower skills for effective operation of renewable energy installations?
10. What is management position on training and development?

11. How has management dealt with land accusation and payment of compensation to victims?
12. How do the company deal with high initial capital investment for renewable energy technology?
13. What is the ratio of investment by VRA's conventional energy as compared to renewable energy?
14. How are uncertain financial feasibility studies on renewable energy installations handle?
15. What is the Authority investment portfolio on research and development aspect of renewable energy?
16. How do the company influence the regulatory authorities on effective policies and practical government commitment on promotion of renewable energy in the country?
17. How are new renewable energy projects appraised?
18. Is the Return on Investment (ROI) on the Navrongo Solar Project expansion valuable?
19. What challenges does management face as market leader in renewable energy provided?
20. Do you have any suggestions for the enhancement of renewable energy investment in the country?

THANK YOU!