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Determinants of carbon finance uptake and its role in deployment of renewable energy projects in Kenya

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Determinants of Carbon Finance Uptake and its role in Deployment of Renewable Energy Projects in Kenya

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DECLARATION

I declare that this work has not been previously submitted and approved for the award of a degree by this or any other University. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made in the thesis itself.

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ABSTRACT

Carbon finance has been advanced as a strong financial mechanism to help the world transition to low carbon development, in the face of ravaging climate change. Projects that sequester greenhouse gases from the atmosphere are eligible to accrue carbon finance, either through sale of carbon credits in the designated carbon markets or through other flexible mechanisms. This thesis analyzed the determinants of carbon finance accrual in renewable energy projects, in the context of a low and middle income country, Kenya. The aim was to explore the role played by carbon finance in promoting the deployment of renewable energy, as envisaged in the international climate agreements, for a country with a reportedly enormous renewable energy potential. While carbon finance use in renewable energy has been extensively analyzed in developed countries, low and middle income countries, especially those in Africa, have received considerably less attention. In an attempt to address this gap, the thesis analyzed the determinants of carbon finance uptake in renewable energy projects registered under the Feed-in-Tariff scheme of the Kenyan government. Renewable energy projects were selected because prior evidence shows that a significant percentage of carbon finance is targeted to these projects, because of their emission reducing abilities. Triangulation of methodology, including the use of questionnaires, interviews and analysis of policy documents, was used to collect and analyze qualitative and quantitative data from renewable energy projects and other carbon business stakeholders on their understanding, uptake and determinants of carbon finance accrual in renewable energy projects. In addition to analyzing the determinants of carbon finance uptake, the study uncovered the constraints of accessing carbon finance and the challenges renewable energy developers face in the country. The evidence and analyses presented reveal that the size of the renewable energy project, the carbon market affiliation of the project and the level of low carbon technology employed in the project are significant determinants of carbon finance flows into the projects. At the same time, lack of capital to develop renewable projects to completion, primarily the absence of financial instruments from local banks and high transaction costs to meet carbon credits generation were identified as the main constraints in accessing carbon finance by the developers. The analyses also reveal low levels of understanding and awareness of the carbon finance uptake, suggestive of the low levels of uptake that were uncovered by the study. Based on these findings, the research recommends for the creation of a framework to educate and create awareness to local renewable energy developers on the existence and processes of accessing carbon funds from international carbon markets. There is also need to develop financial instruments to cater for risk investments with environmental benefits like those in renewable energy in the Kenyan capital market.

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DEDICATION

To my family; my wife Joy Nkirote, for our ever enduring friendship and love, my children, Larry and Cheryl, for enduring long periods of my absence from home to pursue this PhD. My parents, Joseph and Joyce Kanyaru, for their ever useful counsel into my life and my brothers and sisters, thank you for always being there for me.

God bless you all.

ABBREVIATIONS

AAUs	Assigned Amount Units, or
ADB	African Development Bank
CAPM	Capital Asset Pricing Model
CCBA	Climate, Community and Biodiversity Alliance
CCS	Carbon Capture and Storage
CDKN	Climate and Development Knowledge Network
CDM	Clean Development Mechanism
CERs	Certified Emission Reduction
Ci-Dev	Carbon Initiative for Development
COP	Conference of the Parties
CPI	Climate Policy Initiative
DNA	Designated National Authority
DOI	Diffusion of Innovations
EEEFP	Energy & Energy Efficiency Financing Programme
EEP	Energy and Environment Partnership
ERC	Electricity Regulatory Commission
ERPA	Emission Reduction Purchase Agreements
ERU	Emission Reduction Units
ETS	Emissions Trading Scheme
EU	European Union

EU ETS	European Union Emission Trading System
FiT	Feed-in Tariff
GDP	Gross Domestic Product
GHG	Green House Gases
GoK	Government of Kenya
GS	Gold Standard
GSR	Global Renewable Status,
IATA	International Air Transport Association
IDA	International Development Association
IEA	International Energy Agency
INDC	Intended Nationally Determined Contribution
IPCC	Intergovernmental Panel on Climate Change
IRENA	International Renewable Energy Agency
JI	Joint Implementation
KCIC	Kenya Climate Innovation Centre
KenGen	Kenya Electricity Generation Company
KEREA	Kenya Renewable Energy Association
KIPPRA	Kenya Institute for Public Policy Research and Analysis
KJAS	Kenya Joint Assistance Strategy
KNBS	Kenya National Bureau of Statistics
KP	Kyoto Protocol

KPLC	Kenya Power and Lighting Company
KTDA	Kenya Tea Development Agency
LCPDP	Least Cost Power Development Plan
LDCs	Least Developed Countries
MENR	Ministry of Environment and Natural Resources
MoE	Ministry of Energy
MoEP	Ministry of Energy and Petroleum
MoF	Ministry of Finance
NAMA	Nationally Appropriate Mitigation Action
NCCAP	National Climate Change Action Plan
NCCRS	National Climate Change Response Strategy
NEMA	National Environmental Management Authority
NEP	National Energy Policy
NEPAD	New Partnership for Africa's development
NSW GGAS	New South Wales Greenhouse Gas Reduction Scheme
PoA	Programme of Activities
PPA	Power Purchase Agreement
REDD	Reducing Emissions from Deforestation and forest Degradation
REEEP	Renewable Energy and Energy Efficiency Partnership
RES	Renewable Energy Support,
RET	Renewable Energy Technologies

RGGI	Regional Greenhouse Gas Initiative
RTAP	Regional Technical Assistance Programme
SEFA	Sustainable Energy Fund for Africa
SEI	Stockholm Environment Institute
SNC	Second National Communication
SREP	Scaling up Renewable Energy
TEM	Technology-Emissions-Means
TEP	Tradable Emission Permits
TFEC	Total Final Energy Consumption
TGC	Tradable Green Certificates
TT	Technology Transfer
UNDESA	United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
USAID	United States Aid Agency
VCM	Voluntary Carbon Market
VCS	Verified Carbon Standard
VER	Verified Emission Reductions

CHAPTER ONE
INTRODUCTION

1.1 Background to the Study

Climate change, the observed changes in global weather patterns, continues to pose a great challenge to the global economy in terms of its observed and potential impacts (Karl & Trenberth, 2003). Prior research shows that there is a consensus among scientists that global warming, the main cause of climate change, is caused by anthropogenic greenhouse gases attributed to human actions (Doran & Zimmerman, 2013; Somerville, 2012). Even among the climate sceptics (Legras, 2013; Whitmarsh, 2011), the point of departure is not on the changing climate, but on whether the cause is natural or man-made, with the sceptics insisting on the former. The evidence adduced suggests that unabated climate change adversely affects the world economy, with some studies suggesting that it is likely to cost the world as much as 20 per cent of its gross domestic product per year (Anderegg, Prall, Harol & Schneidera, 2010; Stern, 2008). Therefore, to achieve sustainable development, there is need to combat climate change and this requires a workable global strategy to reduce concentrations of greenhouse gases (Marcu, 2014). The fundamental question has been how to reduce the emissions of these gases, while at the same time maintaining global economic growth, when energy for industrial production, the main catalysts of these emissions, is key to economic growth.

For a strategy to reduce GHGs to work across the globe, researchers and policymakers believe that it must encourage the use of financial and technical cooperation between countries to adopt more climate-friendly policies and low carbon-technologies (Aglietta, Hourcade, Jaeger & Fabert, 2015; Labbat & White, 2011). While various responses to climate change have been proposed, the international community, under the auspices of United Nations Framework Convention on Climate Change (UNFCCC) have agreed to carbon pricing as a key financial mechanism to enable trade in greenhouse gases (IPCC, 2014). The creation of flexible financing mechanisms, such as those under the Kyoto Protocol, have made it possible for countries and projects to reduce greenhouses gases at the lowest cost possible (Agbelie, 2016). It is these resources, provided through the UNFCCC framework and outside of this framework, aimed at acquiring appropriately certified greenhouse gas (GHG) emission reductions that are collectively known as carbon finance (World Bank, 2015).

Carbon finance, as a new field of environmental finance, explores the financial implications of living in a carbon-constrained world in which carbon emissions carry a price (Labatt & White, 2011). As part of the wider development finance, carbon finance helps developing countries, such as Kenya to attain sustainable development in the face of the ravages of climate change (World Bank, 2010). Ervine (2014) observe that the development of carbon finance is premised on the notion that trading GHGs emissions could help bring down the cost of reducing these emissions. However, Nie, Chen, Yang and Wang (2016) find that a contentious issue shaping global climate action is the question of how and through what channels carbon finance will be mobilized to meet low-carbon development in the global south.

Prior research confirms that a significant portion of carbon finance available across the globe to address climate change has been directed towards renewable energy production (Climate Policy Initiative, 2016; Hamrick & Goldstein, 2015). Schandl et al. (2016) posit that the reason could be because energy production is the biggest contributor to the increase in GHGs, accounting for an estimated 60 per cent of global emissions. Nie et al. (2016) observe that for developing countries to achieve sustainable development, there is a need for more carbon finance to help them to substitute the energy sources they are currently reliant on with low-carbon or zero-carbon energy production technologies. But the role of carbon finance in renewable energy deployment has lately come into sharp focus, as arguments have emerged questioning its contribution to greenhouse gas reductions (Hamrick & Gallant, 2017; Purdon, 2015).

The inflows of carbon finance into developing countries or emission reducing projects has been shown to vary across regions, countries and projects (Burian & Arens, 2014). For instance, countries in Asia and Latin America have accrued more carbon finance than their African counterparts (Veld-Merkoulova & Viteva, 2016). Prior research shows that as at 2016, the Clean Development Mechanism had registered a total of 8,814 projects, of which only 261 were from Africa, a mere 3.0%, against a total population of over 900 million while China holds over 65 per cent of these projects (Wood, Sallu & Paavola, 2016). Scholars have tried to explain these variances in the flows of carbon finance by examining the variability in factors that determine the inflows of carbon finance. Variables such as the size of the renewable energy projects, the prevailing carbon offset prices, the technology employed in emission reducing projects and the carbon market inclination of these project have all been investigated for their impact on carbon finance accrual, with varying conclusions (Veld-Merkoulova & Viteva, 2016). The scope and magnitude of these factors have been shown to vary across regions, countries and projects as well (Purdon, 2015). However, while these determinants have been well analyzed in developed countries, there is ambivalence as to their effects on inflows of carbon finance for Kenya and other low and middle-income countries in Africa.

As confirmed by prior research, renewable energy projects are strong candidates for carbon finance accrual, because of their carbon emission reducing abilities (Abdullah & Jeanty, 2011). In relation to this, several scholars have demonstrated that Kenya has enormous renewable energy resources, capable of producing over 6 GW of electricity, more than double the current installed capacity (Kiplagat, Wang & Li, 2011; Oji, Soumonni & Ojah, 2016). Oji et al. (2016) further posit that Kenya can achieve 100 per cent switch to renewable energy use by 2030 if only half of this potential is harnessed. However, Olang and Esteban (2017) find that there is a big financing gap for renewable energy deployment in Kenya, and most of the feasible projects are rarely completed. The question for scholars and policymakers is why hasn't the country leveraged on the available carbon finance in the international markets to close this financing gap. As a signatory to major climate agreements and a sound regulatory regime for renewable energy production (Oji et al., 2016), developers in the country should be able to attract carbon revenues to their projects. However, research shows some level of ambivalence as to the use of carbon finance by renewable energy developers in Kenya (Nyambura & Nhamo, 2014).

1.2 Motivation for the Study

This research is motivated by interesting challenges that low and middle-income countries face in the use of carbon finance as a way of curbing the increase in carbon emissions. While investments in renewable energy is key to reducing these emissions, there is lack of clarity on the use of carbon finance in funding these investments, hence need to investigate this link in the context of these countries. Further, there is need to scrutinize the levels of awareness and understanding of carbon finance as a financing mechanism among investors in renewables in order to try and explain this ambivalence. Prior research has also not established clearly what determines the inflows of carbon finance into emission reducing projects for Kenya as a low and middle-income country (Burial & Arens, 2014). These motivations are as discussed in the sections below;

1.2.1 Understanding and Uptake of Carbon Finance

Efforts to mitigate climate change were started in earnest by the United Nations when the United Nations Framework Convention on Climate Change (UNFCCC) was formed in 1997. Since then, the concept of carbon finance started featuring in the global agenda, particularly with the ratification of the Kyoto Protocol in 2005 (IPCC, 20017). As the world continued to find sustainable ways of responding to climate change, carbon finance has continued to evolve in terms of form and structure (Silver, 2015). As such, Hermwille, Obergassel, Ott and Beuermann (2017) find that there isn't yet an internationally agreed definition of carbon finance. As the ravages of climate change increase, the multiplicity of funding sources, ranging from corporations, state, regional and international sources, coupled with different applications for these funds makes it especially a tall order to directly define carbon finance (Lambe, Jurisoo, Lee & Johnson, 2015). Moreover, Descheneau (2012) reports that lack of mainstream theories to describe the emergence of carbon finance as a form of project finance, as opposed to traditional forms of finance, could probably explain the lack of congruency among researchers on this subject of carbon financing.

The differences in definitions and understanding of carbon finance can also be attributed to an extent to the functionality and orientation of the entity using carbon finance (Aglietta et al., 2015). For instance, some of the descriptions range from resources provided to activities and projects generating greenhouse gases, to financial compensation from rich nations to poor nations for environmental pollution (Purdon, 2015). Other descriptions and categorizations of carbon finance vary in scope and direction of flow. Some researchers characterize it as a form private financial flows to carbon emission reducing projects (Gomez-Echeverri, 2013), while others see it as a kind of public finance, emanating from country to country (Labbat & White, 2011). Yet others see it as a form of overseas development aid on climate change related endeavours (Halimanjaya & Papyrakis, 2012). These definitions and categorizations provide the premises on which carbon finance is based and can be applied to guide the overview of certain forms of carbon finance flows. However, they may not solve the problem that organizations who collect data may have no clear (or a very different) definition of carbon finance (Reyes, 2013).

Researchers in the field of carbon finance find that there is a whole multitude of ideas and proposals for old and new forms of finance for climate action in developing countries (Nie et al., 2016). Aglietta et al. (2015) find that the multiplicity of funds, funding sources and increased financing mechanisms dedicated to climate change has affected the understanding of carbon finance, particularly among researchers in developing countries. Prior research shows low levels of understanding of the concepts and use of carbon finance in Kenya as well (Sena, 2015). A report by Carbon Africa (2015), a carbon advisory consultancy based in Africa, finds little interest in carbon credits sales for developers in Kenya, with more focus on electricity sales from their projects. This study was motivated by the desire to explore the level of understanding of carbon finance by renewable energy investors in Kenya, in order to assess how international carbon finance has been used to help promote emissions mitigation in the context of low and middle-income country.

Prior research also shows that the flows of carbon finance have been less than steady, partly due to the promises made by the global north to the global south that have not been met (Aglietta et al., 2015; Liu, Chen, Zhao & Zhao, 2015). However, the World Bank (2016) reports that significant amounts have been available to low and middle-income countries. But, as reported elsewhere in the study, the distribution of the available carbon finance across the globe has been uneven, with little of it accruing to low and middle income countries in Africa (Veld-Merkoulova & Viteva, 2016). Research shows that there is a mismatch between the renewable energy investments and the carbon finance accrued in Kenya (Kippra, 2015). Nyambura and Nhamo (2014) observe that Kenyan developers, for lack of awareness on carbon finance procedures, submit proposals to request for funding, when such proposals ought to be part of the financing arrangements. This study was also motivated by the need to explore the uptake of carbon finance in Kenya, and the reasons thereof of the reported uptake.

1.2.2 Determinants for Carbon Finance Uptake in Renewable Energy in Kenya

The flows of carbon finance to mitigate climate change is determined by many factors, cutting across two levels; the country level and the project level (Halimanjaya, 2015). However, research shows that factors determining carbon financial flows at the country level are more diverse and stringent than at project level (Farrell & Lyons, 2016). For a country to accrue carbon finance, it has to fulfil the basic requirements, such as ratifying an international climate agreement or creating the necessary legal and policy framework. Michaelowa (2012) observes that once this is done, the carbon revenues inflows at the project level are dependent on the efforts of the developers as well as conditions in the wider carbon markets.

Halimanjaya (2015) and Dolsak and Crandall (2013) find that private mitigation finance at the country level is influenced by geopolitical factors such as colonial ties, country size as well as the geographical location, which strongly determine Clean Development Mechanism (CDM) host location. Other scholars find that carbon finance is also influenced by the economic performance of a country, as it improves the ability of developers to invest in emission reducing projects (Eyraud, Wane, Zhang & Clements, 2011; Whitley, Granoff, Chiofalo, Halimanjaya & Pickard, 2014). Further, Del Rio and Linares (2014) also find that the bureaucracy of the designated national authority plays a substantial role in unlocking carbon finance flows into a country, with countries whose Designated National Authorities are more proactive accruing more carbon revenues. Lee (2013) also finds that countries with stringent foreign direct investment policies do not attract many bilateral and multi-lateral institutions, from which much of the carbon finance flows.

Researchers report different factors that determine the accrual of carbon finance into emission reducing projects. Michaelowa (2012) finds that large emission reducing projects, such as big renewable energy producing plants, do attract carbon buyers who need to fulfil their cap requirements. However, Abbasi and Abbasi (2011) find that large-scale projects, while providing significant benefits on emission reductions, require significant capital outlays, placing them out of reach for many low and middle-income countries' developers. Scholars such as Luxmore, Tauyanashe and Lawrence (2013) and Kiplagat et al. (2011) argue that to enhance the geographical spread and hence increase the per capita emission reductions in these countries, small-scale projects, especially those in renewable energy should be implemented.

The inflows of carbon finance into emission reducing projects has also been shown to be influenced by variability in carbon offset prices. Some scholars find that the prevailing carbon offset prices impact the enthusiasm of project developers, as well as the location of the project (Conte & Kotchen, 2010; Nazifi, 2013). However, Hamilton, Sjardin, Peters-Stanley and Marcello (2010b) find that the drop in offset prices over the years has not dampened the morale of developers hoping for a price recovery. The variability in offset prices is also a factor of the carbon market in which the offsets are traded (Agrawal & Tiwari, 2013). While some scholars find the compliance market more lucrative for developers (Bode, 2013), others find that the rigorous validation process in the CDM market has driven developers to the less bureaucratic voluntary carbon market (Hamrick & Gallant, 2017). However, Ervine (2014) argues that market-based carbon finance has remained highly volatile because of its dependence on conditions in the broader global carbon market, regardless of the market affiliation.

Prior research also shows that the level of technology employed in a project is also a factor in the uptake of carbon finance because it determines how much carbon emissions a project can reduce (Kriegler et al., 2014). The level of low carbon technology employed in an emission-reducing project has also been shown to vary with the sectoral scope of the project (Weitzel, 2015). For instance, sectors such as those of renewable energy and energy efficiency, have been shown to yield more lucrative offsets, partly because of the emission reducing abilities of the technology used (Dolsak & Crandall, 2013). However, carbon finance outcomes for technology transfer, which was designed to play a vital role for Annex II countries in achieving greenhouse gas emission reductions, have not been clearly articulated (Farrell & Lyons, 2016).For low and middle-income countries, such as Kenya, the problem is that new and emerging technologies often struggle to secure investments, hampering their development and market uptake (Byrne & Mbeva, 2017). Moreover, these new and advanced technologies are initially capital intensive, making them inaccessible for developers in these countries. This study was motivated by a desire to explore the carbon finance outcomes in the deployment of such technologies in renewable energy projects in Kenya.

Empirical evidence on the determinants of carbon finance inflows into renewable energy projects is limited to developed countries, where the complementarity between carbon finance and renewable energy has been well scrutinized (Cacho, Lipper & Moss, 2013; Conte & Kotchen, 2010; Lovell & Liverman, 2010). Twidale (2013) and Olang and Esteban (2017) observe that the marginalization of some poor and developing countries and the misuse of the carbon markets by certain influential groups such as financiers, has impacted carbon finance uptake in these countries. For Kenya, studies such as Nyambura and Nhamo (2014) and Sena (2015) show that carbon finance uptake remains low. However, there is ambivalence as to these determinants have impacted the uptake in renewable energy investments, which this study sought to address.

1.2.3 Theoretical Perspectives in Studying Carbon Finance

Researchers on environmental finance have employed different theories to bring an understanding of the subject, but a single theory that captures the whole meaning and application of the subject has remained elusive (Aldy & Stavins, 2012). While some of the theories have focused on the conceptual nature of carbon finance (Benessaiah, 2012), others have explored its contribution to various aspects of sustainable development such as renewable energy deployment, sustainable land use and waste management (Sulemana, James & Rikoon, 2016; Paola & Luca, 2010). Moreover, as a new field of development finance, differing in structure and concept from the traditional corporate finance, there is ambiguity as to the applicability of mainstream finance theories.

In an endeavour to explain the impacts of the described determinants on carbon financial uptake, this study is anchored in four theories. The Asset Pricing Theory is variously applied to explore the concept of carbon pricing, the principle tenet on which the concept of carbon finance is based. The trading of carbon assets, such as carbon emission reduction permits generated by renewable energy projects is primarily the foundation of carbon finance accrual to a project. The Diffusion of Innovations theory by Rogers (1962) is used in the study to explain how new innovations, such as carbon finance instruments and renewable energy technologies, are adopted and spread through a social system. The theory has been identified as useful in predicting adoption of renewable energy technologies (Lacerda & Bergh, 2014) and those of new environmental finance innovations (Newell, Pizer & Raimi, 2013), because of the benefits the up takers get from these innovations. However, it has been criticized on its inability to predict human behavior towards adoption of the innovations (Tews, Busch & Jorgens, 2003).

The Value Belief Norm theory by Stern, Dietz, Abel, Guagnano and Kalof (1999) which prescribes pro-environmental beliefs and sustainability practices, shows how sustainable values that emerge out of the desire for environmental protection and development can lead to the concept of sustainable development. Proponents of the theory, Turaga, Howarth and Borsuk (2010) and Van Riper and Kyle (2014) propagate that these beliefs and practices lead to passing of international agreements such as the Paris agreement, born out of the desire to protect the environment. It is from these beliefs and practices that carbon finance, directed towards achieving sustainable development has emerged (Prati, Albanesi & Pietrantoni, 2015).

Lastly, the Technology-Emissions-Means (TEM) developed by Pickl (1999) describes the economic interaction between actors who intend to minimize carbon emissions using low carbon technologies which must be paid for. The theory emphasizes the need for carbon finance to pay for technologies that can lead to reductions of carbon emissions. It simulates a real carbon market scenario, similar to the flexible mechanisms of Kyoto Protocol, by expressing how effective technology co-operation between countries or project developers can help achieve sustainable emission reductions (Pickl, Kropat & Hahn, 2010).

Scholars have recently devoted considerable attention to the understanding of various ways to deal with the increase of greenhouse gases. As one such solution to the climate crisis, carbon finance has gained attention but its structures remain rather underdeveloped. This study sought to conjure a multi-theoretical approach to the concept of carbon finance, that could make the understanding of the concept easier. As a new field of environmental finance, the diversity and richness of theories in the field are limited, hence the need to use a multi-theoretical approach.

1.2.4 Challenges of Investing in Renewable Energy

Prior research shows that the world must transition to low carbon energy if the targets of maintaining global warming to less than 2^0 C is to be met (Farrell & Lyons, 2016). For this reason, global investments in renewable power capacity have increased over the years, hitting USD 265.8 billion in 2015, more than double dollar allocations to new coal and gas generation, estimated at USD 130 billion in the same year (GSR, 2016). However, while research shows renewable investments increased for low and middle-income countries, the increase was at a lower rate than that of developed countries (Olang & Esteban, 2017). For instance, Kenya attracted USD 316 million of asset finance in 2015, well down below the 2014 figure of USD 1.1 billion that was buoyed up by the financing of the Lake Turkana wind project. Prior research shows that low investments in renewables have constrained electricity generation in many African countries to the extent that the continent has the lowest access rates in the world (Abdullah & Jeanty, 2011). Kenya, with an estimated population of 45 million people, has an installed power capacity of only 2,295.5 MW, which translates into a per capita access rate of only 0.049kW (KNBS, 2016).

Prior research enumerates several challenges that deter renewable energy investments in Kenya, which has a reported huge renewable energy potential (Pegels, 2010; Rambo, 2013). But some of the reported challenges have since been overcome in the rest of the world, prompting some more research to find out what's the situation for Kenya. For instance, costs for new renewable energy equipment have been falling since 2012, such as solar installation equipment whose costs have decreased by a whole 70 percent (Mukasa, Mutambatsere, Arvanitis & Triki, 2015; GSR, 2016). Further, while technology costs have reduced due to advancements in technology, Lacerda & Bergh (2014) find that new and advanced technology for renewables is still a barrier for developers in low and middle-income countries. For instance, Oji et al. (2016) posits that countries like Kenya need financial and technological support in order to leapfrog fossils and move straight into renewables. Other scholars list financial and bureaucratic constraints, such as the inability of financial institutions to lend to otherwise feasible renewable energy projects, citing collateral problems (Mukasa et al., 2015; Pueyo, Bawakyillenuo & Osiolo, 2016). This study was driven by the quest to identify the challenges that renewable energy developer face in Kenya, in order to understand why significant proportion of renewable energy resources remain untapped.

1.3 Statement of the Problem

Climate changes pose a social, environmental and economic challenge to the world today (IPCC, 2014). The increase in anthropogenic GHGs, particularly the burning of fossil fuels, to provide energy for industrial and home uses, has been shown to be the main of global warming (Somerville, 2012). While addressing this crisis requires broad-based efforts and wide-ranging expertise, the aspect of payment for greenhouse gases emitted to those who sequester the gases from the atmosphere has taken the centre stage (Zimmer, Frierson, Startz & Liu, 2017). Research shows that carbon finance, the resources that are provided to projects that are generating or are expected to generate greenhouse gases, has emerged as an important mechanism to address the increase in GHGs (Silver, 2015). But the policy processes and development of carbon finance instruments has been a rough ride, creating barriers that have hampered its success as a key instrument of mitigating climate change.

Prior research shows that a significant percentage of the carbon finance available across the world (over 80 percent of all mitigation finance) has been targeted to renewable energy projects (Nie, Chen, Yang, & Wang, 2016; CPI, 2016). This is because the production of energy from burning of fossils has been shown to be the largest contributor to the emission of greenhouse gases, accounting for over 80 percent of all GHGs (Bhattarai, Stalick, Mckay, Geme & Bhattarai, 2011). Fossils fuels are also expected to be depleted over time, leaving the world without a dependable source of energy. Therefore policy makers, investors and governments have identified renewable energy as an alternative to fossils that can provide an efficient and sustainable energy source to sustain future economic growth (Stern, 2008; Eloka-Eboka & Inambao, 2014). However, many factors, including capital intensity of renewable technologies and continued provision of subsidies to fossil fuels, make renewable energy generation in the short term, more costly or more difficult to implement than conventional fossil fuel-based technologies, particularly on a large scale for low and middle income countries (UNEP, 2014; Kiplagat et al., 2011).

While carbon finance has emerged as an attractive financing option and technology vehicle to help scale-up renewable energy investments, there is ambivalence on its use and role in financing renewable energy production in low and middle-income countries (Jakob, Chen, Fuss, Marxen, Rao & Edenhofer, 2016). Climate Policy Initiative (2017) shows that carbon finance contributed over USD 437 billion and USD 385 billion worth of renewables in 2015 and 2016 respectively. However, East Asia and Pacific are the largest destinations for carbon finance with $132 billion/year, or 32% on average for 2015/2016, with sub-Saharan Africa only receiving USD 12 billion, representing a mere 3 percent (CPI, 2017). For Kenya, prior research shows that carbon finance for the development of renewables is low or lacking, especially for a country whose electricity base is renewables (Lambe et al., 2015). Although Kenya has a potential for of 6 GW of electricity from renewables (Kiplagat et al., 2011), only 2300MW has been installed. Moreover, for a country with such a huge renewable energy potential, and a national grid based on renewable energy, only 16 projects have been registered with the CDM (NEMA, 2016). While carbon finance can provide an additional source of revenue for sustainable energy projects by creating a commercial value for reducing greenhouse gas emissions, Nyambura and Nhamo (2014) find that this is hardly the case for Kenya. Further, the determinants of carbon finance inflows into projects, including the size of the project, technology employed, market for generated carbon credits and their sectoral scope, all combine to make it daunting for developers to meet the market requirements.

Carbon finance can increase the commercial viability of renewable energy projects and thus play an important role in sustaining and growing renewable energy in Kenya. However, access to these finance has been shown to be a problem for renewable energy developers in a low and middle income country like Kenya, even though it has enormous renewable energy potential (Mulugeta, 2012). As a party to UNFCCC, Kenya is eligible to benefit from carbon finance inflows, as it can host both the voluntary and compliance carbon market projects. But evidence is lacking as to how much Kenya has accrued from pledges made by the developed countries, through these agreements, since they were first made in the Conference of Parties 16 in Mexico in 2010. Further, while Kenya has enacted necessary laws and policies to spur use of carbon finance in renewable energy, such as the Feed-In-Tariff policy of 2008 and the Climate Change Act of 2016, the story on the ground is different. The understanding and levels of awareness on the incentives provided by these policies seem to be wanting for developers. The fundamental question here is how, for a country with such a renewable potential and a party to international climate agreements, has international carbon finance helped promote carbon mitigation through renewable investments.

1.4 Broad Objective of the Research

The broad objective of the study was to establish the determinants of the uptake of carbon finance among developers of renewable energy projects in Kenya, in order to establish the role carbon finance has played in the financing renewable energy projects in the country.

The specific objectives were as follows;

1. To examine the understanding of carbon finance among renewable energy developers in Kenya.
2. To determine the level of the uptake of carbon finance among organizations producing renewable energy in Kenya
3. To establish the determinants of the uptake of carbon finance among renewable energy developers in Kenya
4. To establish the challenges of investing in renewable energy projects in Kenya.

1.5 Research Questions

The research objectives stated in section 1.4 were formulated into the following research questions;

i. What is the understanding of carbon finance among renewable energy developers in Kenya?
ii. What is the level of the uptake of carbon finance among organizations producing renewable energy in Kenya?
iii. What are the determinants of the uptake of carbon finance in Renewable Energy investments in Kenya?
iv. What challenges do developers in Kenya face in developing renewable energy investments?

1.6 Significance of the Study

This study examines the uptake of carbon finance in renewable energy for a low and middle-income country, Kenya. Renewable energy has the much-needed potential to reduce carbon emissions, and earn project developer's carbon revenues, from the sale of such emissions. As the country is a signatory to international agreements that promote use of carbon finance to help reduce carbon emissions, the study is important to many groups that could have a bearing on this subject such as the government on policy formulation, academics on furthering research on the subject and developers, on the gains they could accrue from their projects. This section explores the significance of the study to the various players in the field of carbon finance.

(i)Government: Kenya is endowed with enormous potential for renewable energy generation. However, the uptake of carbon finance by the renewable developers is evidently low, as only a handful of projects are registered with CDM board or floated in the voluntary carbon markets. Although the Kenyan government has provided an enabling environment for CDM and voluntary market participation, it does not have a framework to help renewable energy producers access the international carbon markets (NEMA, 2016). By providing information on the uptake and determinants of accessing carbon finance by renewable energy developers, the study will serve to inform government policy on use of carbon finance to promote renewable energy development.

(ii). Academia: Academic literature on the use of carbon finance in renewable energy investments is mostly available in developed countries. Although a few research studies are available in Kenya on carbon finance, most of the literature available is in the form of policy documents, which are not complete regarding research findings and conclusions. There is a dearth of research on carbon finance in Kenya, and indeed the wider African context, which is a pointer to the poor rigour with which African scholars have treated the subject of carbon finance. Most prior research is concentrated in the European Union, probably because of the success of its emission trading system (EU, 2004). This study will contribute to knowledge enhancement in the subject of carbon finance in Kenya. It will also help build academic literature in Kenya on access and use of carbon finance, from which upcoming scholars can rely on to advance knowledge in the subject

(iii). Renewable energy project developers: Many renewable energy developers are not aware and do not understand the processes of accessing carbon finance (Oji et al., 2016). The importance of renewable energy projects in climate mitigation cannot be understated. Project developers in low and middle-income countries in Africa do not have the financial ability to develop their projects to completion to enable them access carbon finance (Chiyembekezo, 2012). Moreover, the carbon markets operations remain complicated for many developers, especially those with small-scale projects. This research provides knowledge of the requirements that developers need to fulfil, in order to accrue carbon finance. By identifying the determinants and constraints of accessing carbon finance, developers in Kenya will be in a better position to accrue the resources for their investments, which have been shown to be scarce. The results of this study will provide a sound practical basis on which more funding can be accrued. This could be timely, especially given the potential of renewable energy resources in Africa.

(iv). Climate change advocates: The world faces a serious economic and social problem in climate change. To inform public opinion and advocacy on issues relating to mitigation, studies such as this one, on ways of arresting the problem are not only necessary but essential. This study is therefore important in informing public debate on how carbon finance can be used to promote clean energy development, as a way of mitigating climate change.

1.7 The Scope of the Study

This study examines the role of carbon finance in the deployment of renewable energy projects in the context of a low and middle-income country, Kenya. It explores the uptake of carbon finance in Kenyan renewable energy developments, both from the compliance carbon markets and from the voluntary carbon markets. It also examines the determinants and constraints of the carbon finance uptake into these projects across the country. It collected data from five strands of renewable energy in Kenya; wind, hydro, geothermal, solar and biomass over a window of ten years, 2006 to 2016. This window coincides with the ratification of the Kyoto Protocol, which enabled Kenya to host Clean Development Mechanism projects. To triangulate the data sources, in order to gain better understanding of the topic, data was also collected from other carbon business stakeholders in the country. While renewable energy development remains by far the largest recipient of carbon finance, little attempt has been in a low and middle-income country to explore this relationship. The study also reviews past studies on the link between carbon finance and renewable energy, where the variables of the study have been examined in other contexts.

1.8 Organization of the thesis

This thesis sought to analyze the determinants of carbon finance among renewable energy developers in Kenya. It is organized into eight chapters. The first chapter presents the background of carbon finance and renewable energy deployment and sets the basis for the motivation of the study on which the literature review is based. It also provides the problem statement as well as the research objectives and research questions. The rest of the thesis is arranged as follows;

The second chapter of explores the theoretical framework of the research on carbon finance. It provides theories and models that drive the basis of investigating the relationship between carbon finance and its effect on deployment of renewable energy technologies. The application of each theory and the empirical evidence backing its use in the study of carbon finance is also provided. The third chapter reviews empirical literature on the nature and justification for carbon finance use in renewable energy projects. It also reviews the literature on carbon finance use by developers in Kenya, as well as the constraints they encounter in their quest to accrue carbon finance. In a bid to provide the context of the study, it reviews the carbon market landscape and renewable energy potential for Kenya. Emanating from the literature reviewed, the chapter also provides the research gaps addressed by the study. Finally, it provides a conceptual framework which draws the relationship between the variables studied.

Chapter four of the study presents the development and formulation of the hypotheses tested by the study, based on the literature reviewed in chapter three. Chapter five describes the research methodology adopted for the research providing the philosophical basis of the study, by describing its ontology and epistemology. The sixth chapter presents the results of the analysis of the data collected as well as the hypotheses tested. Based on the study findings from chapter six, chapter seven provides the discussion which positions these findings against prior research. The discussion of the findings helps to point out various areas of diversion and convergence between the research and other studies, and in particular on the premises of time, scope and geography.

Finally, chapter eight presents the summary, conclusions and recommendations of the study. First, it presents a summary of the research approach to the study, the research findings and the research approach. Then based on each objective studied, a conclusion is made followed by theoretical and practical implications of the study. The contribution to knowledge by the study is also presented and finally, the limitations of the study and suggestions for further research are presented.

CHAPTER TWO

THEORETICAL PERSPECTIVES UNDERLYING THE STUDY ON CARBON FINANCE AND RENEWABLE ENERGY

2.1 Introduction

The meaning, nature and scope of carbon finance differ across organizations and countries (Gomez-Echeverri, 2010). For this reason, getting a single theory that encompasses the subject has not been possible. The study, therefore, adopts a multi theoretical approach and reviews several theories that seek to explain the variables of the research. The aim of this chapter is to explore these theories and models that try to justify the use of carbon finance in environmental innovations, such as those in renewable energy. Moreover, the theories presented also form a conceptual basis for understanding, analyzing, and designing ways to investigate the relationship between uptake of climate finance and the growth of renewable energy investments in Kenya.

The chapter is organized as follows; Section 2.2 explores the theoretical framework of the research, including the strengths and weaknesses of each theory. The various theories reviewed start from section 2.3 with the Asset Pricing Theory, the main theory underscoring how the pricing of carbon emissions originates carbon finance. Section 2.4 reviews the Diffusion of Innovations while Section 2.5 expounds on the Value-Belief-Norm Theory. The Technology Emissions-Means (TEM) Model, which simulates a carbon market situation is reviewed in Section 2.6. Finally, section 2.7 provides a brief summary to the chapter.

2.2 Theoretical Framework for the Study on Carbon Finance

To explore the relationship between renewable investments and flow of carbon finance, it is important to explore the theories that form the foundation of the concepts of carbon finance and renewable energy. Theories are important in trying to predict and understand phenomena. They can also be used to challenge and extend existing knowledge within the limits of critically binding assumptions (Gray et al., 2011). This theoretical framework attempts to connect research on carbon finance to existing knowledge in the area of environmental innovations. It also attempts to explain how environmental innovations, such as those in renewable energy and climate finance, are readily supported by existing theories (Torraco, 1997) and helps researchers in understanding the research problem under the study (Cresswell, 2014). The search for a theory that tries to explain this innovation is therefore necessary, to try and hold or support the research study (Sutton & Staw, 1995). Theories also help in the specification of key variables that influence the uptake of carbon finance, and provide a basis of interrogating how those variables might differ and under what circumstances (Ravitch, & Riggan, 2017).

The study was anchored on several theories to explain the relationship between carbon finance and renewable energy project deployment, in the context of a developing country. The Asset Pricing Theory is applied to ground the concept of carbon pricing, which forms the basis of carbon finance. The Diffusion of Innovations theory by Rogers, which explains the uptake of new innovations, both in environmental finance and renewable energy technologies. The Value-Belief-Norm theory of Stern is used to explain support for a social movement concerned with environmental protection, such as the climate change agreements spearheaded by UNFCCC (2013), for example, the Kyoto protocol or the Paris Climate Agreement of 2015. The Technology Emissions Mean (TEM) model is used to explain the financial relationship of emission reduction and financial uptake through the Joint Implementation mechanism of the Kyoto Protocol.

2.3 Asset Pricing Theory

The Asset Pricing Theory relates the price of an asset with its future (risky) dividends, which incorporates an aspect of adjusting for both time and risk in the value of an asset. One of the early foundations of the Asset Pricing Theory was formulation of the Capital Asset Pricing Model (CAPM) by William Sharpe in 1964. Along this reasoning, the CAPM was built on the principles of nature of tastes and investment opportunities, with clear testable predictions about risk and return (Sharpe, 1964). Based on the principle tenet of the model, the price that an investor pays for an asset today is dependent on the expected future benefits that will accrue form the asset.

In view of this study, the prices investors are willing to pay for carbon assets depends on the future benefits they will accrue from these assets. By pricing greenhouse gases, Daniel, Litterman and Wagner (2015) find that investors are making a trade-off between consumption today and potentially catastrophic damages (climate change) in the future. The commoditization and pricing of carbon emissions converts them into carbon assets, which can accrue carbon finance for investors by trading them in a carbon market. Munk (2013) also find that it is the willingness of any utility-maximizing investors, in this case carbon investors, to shift their consumption over time that defines the prices they are willing to pay for the asset, in this case carbon credits. In quantifying the amount of carbon finance that can accrue to a project, such a renewable energy project, the amount of the projected carbon emission reduction is critical (Nhamo, 2011). Aldy and Stavins (2012) find although converting greenhouses gases to tradable permits creates assets, the pricing of such assets are complicated by the valuation of the nature of the commodity and is not as straight forward as trading of equity investments in the capital markets.

Through carbon pricing, the burden of damage from GHGs is shifted back to those who are responsible and can avoid it (Veld-Merkoulova & Viteva, 2016). Further, Nhamo (2011) observes that a carbon pricing helps to mitigate climate change in a flexible and least-cost way, by allowing emitters to full internalize the consequence of their actions. However, Liu et al. (2015) find that the quantification and determination of the carbon prices has become a bone of contention between policy makers and researchers. Consistent with the concept of higher returns for assets with large payoffs, as set out in the Asset Pricing Theory, the carbon prices paid for a carbon asset will depend on its likely future climate benefits. Based on this notion, projects that contribute large emission reductions, equated to large payoffs, accrue more carbon finance. For instance, projects that reduce methane, which is more harmful to the environment, are more handsomely rewarded in the carbon markets.

The concept of carbon finance is based on the pricing and payment for carbon emissions reductions. Through the flexible mechanisms created by the Kyoto protocol, international carbon pricing has effectively contributed to carbon emission reductions in a way would transition the world to a low carbon development pathway. Hamrick and Goldstein (2015) observe that based on the flexible mechanisms and other developments in the carbon markets, carbon pricing has acquired many forms and shapes, which in total contribute to the body of carbon finance. There are those that put an explicit price on GHG emission (a price expressed as a value per ton of carbon dioxide equivalent (tCO2e). Others, like carbon taxes, guarantees the carbon price in the economic system against an uncertain environmental outcome. Yet others include results-based climate finance (RBCF) and internal carbon prices set by organizations. However, Liu et al. (2015) find that these multiplicity of pricing mechanisms creates some form of confusion for investors in the carbon markets, which affects policy decision making and climate risk management.

2.3.1 Empirical Literature on Asset Pricing Theory

Prior research shows a growing consensus among policy makers and corporations that carbon pricing is a fundamental requirement to decarbonize the globe (Nhamo, 2011). From these realization, many researchers have applied the asset pricing theory to the problem of carbon pricing, in an effort to value climate change. For instance, Daniel et al. (2015) apply the asset pricing theory to model the effects of climate change as a standard asset pricing problem. They use the CAPM to price carbon emissions as asset, albeit with negative payoffs. Chevallier (2009) also investigates the properties of the new carbon asset class in terms of portfolio management, by adopting the basic framework of the CAPM and mean-variance optimization. Through the mean-variance optimization analysis, he shows that a global portfolio composed of energy (including carbon), weather, bond and equity risky assets could achieve a level of return that would make them plausible investments.

Trinks, Ibikunle, Mulder and Scholtens (2017) applied the concept of asset pricing to examine how a firm's greenhouse gas emission intensity affects their cost of equity. They find that the transition from high- to low-carbon energy sources will differentially impacts financial assets, to the extent that low-carbon assets may benefit from lower costs of capital through a reduction in their perceived risks. Han, Liu, Lin and Huang (2015) also observe that carbon pricing and fuel-mix should be taken into account when valuing carbon assets, as they contribute to contribute to carbon risk. Despite the sparsity of literature on carbon assets, the reviewed studies serve to position trading of carbon assets, primarily the pricing of carbon emissions, as a tangible solution to climate change.

2.4 Diffusion of Innovations Theory

The Diffusion of Innovations theory was developed by E.M. Rogers in 1962, in an attempt to explain how a new idea or innovation gains momentum and diffuses or spreads through the social system, with the goal of being adopted. Rogers (1962) postulates that adoption of an innovation, be it a new idea, behaviour or product does not happen simultaneously in a social system, as illustrated in figure one below. He identifies five established categories of adopters, based on their affinity or speed of taking up the new innovation; innovators, early adopters, early majority, late majority and laggards in that order (Rogers, 1962; Rogers, 2010). Further refinements to the theory were proposed by Darley and Beniger (1981), who elaborated the diffusion theory to show that the adoption of innovations is a stepwise process. Figure 1 shows the interactions between the variables of the diffusion of innovation model.

Diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system (Rogers, 2010). Mahapatra and Gustavsson (2008) see diffusion also as a special type of communication concerned with the spread of messages that are perceived as new ideas while Tapaninen, Seppanen and Makinen (2009) find an innovation to be an idea, practice, or object that is perceived as new by an individual or another unit of adoption. Veer Martens (2006) postulates that the characteristics of an innovation, as perceived by the members of a social system, determine its rate of adoption. Rogers (2010) stresses four main elements in the diffusion of new innovations; the innovation itself, the presence of communication channels, the time period over which the innovation is to spread and the presence of a social system over which the idea is to spread.

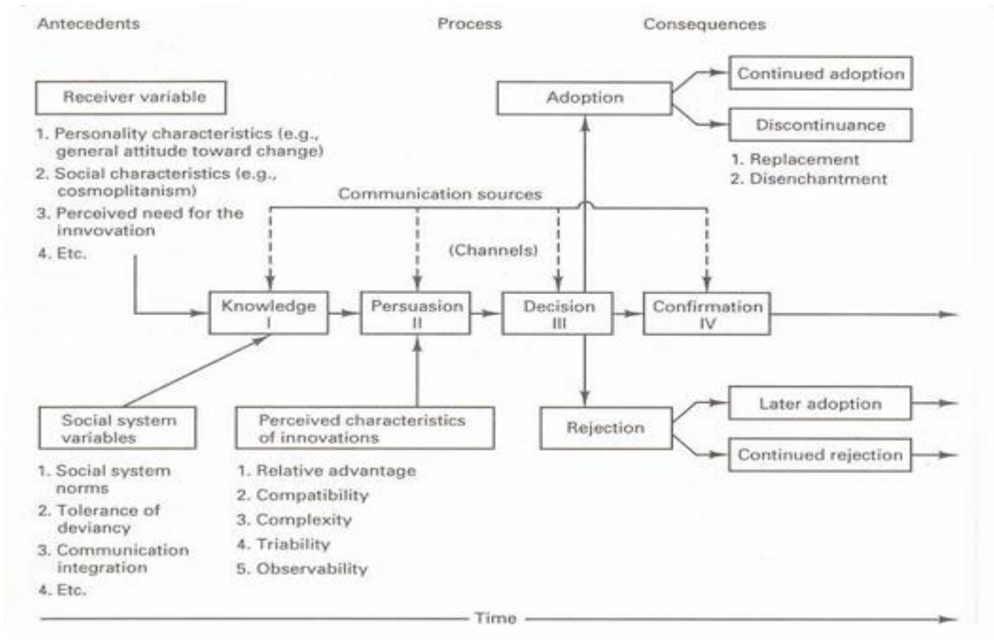
The innovation adoption decision can be regarded as a process (Rogers, 2010). This process includes stages of knowledge, persuasion, decision, implementation, and confirmation in which persuasion refers to a stage when a person or group has an attitude with positive or negative attributes of the innovation (Vollink, Meertens & Midden, 2002). The adoption of environmental innovations such as carbon finance, just like other innovations, have been shown as a process whereby some people are more apt to adopt the innovation than others (Tapaninen et al., 2009). Researchers (Quitzow, 2015; Veer Martens, 2006) have found that people who adopt an innovation early have different characteristics than people who adopt an innovation later. Early adopters are fewer than all the other categories, signifying the skepticism with which people treat new innovations. The majority of the adopters fall under the late adoption categories, with few of them lagging even more behind.

The variation in the adoption of an innovation can be explained in terms of five characteristics: relative advantage, compatibility, complexity, trialability, and observability (Rogers, 2010), each of which plays a role in some role in each of the five adopter categories (Veer Martens, 2006). Relative advantage is based on an individual's perception of an innovation being objectively advantageous, with innovations perceived to be advantageous being adopted more rapidly. Innovations that are compatible with existing values, past experiences and needs of potential adopters are also more rapidly adopted (Rogers, 1995). Trialability is the degree to which an innovation may be experimented with on a limited basis, with new ideas that can be tried on the instalment plan will generally be adopted more quickly than innovations that are not divisible because of risk averseness of individuals. Finally, innovations whose results are more visible to others who have not adopted are more easily adopted, especially if the outcomes are advantageous to the adopters, as in the case of environmental innovations (Baker, Newell & Phillips, 2014).

The diffusion of Innovations theory, however, has faced criticism as to the prediction of individual behaviour towards adoption. One main criticism is that the theory pays too much attention to the individual and does not look at the social context and the role the media plays in that social context (Tews et al., 2003). The theory is said to work better with the adoption of behaviours rather that cessation or prevention of adoption. Further, pro innovation bias is said to cloud the study of the diffusion of innovations, mostly funded by change agencies, which generally are in the business of promoting those innovations. Moreover, the theory doesn't take into account an individual's resources or social support to adopt the new behaviour (or innovation), also known as the individual blame bias (Kern, Jorgens & Janicke, 2001).

Despite the criticisms, the theory remains a strong basis of studying the adoption of new innovations in many fields such as health, education and business. The theory was applied in this study to explain the uptake of this new innovation, in form of renewable energy technologies as well as carbon finance instruments. The assessment of the uptake of this innovative carbon finance instruments in Kenya and their application to the deployment of renewable energy technologies was also examined.

Figure 1: Diffusion of innovation model.



Source: Rogers (1995)

2.4.1 Diffusion of Renewable Energy Technologies

In recent years, many scholars have analyzed the adoption of new technologies in energy production, with varying conclusions. In some studies, the diffusion of energy innovations has been found to be as a result of people's decision to adopt energy-conserving processes and products (Darley & Beniger, 1981). Vollink et al. (2002) show that perceived compatibility is a general and important predictor of the intention to adopt energy conservation interventions while Wustenhagena et al. (2006) contend that social acceptance is the main constraining factor in increasing renewable energy investments. Lacerda and Bergh (2014) also agree that renewable energy technologies are influenced by sociopolitical and community acceptance, both of which are increasingly recognized as being important for understanding the apparent contradictions between general public support for renewable energy innovation and the difficult realization of specific projects.

Using the DOI, Kern et al. (2001) show that the diffusion of environmental policy innovations, as a contribution to global environmental policy increases the uptake of renewable energy technologies. This view is confirmed by Garrone, Piscitello and Wang, (2011), who show that international knowledge developed by other countries has positive effects on the focal country's innovation in renewable energy technologies. Others researchers show that innovations in sustainable energy are easily adopted across countries, although with varying time periods and social acceptance (Rao & Kishore, 2010; Vollink et al., 2002). A recurring theme in the literature concerning sustainable energy sources is the observation that whenever a cleaner or a cost-reducing technology is available on the market, its uptake across households takes several years and sometimes even decades (Quitzow, 2015).

Using the five characteristics of various adopter categories, Vollink et al. (2002) show that energy conservation interventions are judged on their relative advantage, with the potential adopter mainly rejecting it if the advantage is minor. If the perceived advantage was high, the evaluation process usually continued. Perceived compatibility then became the second evaluation criterion, followed by complexity, trialability, and then observability in that order (Dechezlepretre, Glachant & Meniere, 2008). While there are ambitious government targets to increase the share of renewable energy in many countries (AIE, 2014), it is increasingly recognized that social acceptance may be a constraining factor in achieving this target (IPCC, 2015; Ravitch & Riggan, 2017).

Janicke and Jacob (2004) and Quitzow (2015) also agree that if the share of renewable energy investments was to increase, the innovation and diffusion of environmental technologies and their support through national environmental policies must be spearheaded by the states. However, this has not always been the case (Tapaninen et al., 2009), with the adoption of new RE technologies taking longer to be adopted, due to lack of government support (Bale, McCullen, Foxon, Rucklidge & Gale, 2013). Beisea and Rennings (2004) demonstrate that environmental innovations, when supported by global demand or regulatory trends, strict regulation results in the creation of lead markets that will pioneer their adoption (Bredin, Hyde & Muckley, 2014; McMichael & Shipworth, 2013).

2.4.2 Diffusion of Environmental Finance Innovations

It is widely recognized that financial innovations play a crucial role in improving productivity and efficiency in an economy (Ang & Kumar, 2014). The rate at which the innovations diffuse is also equally important, as it helps in understanding the nature and impact of the innovation in the economy (Akhavein, Fram & White, 2005; Cantono & Silverberg, 2009). Although financial innovations have been seen as essential for efficient and responsive capital markets, the number of quantitative studies on financial innovations are few and quite recent (Knill, Heichel & Arndt, 2012).

Several researchers have deployed the diffusion of innovations theory (DOI) to explore the diffusion or spread and adoption of financial innovations (Akhavein et al., 2005; Porter, Bird, Kaur & Peskett, 2008). Carbon finance, a form of new environmental finance, is considered an important innovation of international finance in recent years (Ma, 2013) and its adoption is hinged on the benefits the up takers get from the innovation (Newell et al., 2013). The international carbon finance market has shown a trend of rapid development since its inception (Janicke & Jacob, 2004) and the adoption of carbon finance instruments has indeed deepened across countries (Ma, 2013). However, CDM investments have so far failed to reach all of the high-potential sectors intended by the protocol. This raises doubts about whether the CDM has been able to follow a path similar to other kinds of innovations (Rahman, Dinar & Larson, 2010).

To stimulate the generation and adoption of environmental innovations, a framework of environmental regulations must be developed (Beisea & Rennings, 2004). Such a framework, though initially put together in the Kyoto Protocol, did not stimulate enough the uptake of climate finance. Many poor and lower income countries were left out of the mainstream carbon markets, either because of the costs of the instruments required to participate in the markets, or the very structure of how the markets were designed (Halimanjaya, 2015). However, carbon finance remains an important market incentive (Hogarth, 2012) that coupled with international and domestic policies, could promote the achievement of greenhouse gas stabilization targets while also meeting other societal goals (Szarka, 2012).

Many kinds of financial innovations associated with climate change have emerged with time, including swaps between CERs and ERUs, carbon options, carbon funds, futures contracts and asset backed collaterals (World Bank, 2012b; Capoor &, Ambrosi, 2009). Ang and Kumar (2014) report that these financial innovations have succeeded in increasing the development of greenhouse reducing technologies. However, Karakosta, Marinakis, Letsou and Psarras (2013) argue that the challenge for future carbon financed clean technology projects will be to leverage inherent symbioses between climate and development areas in order to overcome its impediments. Moreover, effective mitigation of climate change will depend on a complex mix of public funds, private investment through carbon markets, and structured incentives that leave room for developing country specific innovations (Stewart, Kingsbury & Rudyk, 2009). Lambe et al. (2015) argue that nation states must pioneer new approaches and push for advancement in environmental policies, for clean technologies to be highly adopted.

There is widespread recognition that carbon finance needs to be scaled up from its current levels if the world is to achieve the target of reducing GHG emissions (Stewart et al., 2009). For this to happen, climate finance must move from the traditional project based cap and trade mechanism. New innovations of generating more finance to pay for GHG reduction must be made, and the spread of their adoption well thought out. Scaling-up and replication of these climate finance innovations could be an efficient way to increase the private sector's interest in the mobilization of climate finance (Kato, Ellis, Pauw & Caruso, 2014). New innovative forms of carbon finance can help to make clean technologies more attractive to international actors (Rao & Kishore, 2010), with the effect of having more of them being adopted. This could help increase the reductions in carbon emissions, mitigating climate change (Rahman et al., 2010).

2.5 Value-Belief-Norm Theory

The value-belief-norm theory (VBN) proposed by Stern and colleagues (Stern et al., 1999), is a general theory of environmental concern that is applied to risk perceptions. The theory explains the basis of support for a social movement, such as environmental activism, and the risks inherent therein (Slimak & Dietz, 2006). It hypothesizes three types of support; citizenship actions, policy support and acceptance, and personal-sphere behaviours that accord with movement principles and are empirically distinct from each other and from committed activism (Kaiser et al., 2005). The VBN theory has also been shown to account for, variance in consumer behaviour, policy support, environmental citizenship, and awareness of consequences of individual and group action in undertaking pro-environmental activities (Stern, 2000).

Embedded within the VBN theory is a theory of environmental beliefs (Stern, 2000) which postulates that values, and especially the concern with the well-being of other humans and the biosphere (altruism), are at the core of environmental perceptions (Slimak & Dietz, 2006). Slimak and Dietz (2006) also suggest that the value and belief components of the VBN theory may offer a useful explanation of variation in risk perception across individuals when it comes to environmental concerns. Dietz et al., (2005) show that values are deemed relatively stable over the life course, and act as filters or amplifiers with regard to information about threats to objects of value, in this case, the environment. The theory also suggests those general beliefs about the sensitivity of the environment to human intervention act as a filter on the plausibility of new information.

The implication of the VBN theory is such that the adoption of instruments to combat climate change, such as the use of carbon finance and renewable energy projects, is based on the belief that climate changes pose a big risk to the environment in which we live. Hence, the value of combating this environmental challenge, to help prevent damage to an object of value to us, the environment. Riper and Kyle (2014), in their examination of factors influencing pro-environmental behaviour, find that biospheric-altruistic values geared toward nonhuman species and concern for other people positively predicted environmental worldview and pro-environmental behaviour, whereas egoistic values negatively influenced moral norm activation. It is this concern that helps us quantify the inherent environmental risks and thus form an opinion to help restore the environment, in a similar way the IPCC decisions are arrived at. Sjoberg (2000) emphasized that severe consequences, such as those brought by climate change, are an important factor in risk perception, a concept very similar to the idea of awareness of consequences in the VBN theory. Using the VBN theory, and drawing on values and the norm-activation process, many research studies (Stern et al., 1999; Stern, 2000; Kim et al., 2015), propose that environmental sustainability practices, such as those involving renewable energy deployment, stem from perceived value of altruism, personal pro-environment belief and sustainable practices.

2.5.1 Sustainable Values

The VBN theory postulates that values, and especially the concern with the well-being of other humans and the biosphere (altruism), are at the core of environmental perceptions (Stern et al., 1999). Values are important to individuals because they affect a wide spectrum of human behaviour (Soyez, 2012) and attitudes with emotional intensity (Dietz et al., 2005). Stern et al. (1999) categorize values as social and environmental values. According to Barr and Gilg (2006), sustainability values are clearly held by committed environmentalists who hold values emphasizing social unity more than personal wealth. Kim et al. (2015) argue that an individual concern for his natural environment makes him acquire sustainable values with an emphasis on the intrinsic nature of that value, a view many scholars (Stern & Dietz, 1994; Dietz et al., 2005; Steg & Vlek, 2009) seem to agree with.

Sustainable values emerged out of the desire for environmental protection and development, leading to the concept of sustainable development. Sustainable development emerged out of the effort to reconcile the competing demands of development and environmental protection beginning with the 1972 Stockholm Conference (Leiserowitz, Kates & Parris, 2006). The concept of sustainability value uses the notion of three types of values: altruistic, self-enhancement and biospheric values (Kim, Lee & Yang, 2015). Altruistic value refers to moral imperatives that have been conceptualized as a basis for environmental attitudes and behaviour (Stern et al., 1999; De Groot & Steg, 2008). Altruistic individuals are likely to reveal more sustainable lifestyle practices, as opposed to egoistic or competitive social value orientations (Steg & Vlek, 2009).

Self-enhancement value represents power and achievement, and are likely to be possessed by people who have an environmentally friendly intention (Kalkbrenner & Roosen, 2016). These individuals are likely to favour environmentally sustainable practices, because of their social interest (Davidov, Schmidt & Schwartz, 2008). It is through self-enhancement values, that the concept of climate finance was born, with the West feeling that their interests were being threatened by climate change, agreed to pay to clean the environment, through the Kyoto protocol mechanisms. Thus, self-enhancement values led to support for biospheric values when interests of the people pertain to protecting the environment (De Groot & Steg, 2008). Biospheric values emerge when people take account of phenomena on the basis of costs or benefits to ecosystems or to the biosphere (Lopez-Mosquera & Sanchez, 2012). These values contribute uniquely to the explanation of environmental beliefs and intentions and hence costs to attain those beliefs.

2.5.2 Pro-environmental Beliefs

Pro-environmental belief represents an attitude toward the environment (Stern, 2000) and the collective good which is distinguished from a purely self-interested attitude (Turaga et al., 2010). Pro-environmental believes are associated with support for sustainable movements, which are concerned with the environmental conservation (Wall, Devine-Wright & Mill, 2007). Many scholars agree that pro-environmental belief is mainly determined by values and leads to pro-environmental behaviour (Clark, Kotchen & Moore, 2003; Turaga et al., 2010; Soyez, 2012). It is this belief that many pro-environment movements, including the UNFCCC, are believed to have emanated (Staats, 2003). De Groot and Steg (2008) have argued that there are positive relationships between biospheric values and pro-environmental beliefs, though Davidov (2008) show that biospheric value orientation is distinct from the altruistic and self-enhancement value orientations.

In this era of dangerous and potentially catastrophic global climate change, inducing pro-environmental behaviours (PEBs) in individuals is an important aspect of attaining sustainable development (Turaga et al., 2010). The basis of many environmental degradation solutions is the pro-environmental belief that individuals and groups hold. These beliefs, to a large extent, are influenced by risk perceptions (Slimak & Dietz, 2006) and the fear of the consequences that would result from environmentally harmful activities (Andersson, Shivarajan & Blau, 2005). However, sometimes, individuals with extensive knowledge of environmental issues may not necessarily engage in sustainable practices or pro-environmentally. Individuals with a biospheric value orientation are likely to weigh the costs and benefits of acting pro-environmentally, before arriving at the decision to do so (De Groot & Steg, 2008).

2.5.3 Sustainability Practices

The social movement support of the VBN theory holds that sustainable values and beliefs lead to the development of acceptable behaviours which lead to sustainable practices (Turaga et al., 2010). Sustainable practices reflect an ethical response to environmental threats and risks, based on the activation of an individual or groups social norms (Kim et al., 2015). The suggestion here is that environmental sustainability practices, such as investing in renewable energy, are based on the belief that they will bring forth control of environmental threats, such as reducing greenhouse gasses which lead to global warming.

The type of sustainable activities individuals or groups engage in will depend on the level of their committed activism to the environmental issues. Kim et al., (2015), based on Stern's (1999) typology, identified three aspects of sustainability practices; ecological citizenship, green consumption and green product purchasing. Ecological citizenship refers to a shared personal commitment to sustainability (Seyfang, 2006) while green consumption takes into account the consumers' social responsibility in decision-making processes in the private sphere (Hurth, 2010). Green product purchasing, on the other hand, refers to eco-friendly product purchases resulting from awareness and knowledge of environmental issues (Abdul-Muhmim, 2007). These sustainability activities, though distinct by their very own nature, appear to be highly related to pro environmental beliefs. Moreover, taken together, they coalesce into the wide concept of sustainable development. Sustainable practices reflect an ethical response indicative of either a New Ecological Paradigm (Dunlap, Van Liere, Mertig & Jones, 2000), which measures the public's more recent and sophisticated understanding of complex environmental issues, such as global warming and the subsequent climate change.

2.5.4 Empirical Studies informed by VBN Theory

Research on the VBN suggests that the theory has been used in many studies, to test the acceptability of environmentally friendly behaviours. Steg, Dreijerink and Abrahamse (2005) examined factors influencing the acceptability of energy policies aimed to reduce the emission of CO2 by households, using the VBN theory. Using 112 Dutch respondents, their results confirmed the causal order of the variables in VBN theory, moving from relatively stable general values to beliefs about human–environment relations, which in turn affect behaviour specific beliefs and norms, and acceptability judgments, respectively. Similar to Prati (2015), they also found that biospheric values were also significantly related to feelings of moral obligation to reduce household energy consumption and hence the carbon footprint for the household. Steg and Vlek (2009) find a strong correlation between environmental quality and human behaviour patterns, with (Jansson, Marell & Nordlund, 2011) reaffirming, using eco-feedback technology, that individual or group behaviours are critical in reducing environmental impacts.

Andersson et al. (2005) employs the VBN theory to show how multinational corporations must play a significant role in the advancement of global ecological ethics, by helping combat the global challenge of climate change. Stern et al. (1999) stress that pro-environment behaviour is acquired by individuals who accept an environmental movement's basic values. The notion of paying for carbon emissions is based on these values that a valued objects- the environment- is being threated and action must be taken to restore it. Kim et al. (2015) and Van Riper and Kyle (2014) also postulate that people will support a movement to restore objects of value if only such objects pose some form of risk to them.

The value-belief-theory has, however, been shown to exhibit some weaknesses. Kaiser, Hubner and Bogner (2005), used survey data and adopted previously established compound measures to contrast the value-belief-norm (VBN) model and the theory of planned behaviour (Ajzen & Madden, 1986) regarding their ability to explain conservation behaviour. Using structural equation analyses, they revealed a remarkable explanatory power for both theories but compared to the VBN model, the TPB covered its concepts more fully in terms of proportions of explained variance. More importantly, the fit statistics revealed that only the TPB depicts the relations among its concepts appropriately, whereas the VBN model does not. This is similar to Lopez-Mosquera and Sánchez (2012), who find that the theory of planned behaviour has a greater influence on explaining the willingness to pay for environmentally sustainable behaviour than the VBN. However, Harland et al. (1999) and Kaiser et al. (2005), on the contrary, find personal norms, as advocated by VBN appear to increase the proportion of explained variance in environmentally relevant behaviours beyond that explained by the theory of planned behaviour constructs.

2.6 Technology-Emissions-Means (TEM) Model

According to Kollmuss, Zink and Polycarp (2008), one of the main contributors to the growth of the voluntary carbon market is the Joint Implementation (JI) mechanism of the Kyoto Protocol. The aim of the JI program is to strengthen international cooperation between enterprises in order to reduce carbon dioxide emissions. The UNFCCC (2007) also provides that sustainable development can only be guaranteed if the instrument is embedded into an optimal energy management instrument. It is for this reason that Stephan Pickl developed Technology-Emissions-Means-Model (TEM) model to give the possibility of simulating such an extraordinary market scenario (Pickl, 1999). The model gives the possibility of simulating economic behaviour in a market scenario that allows the trading of carbon emissions.

The Technology-Emissions-Means-Model(TEM) describes the economic interaction between several actors (players) who intend to minimize their emissions (E_i) caused by technologies (T_i) by means of expenditures of money (M_i) or financial means, respectively (Pickl, 2001). The players are linked by technical cooperation and the market which, expresses itself in the nonlinear time-discrete dynamics. The model expresses how effective technology co-operations between countries or project developers which, is the central element of the Kyoto Protocol's Joint-Implementation mechanism can be used in reducing carbon emissions.

This model has been used by researchers to model environmental protection by players who intend to minimize their emission reductions (Pickl, 2001; Rahman et al., 2010 and Krabs & Pickl, 2004). It has also been used to develop an optimal energy management tool and compare several technology options that would better help in emission reductions (Krabs & Pickl, 2004). The model also invents an effectivity parameter which describes the effect on emissions of a player if another actor invests money in technology such as renewable energy (Pickl, 1999).

The TEM model is an appropriate model to simulate carbon emission reductions (Pickl, 2001). Energy consumption, especially the burning of fossil fuels, is expanding rapidly as developing economies increase the production of goods to growing populations (Rahman et al., 2010). This, in turn, will increase GHG emissions, leading to global warming (Linares, Santos & Ventosa, 2008). Optimal energy management and deployment of renewable energy projects will ensure more clean and efficient energy use. This can only be possible by investing more in new energy technologies to reduce the emissions (Mantovani, Tarola & Vergari, 2016). These are the three parameters that comprise the TEM mode; technology, expenditure and emissions (Pickl & Scheffran, 2000). For this to be possible there has to be a sustainable market for linking these three parameters, possibly the carbon markets. It describes the economic interaction between several players which intends to maximize their reduction of emissions caused by technologies and by spending money. The players are linked by technical cooperation and the market. The model invents an effectivity parameter which describes the effect on emissions of a player if another actor invests money in technology (renewable energy).

2.6.1 Empirical Studies informed by Technology-Emissions-Means (TEM) Model

The Technology-Emissions-Means (TEM) Model has been used to model carbon emission reductions and optimization of energy management by several researchers. Krabs & Pickl (2004) use game theory to extend the use of TEM model in the area of time-discrete dynamical games where the model comes out as a useful tool to implement and verify a technical Joint-Implementation Program. Scheffran & Pickl (2000) apply the model in analyzing the interaction between energy technologies, emission reductions and economic output with regard to energy use. Based on the TEM model, Grimm, Pickl and Reed (2006) develop two tools, TEMPI and VERIGESTER that can be used in optimal energy management within emissions trading markets. The application of the TEM model across all these studies brings an important focus on energy management in the process of reducing carbon emissions. The studies also emphasize the use of dynamic game models to identify, assess and compare options for avoiding and minimizing anthropogenic climate change (Scheffran & Pickl, 2000).

In analyzing the mathematical foundations of dynamic and complex regulation networks, Kropat, Weber and Akteke-Ozturk (2008) examine the use of the TEM model in exploring the structure of the underlying regulatory networks for environmental finance. Ozmen (2016) further uses mathematical models such as TEM to model environmental regulatory regime such as the Joint Implementation mechanism. Their analysis shows that modelling can be successfully applied to important problems in finance and technology, such as renewable energy and emission reductions. The use of the TEM model to model technical cooperation in the emission markets thus plays an important role in promoting renewable energy technology in climate mitigation.

2.7 Summary of the Chapter

The application of the underpinned theories and their tenets in explaining the underlying relationships between carbon finance is the main objective of this chapter. The Diffusion of Innovations theory is backs adoption of carbon finance as a new financial innovation among renewable energy developers in Kenya. The Value-Belief-Norm theory expounds on how individuals acquire the sustainability and pro environmental beliefs, which lead them to adopting carbon finance as a solution to an environmental challenge. The Asset Pricing Theory explains how carbon emissions, which lead to global warming and is the premise on which carbon finance accrues, are priced in order to enable trading in the carbon markets. Lastly, the Technology-Emissions-Mean model simulates a real carbon finance scenario, where carbon emission emitters have to spend money to pay for their actions. It is based on how the Joint Implementation, one of the mechanisms under the Kyoto protocol, can achieve maximum benefits in carbon emission reductions. It was not possible to get a single theory that explains the uptake of carbon finance in renewable energy. The multi-theoretical approach employed helps the study to cover all the aspects investigated in the study. Whereas this section tries to review theories that appear to be more explanatory of the two concepts, it by no means exhausts all the related theories, confirming that many theories are indeed required to exhaustively explain the two concepts.

CHAPTER THREE

NATURE OF CARBON FINANCE AND RENEWABLE ENERGY FINANCING

3.1 Introduction

Having presented the theoretical framework backing the study in Chapter Two, this section reviews empirical and theoretical literature on the relationship between carbon finance and renewable energy in Kenya and across the world. It reviews literature on the concept of climate change and how it provides a justification for the development of carbon finance in Section 3.2. To provide the research context, Section 3.3 reviews literature on renewable energy as a solution to carbon emission reductions while Section 3.4 explores the status and potential of renewable energy production in Kenya. Section 3.5 explores empirical literature on the challenges of renewable energy investing in Kenya while Section 3.6 explores the relationships between carbon finance and renewable energy, form an empirical perspective. Section 3.7 provides empirical evidence on the uptake of carbon finance in renewables in Kenya and Section 3.8 provides research gaps in literature, which the study sought to address. Finally, Section 3.9 presents the conceptual framework of the interrelationships between the variables of the study.

3.2 Climate Change: A Justification for Carbon Finance

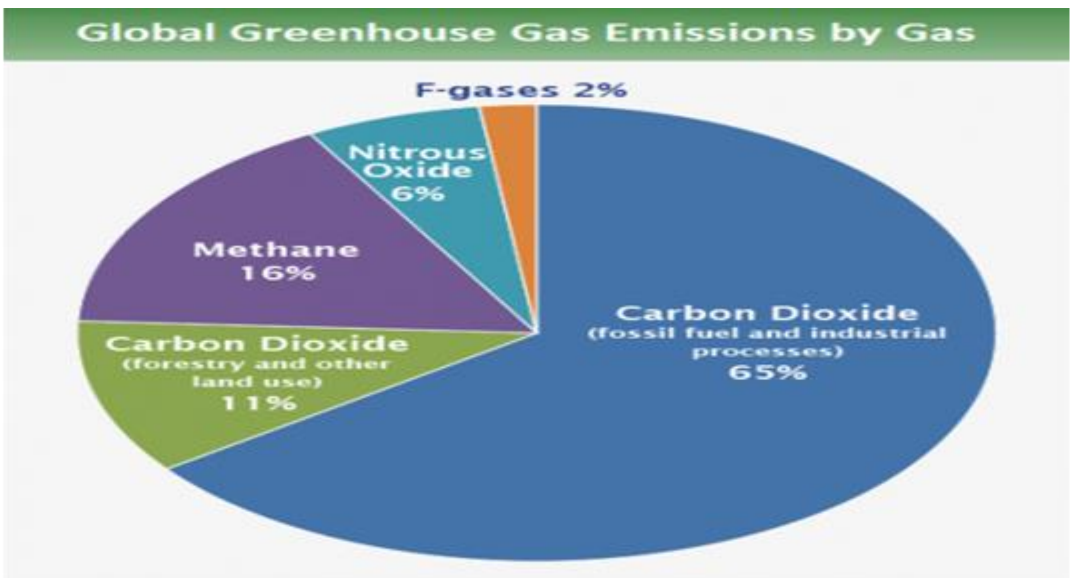
This sections reviews literature on the subject of climate change and explains how the world community resorted to using financial incentives to counter the ravages of climate change. The UNFCCC (2008), defines climate change as a "change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods". Other scholars explain climate change to be a shift in the mean climatic conditions as well as a change in the intensity and frequency of extreme climate events, such as drought, floods, storms, and strong winds, among others, that affect eco systems, water resources, food, health, coastal zones, industrial activities and human growth (Anderegg et al., 2010; Somerville, 2012). Through the Intergovernmental Panel on Climate Change, a United Nations body charged with responsibility of collecting scientific evidence on climate change, the international community has come to an agreement that climate change, whether man made or otherwise, is perhaps the most considerable environment and economic challenge of our time, posing a great danger to sustainable progress globally (Stern, 2008, IPCC 2007; IPCC, 2015; Gore, 2007).

Attempts to quantify scientific consensus on climate change have not been easy. According to Legras (2013), it has taken more than 30 years for climate scientists to reach a point where the doubts about anthropogenic climate change have virtually vanished. Oreskes (2004) also argues that any evidence adduced on climate change, so far, is not empirical but based on a combination of observations, the understanding of the underlying processes and quantitative modelling. Climate skeptics, such as Lindzen and Choi (2011), Schiermeier (2010), who believe that global warming is as a result of the natural earth processes and is not anthropogenic, have not matched the scientific evidence provided to the contrary. IPCC (2014), with its over 800 scientists, points clearly to the fact that climate change is more man made than natural, without disputing the fact that some natural processes as well cause changes in global weather patterns.

According to Stern (2008), the threat of irreversible and dangerous climate change presents a significant economic challenge for governments, businesses and communities across the world. The world bank (2011) provides that poorer countries, especially in parts of Africa, Asia and Small Island states are the most vulnerable to climate change impacts, because they lack adequate infrastructure and support mechanisms to adapt efficiently. Kenya, a USD 6.4 billion economy, is highly vulnerable to these impacts of climate change because of its high dependence natural resources, such as agriculture and tourism for its economic survival (Bryan et al., 2013). For instance, Ogalleh, Vogl, Eitzinger & Hauser (2012) report declining agricultural yields due to unreliable rainfall, which also affects tourism through declining animal population.

The mounting scientific evidence of climate change has brought consensus among policy makers, scientists and economists that changes to global weather patterns are becoming severe and must be addressed (IPCC, 2014; Ervine, 2014). With research showing that the growth in the concentrations of Greenhouse Gases (GHGs) is the main cause of global temperature rise (Renner, 2011), any strategy to address climate change must include reliable and sustainable methods of reducing these emissions. Figure 2 provides relative percentages of the various GHGs as provided by IPCC in 2014. Evidence shows that most of the anthropogenic greenhouse gases are as a result of human activities, such as burning of fossil fuels, deforestation and agricultural land use (Pielke, 2010; Boden, 2015). It follows that the best option to reduce these gases would be to halt these human activities. But it is not possible for the world to run without some form of energy or even food, for that matter. Therefore, scholars advance that any good strategy to address the growth in concentration of greenhouse gases without affecting the growth in our economies must include financial incentives to spur low carbon technologies across the globe (Celiktas et al., 2009; Labbat & White, 2011; Ghoneem, 2016). The main international agreements on climate change, the Kyoto Protocol and its predecessor, the Paris Climate Agreement, both include proposals for a financing mechanism that allows emitters to compensate sequesters of carbon emissions (Mahapatra & Ratha, 2017; Newell, et al., 2013).

Figure 2: Global Greenhouse Gas Emissions by Gas



Source: IPCC (2014)

D'Monte (2015) and De Souza et al. (2015) observe that to combat climate change, and transition the world on a low carbon development pathway, significant financial and intellectual investment in clean growth, sustainable agriculture and energy efficiency is required. The World Bank (2016) estimates that mitigating climate change requires between US$ 140-175 billion per year over the next 20 years, while a further US$ 30-100 billion per year is required for adaptation. Estimates from the Climate Policy Initiative (2016), a body that inventories climate finance across the world, show that over US$ 200 billion per year will be needed to mitigate climate change by year 2030. However, the biggest question is where such enormous amounts of money will come from, given that promises from the developed countries in the past have not been met. According to D'Monte

(2015), concerns have been raised regarding the credibility of the non-binding pledges from the global north to the global south, and their effectiveness in producing outcomes in the future of the climate change. CPI (2016) reports that approximately US$ 97 billion a year is being mobilized for both climate change mitigation and adaptation, but this amount is far less than what is required, if the world is to meet the 2^0C target.

Prior research shows that Kenya, a low and middle income country with limited means to mitigate and adapt to the changing weather, has not been spared by the ravages of climate change (De Souza et al., 2015). Table 3.1 shows how Kenya has experienced temperature changes in the last 50 years. Changes in weather patterns continue to hinder sustainable progress and achievement of the country's economic blueprint, the Vision 2030 (Ford et al., 2015). Evidence adduced shows that it affects ecosystems, water resources, food, health, coastal zones, industrial activities and human growth (Ford et al., 2015; De Souza et al., 2015). Addressing its effects will provide Kenya with opportunities for innovation, business and growth. Researchers have shown that the implementation of the necessary mitigation and adaptation strategies to combat climate will come with huge costs for the country (De Souza et al., 2015; De Jalon, Silvestri, Granados & Iglesias, 2015). Estimates from World Bank (2016) show that Kenya needs about US $500 million per year to address current and future climate change effects as from 2018, with the figure predicted to rise to US $1-2 billion per year by 2030. As the world moves towards a new clean mechanism under the Paris Climate Accords, the question for many African countries, and indeed Kenya, is how the international carbon markets can help raise these finance, to smoothen the process of mitigation and adaptation.

Table 3.1: Observed temperature change 1960 – 2014 in Kenya

Region	**Minimum (night) Temperature**		**Maximum (day) Temperature**	
	Trend	**Magnitude/°C**	**Trend**	**Magnitude/°C**
Western	Increase	2.9 – 0.8	Increase	2.1 – 0.5
Northern & N Eastern	Increase	1.8 – 0.7	Increase	1.3 – 0.1
Central	Increase	2.0 – 0.8	Increase	0.7 – 0.1
South Eastern	Increase	1.0 – 0.7	Increase	0.6 – 0.2
Coast	Decrease	1.0 – 0.3	**Increase**	2.0 – 0.2

Source: NCCRS, 2014

Kenya's development and its energy sector has been highly affected by climate change. While the country relies heavily on renewables to power its households and industries, Kaunda, Kimambo and Nielsen (2012) observe that overreliance on hydro, for example which constitutes over 50 percent of the effective supply has been highly amenable to droughts, affecting supply patterns for electricity in the country. Symons (2014) also report that heavy dependence on biomass resources to provide energy for domestic use fuels deforestation, leading to climate change. The African Development Bank (2011) observes that the growth projections in the Vision 2030, coupled with population increase and urbanization are expected to lead to a rise in the emission levels, essentially because of energy consumption. Mwangi, Kimani and Muniafu (2013) observe that a country cannot experience high levels of economic growth if energy supplies are constrained, and Kenya is not an exception. Without an adequate and reliable supply of energy, the ability to achieve major structural changes in rural and urban economies becomes severely limited. Therefore, for Kenya to achieve any form of sustainable growth and improve the quality of life for its citizens, it must as well address increase in carbon emissions, particularly through the energy sector (GoK, 2010). World Bank (2016) estimate that the continued annual burden of the extreme climatic events could cost the economy as much as US$500 million a year, which is equivalent to approximately 2.6 percent of the country's GDP.

Kenya has operationalized legal and policy responses to climate change. Ongugo et al. (2014) reports that the National Climate Change Response Strategy (NCCRS) and the National Climate Change Action Plan 2013-2017 have provided some clear directions on how the country is to respond to climate change. The enactment of Climate Change Act of 2016 provides a framework for promoting climate resilient low carbon economic development while Vision 2030 also recognizes the use of carbon finance to deploy renewable energy projects (GoK, 2015). However, as energy demand continues to rise due to population increase, Nkonya, Place, Kato and Mwanjololo (2015) observe that the government has also put in place policies to increase the supply of energy services such as promotion of renewables, use of fiscal incentives such as tax holidays for investors and duty exemption, and broadening the energy mix to diversify the energy resource base as much as possible (Kippra, 2015). However, Ongugo et al. (2014) find that the numerous policies simultaneously being implemented on climate change have led to policy incoherence at the national level.

3.3 Renewable Energy and Carbon Emission Reductions

This section provides evidence as to how renewable energy deployment can help reduce carbon emissions. Prior research shows that burning of fossil fuels for home and industrial energy provision accounts for about half of the global emissions of greenhouse gases (Chiu, 2017). For example, carbon dioxide emissions from use of fossils fuels accounts for 80% of anthropogenic emissions (Sclafani, 2010). Even for a low and middle income country like Kenya, records from the Second National Communication (SNC) to the UNFCCC (2015) on the state of carbon emissions in the country show that energy sector emissions have increased by 50% between 1994 and 2005 as shown in Figure 3. These emissions are projected to increase as the country works to realize the Vision 2030. Therefore, as the world population grows, demand for energy to meet social and economic development will continue to increase, leading to increase in carbon emissions. To deviate from this trend, Arent, Wise and Gelman (2011) observe that the world must move to an alternative and low carbon source of energy.

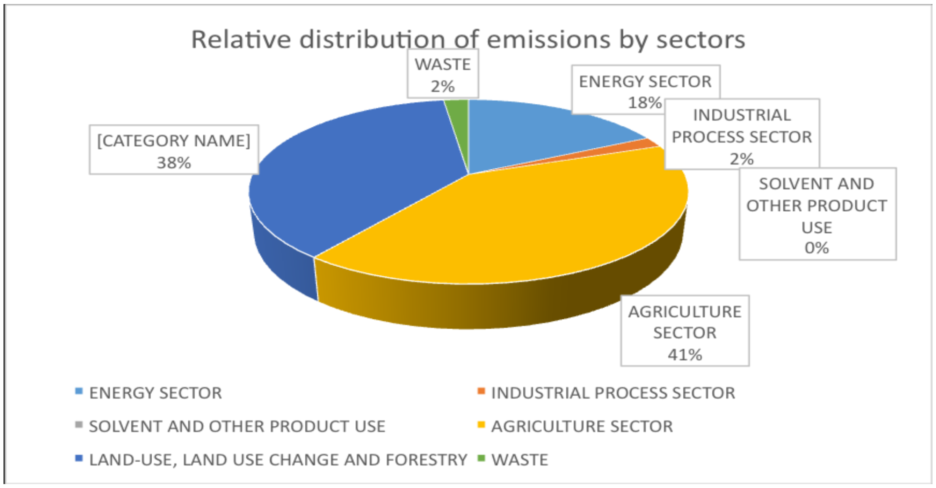
Reliance on fossil fuels is likely to lead to stranded assets, putting the world into a precarious developmental situation for two reasons. First, according to Olah, Goeppert, & Prakash (2015), the amount of fossil fuel reserves that the world holds are finite and are expected to be depleted. Fossil Free (2013a) estimates that the global total reserve levels are 892 billion tones for coal, 186 trillion cubic meters for natural gas and 1,688 billion barrels of crude oil. Prior research shows that, at the current extraction rates, reserves of coal would be exhausted in 113 years, those of natural gas in 2069 while crude oil reserves would entirely be wiped out by 2067 (Olah, Goeppert, & Prakash, 2015; BP Statistical Review of World Energy, 2015). Secondly, burning fossil fuels has adverse environmental effects, and continued use is not tenable if the world has to keep the earth's temperature within 2°C, as has been proposed by the Paris Accord. To counter these effects of fossils, the world must find an alternative and sustainable sources of energy.

The adoption and deployment of renewable energy technologies (RET) have been promoted as one alternative to the burning of fossil fuels that is capable of mitigating the threats of climate change (Krewitt et al., 2009; Trainer, (2013). Because it is derived from replenishable natural processes or sources (Arent, et al., 2011), renewable-energy systems generate little, if any, waste or pollutants, making them an ideal source of clean energy, with multiple environmental benefits (VijayaVenkataRaman, Iniyan & Goic, 2012). Prior research shows that the ability to produce clean energy for electricity generation makes them an essential element of low carbon development and climate change strategies (Bengochea & Faet, 2012; Dent, 2012). Strand (2007) highlights three arguments that justify this support for renewables: the reduction of carbon emissions, the security of the energy supply and, finally, the beneficial effect that technology spillovers coming from research and development and the economies of learning-by-doing can have in curbing production costs in electricity generation. For this reasons, renewable energy offers an immediate means to decarbonize the global energy mix.

Because of these environmental benefits, Kalkbrenner and Roosen (2016) observes that renewable energy has been placed at the core of any strategy for countries to meet climate goals while supporting economic growth, employment and domestic value creation. Prior research shows that doubling the share of renewables by 2030 could deliver around half of the emissions reductions needed and, in combination with energy efficiency, keep the rise in average global temperatures within 2 degrees Celsius, the widely recognized target to prevent catastrophic climate change (IRENA, 2015; Shannyn, 2015). For this reason, leading world states are currently contemplating how to design policies and market structures that support a modernized, low-carbon grid, with renewables at the core (Kalkbrenner & Roosen, 2016). IRENA (2015) estimates that investments of up to USD 500 billion annually between now and 2020 are needed in renewables in order to avoid a lock-in with unsustainable energy systems.

The setting of this study on renewables is primarily because Kenya has a low carbon energy sector, with high renewable electricity generation and household energy dominated by biomass use. According to the Ministry of Energy and Petroleum (2017), renewables account for 74.5% of the electricity production while thermal or petroleum takes the remaining 25.5 %. Although energy sector emissions have increased over time, globally Kenya remains a low emitting country, both on an absolute and per capita basis. According to the estimates provided in the Second National Communication (SNC) to UNFCCC in 2015 relating to the year 2000, Kenya has per capita emissions of 1.35 t CO_2, compared to the global average of 7.58 Mt CO_2e, indicating that Kenya has a relatively low carbon economy. The deployment of renewables could help the country move to a lower carbon pathway without significantly impacting on growth, particularly those concerning energy efficiency measures (KFS, 2015). Moreover, the country has a huge potential for renewables, as described in Section 3.4 of the study.

Figure 3: Relative distribution of emissions by sectors in 2000



Source: Second National Communication to UNFCCC, 2015

Kenya has many options for mitigating GHG emissions. The National Climate Change Action Plan details low-carbon assessment scenarios for six mitigation areas: energy, transport, industry, agriculture, forestry and waste management (NCCAP, 2012). However, Kaunda et al. (2012) finds that renewable energy remains the most visible and productive form of reducing these emissions, while offering other benefits non- market benefits such as job creation, and improved air quality, providing health benefits to populations as a result. Mburu (2009) finds that geothermal power, for example, offers a large abatement potential (projected to be 14 Mt CO_2e per year by 2030) making it a good option for low carbon development of electricity. Osindi (2016) also estimates that, in terms of energy demand, improved cook stoves that reduce the volume of biomass required for cooking, have the potential to reduce GHG emissions by 5.22 MtCO_2e a year. However, adoption of these new technologies is expensive, and especially where they have to be imported, as is the case in Kenya. To achieve energy efficiency, demand management and improved grid operation, large amounts of money need to be invested in RET (GoK, 2012). It is also imperative for the country to identify barriers to transfer and adoption of renewable energy sources (Sanni, Oladipo, Ogundari & Aladesanmi, 2014).

According to Kenya's Intended Nationally Determined Contribution (INDC) presented to UNFCCC before the Paris 2015 Conference of Parties, the country seeks to undertake an ambitious mitigation contribution towards the 2015 Agreement. It seeks to abate its GHG emissions by 30% by 2030 relative to the Business-As-Usual (BAU) scenario of 143 MtCO_2eq, and in line with its sustainable development agenda. However, for a lower middle-income economy, many challenges abound, economic and social. It is estimated that over USD 40 billion is required for mitigation and adaptation actions across sectors up to 2030.To meet the INDCs, Pueyo, Bawakyillenuo and Osiolo (2016) find that the country must seek for international support in the form of finance, investment, technology development and transfer, and capacity building. As it implements its NCCAP (2013-2017), Kenya aims at achieving a low carbon, climate resilient development pathway. The plan intends to focus on many mitigation activities including expansion in renewables such as geothermal, solar and wind energy production, improving the forest cover to 10%, climate smart agriculture and sustainable waste management systems, among other (MoF, 2015).

3.4 Status and Potential for Renewable Energy Deployment in Kenya

As already highlighted, renewable energy has the much needed potential to reduce carbon emissions, and hence mitigate climate change. Because the study explores the use of carbon finance in renewables, this section has been dedicated to reviewing the documented status and potential for renewables generation in Kenya. Lambe et al. (2015) observes that energy is a key component of the Kenyan economy and that the country's economic growth and better quality of life for its citizens requires adequate and reliable supplies of energy. According to Newell and Phillips (2016), the energy sector in Kenya is largely dominated by petroleum and electricity, with wood fuel providing the basic energy needs of the rural communities, urban poor, and the informal sector. An analysis of the national energy shows heavy dependency on wood fuel and other biomass that account for 68% of the total energy consumption, while petroleum provides 22%, electricity 9%, and other sources account for less than 1% (MoEP, 2017).

The installed electricity in Kenya is low, compared to its population. As at 2017, there were only 2295.5 MW of installed electricity, against an estimated population of 45 million people. The access rate represents a mere 0.049kW per capita, signifying low access to electricity, despite the government's ambitious target to increase electricity connectivity from the current 15% to at least 65% by the year 2022(MoE, 2016). But the advantage for the country is that the installed electricity is dominated by renewable energy, at about 65.0% of total electricity installed. However, there is a significant imbalance between rural and urban populations, with a mere 5% of the rural access compared to 51% for urban population, as shown in Table 3.2. Prior research shows that approximately three out of every four Kenyans, of which two-thirds reside in the rural areas, lack access to electricity services resorting to unsustainable use of biomass and agricultural waste, linked with exposure to indoor respiratory infections (KNBS, 2016). These poor households lack adequate access to affordable, reliable, safe and quality energy services leading to a poor quality of life (USAID, 2016).

Table 3.2: Current Energy Access situation in Kenya

		National	Rural	Urban
% of population with access to electricity		15	5	51
Fuel used for cooking	% of population with access to modern fuel for cooking (Electricity, Gas or Kerosene)	17	4	58
	% of population using **wood** for cooking	69	88	10
	% of population using **charcoal** for cooking	13	8	30
	% of population relying on solid fuel for cooking that use **Improved Cook Stoves**	3	3	4

Source: Renewable Energy Country Profiles (IRENA 2015)

Kenya, because of its geographical location between the tropics and straddling the equator, has abundant renewable energy resources capable of generating large amounts of electricity. Prior studies show that the country possesses bountiful wind, solar, small hydro, biomass, and geothermal potential that can generate over 6 gigawatts of electricity (Abdullah & Jeanty, 2011; Kiplagat et al., 2011). Other studies report that this resources remain largely unexploited, leaving the country in dire need of electricity to power its growth (Oji et al., 2016). This section reviews the status and the potential for electricity generation for the various renewable energy strands from hydro, solar, geothermal, wind to biomass. Section 3.5 reviews literature on the reasons scholars attribute to the non-exploitation of these resources. The harnessing of these resources is important because Kenya's economy, population and industry are all expanding at such a rate that demand for electricity is increasing at 13.5% annually, which is expected to reach 15 GW in 2030 (Pueyo et al., 2016).

3.4.1 Wind Energy Resources

Because wind generation produces no carbon emissions, the current surge for wind power expansion across the world has come increasingly from the urgent need to combat global climate change (Acker, Smith, Weathers, & Zinenko, 2012). Tummala, Velamati, Sinha, Indraja and Krishna (2016) show that wind-power systems produce electricity by converting the kinetic energy of the wind, through the use of wind turbines, into mechanical energy, which rotates the wind blades and the connected generators. Mukasa, Mutambatsere, Arvanitis and Triki (2015) report that rapid progress in wind-energy technology has reduced costs of wind energy installation to make them almost competitive with the costs of conventional power, thus making them more accessible in low income countries. The IRENA (2015) estimates that capital costs of wind installation have decreased by about 78 percent from USD 2.2/W in the early 1980s to less than $1/W today. The Global Status of Renewables report (2016) find that the significant cost decrease has led to rapid expansion and adoption of wind energy technologies in many countries across the world.

While Kenya has recently experienced a surge in wind energy installations for electricity generation, research shows that the installed wind energy in the country remains low (Kamau, Kinyua & Gathua, 2010). The installed wind power for electricity generation stands at only 5.45 MW, relative to the country's estimated potential of over 1000 MW (Kengen, 2017). However, projects that are currently being implemented are likely to increase significantly the electricity generated from wind in Kenya. Projects such as the Lake Turkana Wind Project, the largest wind farm in Africa at 310MW, the Kipeto Energy Wind Park, Kinangop Wind Park, Ngong Wind Park Expansion, and the planned Mount Meru Wind Park, are expected to add over 650 MW of electricity to the national grid. Rose, Stoner and Perez-Arriaga (2016) report that small wind turbines of less than 400 W have also been implemented in the country, but their total contribution to the grid has not been significant.

Studies show that, because of its topography, Kenya has some excellent wind regime areas, capable of achieving an accumulated electricity generation of over 1 GW (Kamau et al., 2010). A study done by WinDForce management services (2014) shows that on average wind speed in large parts of the country reaches over 6 m/s at 50 metres, with the areas surrounding Lake Turkana (over 9 m/s at 50 meters) and the coast (5-7 m/s at 50 meters) being particularly attractive. Rose, Stoner and Perez-Arriaga (2016) also reports that an addition of between 10-20 local mountain spots with wind speeds greater than 7 m/s. Windforce projects that using middle to large wind turbines, this could achieve a total of over 1 GW of electricity in the country (Windforce, 2014). Other studies have identified specific areas with wind power generation potential such as Marsabit, Laisamis, Turkana and Samburu (Kamau et al., 2010; Fant, Gunturu & Schlosser, 2016).

Several reasons have been advanced as to why the uptake of wind energy in the country is low. Acker et al. (2012) report that the main problems of wind power installation in Kenya revolve around land acquisition for wind plants, while Kiplagat et al. (2011) report issues of inadequate technical knowledge and capacity. Mukasa, Mutambatsere, Arvanitis and Triki (2015) also observe that initial financial outlays for wind generation such as costs of new turbines is beyond reach for small scale investors in Kenya. A fact that the ministry of energy (2013) alludes to, adding that most of wind generation are not made locally, making them costlier. Several studies also find that security concerns are a major issue for investors, as areas with adequate wind power are mostly remote and far flung (Fant et al., 2016; Oludhe, 2008; Wiser & Bolinger, 2010).

The Kenyan government is keen and ambitious to increase the installed power capacity. The Feed-in Tariffs (FiT) Policy, implemented in 2008, provides wind electricity developers with a tariff not exceeding US Cents 11.0 per Kilowatt-hour of electrical energy supplied in bulk to the grid. By ensuring all the generated electricity is sold, Acker et al. (2012) find that developers can leverage on this market to produce more power. The government has also put in place the 5000+ MW (2014-2017) power plan, which aims at increasing the installed wind capacity from the current 5.45MW to 630MW by 2016 and to 2,036MW by 2030, bringing wind power or 9% of total installed capacity by 2030(MoE, 2013). A Wind Atlas, mapped by the Ministry of Energy provides investors with indicative data on the strength and location of wind resources in Kenya, hence reducing costs for feasibility studies for them (Fant et al., 2016).

Together with the incentives the government has put in place to increase wind power generation, Pueyo et al. (2016) observes that these projects are increasingly being recognized as candidates for climate change mitigation. For example, the National Climate Change Response Strategy, implemented in 2012, proposed the use of wind projects to help the country generate resources to increase its renewables, through the Clean Development Mechanism. Studies such as Nyambura and Nhamo (2014) report that several Kenyan wind projects have applied for CDM registration, such as the 310 MW Lake Turkana wind power project. However, the support from carbon finance for wind power generation is not commensurate with the potential in the country. Kenya needs to overcome a myriad of challenges to implement more wind power projects, to utilize the existing potential (Fant et al., 2016; Lacerda & van den Bergh, 2014). Moreover, favourable financing conditions and long-term policy stability are also needed to attract private sector investment.

3.4.2 Geothermal Energy

Another form of renewable energy that is abundant in Kenya is geothermal. Geothermal power is derived from dry steam, hot water, magma and ambient ground heat, all from the core of the earth, which is estimated to be about 5,500^{o}C hot (Dickson & Fanelli, 2013). Because of the almost limitless ability of the earth to produce magma, and the continuous transfer of heat between subsurface rock and water, geothermal energy is considered a renewable resource (Mburu, 2009; Dickson & Fanelli, 2013). The clean but hot steam and water can be used for commercial electricity generation, giving geothermal a huge potential to mitigate climate change. However, although it is cost effective, reliable, sustainable, and environmentally friendly, scientists report that it is limited to areas near tectonic plate boundaries, the reason why it is mostly found along the Rift Valley (Fridleifsson et. al, 2008).

Bertani (2016) report that recent technological advances in geothermal exploration have dramatically expanded the range and size of viable resources, especially for applications such as home heating, opening a potential for its widespread exploitation. Studies have estimated the electrical potential of the stored geothermal energy within the continental crust to range from 35 to 200GW (Holm, 2010; Stefansson, 2005). The World Energy Council (2016) estimates that this potential is 16 times the current installed generation capacity. Because of international concerns regarding greenhouse gas emissions, Bertani (2016) observe that the policy makers are increasingly recognizing the potential of geothermal energy to displace fossil fuels and help meet the decarburization obligations. Pueyo et al. (2016) also report that more research is being done on how to lower geothermal power production costs, improving methods for finding and characterizing reservoirs, and tapping broader resources.

Kenya is endowed with a huge geothermal potential, mainly along the Rift Valley. Prior research shows that on conservative estimates, the geothermal potential in the Kenyan Rift is over 2,000 MW, whereas the total national potential is put at between 7,000 and 10,000 MW (Omenda & Simiyu, 2006; GDC, 2015). Through the 5000+MW project, the government has scaled up by almost three times the production of energy from geothermal since 2009, from 167 MW to 544 MW. Rose et al. (2016) observe that this increase has been able to reduce the cost of power by 22-35 percent for domestic and industrial consumers respectively. However, many areas with huge geothermal potential remain unexploited such as the Baringo and Silali blocks, which both, have a combined potential of over 3000MW.

While the government has put in place several programmes to boost the electricity production through geothermal production, financial challenges hinder a full scale exploitation of these resource. Studies show that exploration and drilling costs are high, making geothermal electricity expensive at the onset. For example, Bertani (2016) estimate the exploration phase to cost as much as USD 0.5 million for a 100 MW geothermal power project. Moreover, Dickson and Fanelli (2013) find that the capital structure and financial conditions (debt length and interest rate) accessible to the developer also have a major impact on the resulting power production costs. But Pueyo et al. (2016) find that geothermal technology offers low-cost electricity and healthy returns on investment, making it an ideal form of investment for private sector, particularly with the FiT scheme in place. For Kenya, external loans from countries such as Japan has enabled the government to invest in huge geothermal projects, but the resulting power costs have proved dear to tax payers. However, power generated from geothermal is eligible for carbon offsets sales, and the government can leverage on these clean energies to accrue more resources.

3.4.3 Solar Energy

Prior research show Kenya has an abundance of solar energy resources, with daily average solar insolation estimated at about 4-6 kilowatt hours per square meter and 5-7 peak sunshine hours, which is considered one of the best for solar electric energy production in sub-Saharan Africa (Byrne & Mbeva, 2017; Ondraczek, 2013). Evidence provided show that with the conversion efficiency of current solar modules, 10-14% of this energy can easily be converted to electric power, totaling to an estimated potential of 23,046 TWh/year (Ondraczek, 2013). Byrne and Mbeva (2017) reports that this potential is enough to provide power to all the households in the country. However, while the estimated potential for electricity generation from solar is around 10,000MW, less than 1 percent of the country's 2,295.5 MW comes from solar power. The implication thereof, is that Kenya still has a long way to go, in as far as solar energy-institutionalization in the country is concerned (Rose et al., 2016).

While little solar power has been converted to electricity, Matthews et al. (2014) and Da Silva (2014) report that the country has one of the most active commercial photovoltaics system markets in Africa, largely driven by a vibrant private sector, particularly for small scale PV market. Pueyo et al. (2016) find that over 4 million households in rural Kenya connected to solar power, in the off grid market estimated to be over 40MW (IRENA, 2015). However, Byrne and Mbeva (2017) and Ondraczek (2013) reports that PV for grid connection and in mini-grids has so far remained low. In support, the Energy Regularity commission (ERC), reports that as of 2017, the installed solar power capacity in the country for connection to the grid was only 20MW. Rose et al. (2016) find that this low capacity, relative to a huge estimated potential of 10,000 MW, is due to factors related to poor dissemination of these solar technologies.

While enabling legislation has been put in place to improve exploitation of solar power, Rose et al. (2016) observe that such efforts are far from successful. Improved solar tariffs under the Feed-In-Tariff (tariff for solar is fixed at US$0.12 per kilowatt hour for installation connected to the grid and US$0.20 for mini-grids) do not seem to have improved installation rates since 2008 (Hogarth, 2012). The Solar Water Heating Regulations, implemented in 2013 to premises install solar water heaters has not made much progress either. However, recent studies report significant upcoming investments in solar power in the country. A 55-megawatt solar farm, East Africa's largest solar power plant is being planned in Garissa, northern Kenya which will add cheap power to the national grid for onward sale to homes and businesses. The National Energy Policy (NEP) also proposes to grow installed solar capacity up to 500MW by 2030 (Byrne & Mbeva, 2017).

Despite these low levels of installation, Kenya is still ranked 46th in the world in the generation of solar energy. But some studies show that it would rank third if only half of the countries potential is exploited (Nygaard et al., 2015; Hogarth, 2012). However, Kenya has a growing demand and awareness of the potential benefits of solar, especially as the conventional grid, which relies heavily on hydro, continues to prove unreliable (Nygaard et al., 2015). A number of issues affect exploitation of solar resources in the country. This includes but not limited to capital constraints in the acquisition of solar panels, unreliable knowledge on solar technology with few or no trained technicians operating in rural areas. Beyond financial constraints, solar technologies suffer from an image problem in parts of Africa, because they usually operate on a small scale and in isolation (Jacobson, 2007; Nygaard et al., 2015). But Pueyo et al. (2016) point out that solar photovoltaics (PV) could be competitive with expensive diesel generation but its current price does not allow for cost recovery.

3.4.4 Biomass Energy Resources

Prior research reports that biomass energy contributes 68% of Kenya's final energy demand and it is expected to remain the main source of energy for the foreseeable future, particularly for rural households (Alidrisi & Demirbas, 2016). Biomass, the organic matter derived from living or recently living organisms, is abundant in Kenya and could be derived from many sources such as charcoal, wood fuel and agricultural waste. Njenga et al. (2013) observe that as compared to other sources of energy, biomass is cheaper and readily available across the country, the reason it forms such a significant percentage of the energy used in the country. However, the role of biomass, as a significant source of household energy is not officially recognized in Kenya (Mugo & Gathui, 2010). For instance, despite the heavy reliance on firewood and charcoal, the production of charcoal so far remains illegal while the consumption is legal (Njenga et al., 2013).

Kenya has significant potential for generation of electricity from biomass sources. Studies show that agricultural wastes from the sugar cane, sisal, timber (sawdust) and meat industries could help generate over 10,000 MW of electricity in the country (Birundu, Suzuki, Gotou & Matsumoto, 2017). Mugo and Gathui (2010) also that the country has extensive forest cover and shrubbery, such as the Mathenge plant while Kiplagat et al. (2011) highlight opportunities for bio-fuel production from the Jatropha plant and sweet sorghum in many regions of the country such as Eastern, North-Eastern, Rift-Valley and Nyanza. Nzila et al. (2010) also report huge bio fuel potential from a wide variety of oil-bearing plants such as castor, coconut, cottonseed, croton, jatropha, and sunflower, all of which are cultivated in Kenya. Felix and Kai (2010) report an assessed technical potential of over 1.25 million biogas systems across the country, with a potential of over 6,000 MW of electricity.

More potential for electricity generation is also found in other forms of biomass in Kenya. Njenga et al (2013) report that an estimated 5.26 million tones per year of solid municipal waste, capable of generating over 500MW of electricity go to waste from major cities such as Nairobi, Nakuru, Kisumu and Mombasa. Kiplagat et al. (2011) also find that significant potential for bio ethanol production exists along Kenya's sugar belt, in the western part of the country. Alongside ethanol, Alidrisi and Demirbas (2016) identifies the existence of a substantial potential for cogeneration using sugarcane, for over 300MW of electricity from the sugar companies.

Birundu et al. (2017) report that while biomass in form of wood fuel remains the primary form of energy consumed in Kenya, the amount electricity generated from biomass and connected to the national grid remains low. Alidrisi and Demirbas (2016) report that biomass cogeneration, the main form of biomass from which electricity is generated in Kenya, only less than 50 MW has been installed, representing a mere 2.3 % of the total electricity in the grid. These comes only from three projects, Mumias Sugar Company, which generates 35MW out of which 26MW is dispatched to the grid and Kwale Sugar Company which produces 18 MW. The other is Cummins Power Company which supplies 2.4 MW to the national grid from its biogas plant at Baringo along the Kenyan Rift Valley. However, to benefit from the incentives provided for biomass under the FiT scheme, several other companies are in the process of implementing projects such as Tropical power's 20 MW biomass power plant at Naivasha and Nzoia Sugar Company 18 MW project.

While the regulatory and policy framework for renewable energy production is in place and working in Kenya, the Africa Biogas Partnership Programme Kenya (2013) reports that the country lacks a specific legislation on biomass and biofuels generation and use. Birundu et al. (2017) also find that lack of an effective policy has led to poor biomass utilization techniques and lack of value addition methods, contributing to overexploitation of forest resources. But as a renewable form of energy Bhattarai et al. (2011) find that more attention is being focused on biomass for climate mitigation due to dwindling global resources of fossil fuels and rising fuel prices. Kato et al. (2014), for instance, find that substituting biomass for fossil fuels in electricity and heat production is, in general, less costly and provides larger CO_2 reduction per unit of biomass.

Alidrisi and Demirbas (2016) advance that for Kenya to tap into the environmental and economic benefits of using biomass energy, it needs to overcome a myriad of challenges that it faces in the promotion and uptake of biomass and biogas technology (ERC, 2014). Njenga et al. (2013) report that the cost of installing biogas systems is high for most of the population, and its high failure rate has served only to compound the problem of uptake. Further, Nzila et al. (2011) find that inadequate post installation support, poor management and maintenance and inadequate technology awareness make its use even more limited. Moreover, Bazmi, Zahedi and Hashim (2011) also find that biogas projects do have the challenge of requiring large areas of land, which makes them a viable land use option in Africa for un-inhabitable areas like post-mining lands. However, biogas power plants produce bio slurry, which can provide nutrients to improve crop production, and reduce the use of synthetic fertilizers that cause water pollution, making them coexist symbiotically with agricultural land (Mugo & Gathui, 2010). Moreover, because of their climate benefits, these projects could accrue carbon revenues, making it less costly for the implementers. The development of a bioenergy industry can improve energy security, reduce energy imports, and promote the agricultural and forestry sector by adding value to traditional crops. However, the barriers to these abundant form of energy must first be addressed, if Kenya is going to accrue the health and environmental benefits that comes with its use.

3.4.5 Hydro Power Resources

According to the global status report on renewable energy (GSR, 2016), the global capacity for hydro power stands at approximately 1,064 GW, signifying the potential and importance of hydro in the generation of renewable energy. The top countries for hydropower capacity in the world are China, Brazil, the United States, Canada, the Russian Federation, India and Norway, in that order, which together accounted for about 63% of global installed capacity at the end of 2016. Global hydropower generation potential, which is highly vulnerable to climate change and varies with hydrological conditions, was estimated in 2015 at 3,940 TWh (Global Renewable Status, 2016). While Africa holds about 12% of the world's hydropower potential, with a technically feasible output of about 1,800 TWh/year, it holds only about 3% of the global hydropower and exploits less than 10% of its technical potential, the lowest proportion of any of the world's regions (World Bank, 2016).

Studies by Kiplagat et al. (2011) and later by Pueyo et al. (2016) report that Kenya's total hydropower technical resource is estimated to be about 6 GW, with half this potential being attributed to small rivers for small, mini and micro hydro systems (with capacities of less than 10 MW each). Kiplagat et al. (2011) reports that hydroelectric power potential of economic significance available for large scale power generation is estimated to be 1,500 MW of which

1,310 MW is for projects of 30 MW or bigger. Acker et al. (2012) report that the bulk of the country's inland hydro resources are contained within the country's drainage system, consisting of five major basins (Lake Victoria, Rift Valley, Athi and coastal area, Tana River, Ewaso-Nyiro and North-Eastern). However, most of these resources remain unexploited, with the installed hydro capacity conspicuously relying highly on the Tana River alone. According to Balla (2006), of the small hydro potential, which is estimated at 3,000MW, only less than 30MW have been exploited with only 15MW supplying the grid.

Studies report the installed hydro capacity in Kenya to be 758MW, which lie in areas of high energy demand and constitute around 40 percent of the total effective grid connected electricity (Pueyo et al., 2016). Because hydro power is highly vulnerable to hydrology and climate change, overreliance on hydro and low levels of installation means that the country is often amenable to hydroelectricity shortfalls, leading to costlier and GHG-intensive electricity generation through diesel (Kaunda et al., 2012). According to Sambo (2015), the challenges have not diminished the stature of hydro power as a good remedy for climate change mitigation.

Advancement in technology and an enabling legislative framework have combined to make hydro projects, especially the small and pico hydro, more economically viable across many regions in the country (Sambo, 2015). Eberhard and Gratwick (2017) report that the government has enacted several laws and implemented policies to enable the exploitation of its vast hydro resources, such as the FiT scheme and he National Renewable Energy Development Strategy. However, several studies show that high installation costs averaging US$ 2,500 per kW, inadequate hydrological data, effects of climate change, and a limited local capacity to manufacture small hydro power components have combined to impede exploitation of small-scale hydro-electricity (Acker et al., 2012; Pueyo et al., 2016). Jakob, Steckel, Flachsland and Baumstark (2015) report that this climate-related risk and rising shares of variable renewable power are driving adaptation in the hydropower industry, such as co-implementation of hydro power with solar and wind power plants in order to both maximize the efficient utilization of variable resources and conserve water resources.

The development of hydro power has been met with many challenges in the country. Chiyembekezo (2012) find that financial institutions are not willing to lend the whole small hydro power project amount up front because of high risks associated with funding community projects, hence hindering development. Abdullaha and Jeanty (2011) and Sambo (2015), while agreeing with Chiyembekezo (2012) on financing, find that high installation cost averaging US$3,000 per kW, inadequate hydrological data, the effects of climate change, deforestation and degradation of water catchments areas, and the limited local capacity and infrastructure to manufacture small hydro components combined impede development of small-scale hydro power in Kenya. Moreover, the importation of electro-mechanical equipment for the small hydro power schemes makes them overly expensive for small scale developers (Eberhard & Gratwick, 2017).

3.5 Challenges of Investing in Renewable Energy in Kenya

Prior research shows that access to clean, reliable and sustainable energy has been a major problem for developing countries, especially for Sub Saharan Africa (Ebhota et al., 2014; Ebhota & Inambao, 2016). The African Development Bank (2014) reports that only 24 per cent of the entire population of more than 900 million people in Sub Saharan Africa (SSA) are connected to electricity, making it to have one of the lowest electricity access rates in the world. USAID (2016) reports that SSA's installed electricity generation capacity is approximately 70 000 MW, of which 44 000 MW is installed in South Africa, leaving over 45 countries to share the remaining 26,000 MW. Eberhard, Gratwick, Morella and Antmann (2016) find that these low access rates puts energy demand at the top of the challenges to economic growth in the region.

Eberhard et al. (2016) and Ebhota and Inambao (2016) advance that to meet this increasing demand, the power sector in these countries will need to install an estimated 7,000 MW of new generation capacity each year. However, while the World Bank (2017) forecasts rebound in economic growth in SSA, the amount of money required for power infrastructure, to meet these targets, is more than these countries can afford and remains elusive. Ebhota and Inambao (2016) find that a large financing gap exists, with the focus of much of the current spending being on maintenance and operation of the existing but aging power infrastructure. Estimates from the World Bank (2017) show that adequately financing the development of the energy sector in sub-Saharan Africa is expected to require the mobilization of funds in the order of USD 41 billion per year, which represents 6.4 per cent of the region's GDP.

Kenya, the fourth largest economy in sub-Saharan Africa, has shown much progress in the power sector. A USAID (2016) report shows that the country has increased its per-capita power consumption to 161kWh from 98kWHh in just four years while the electricity access has improved from 25 per cent to 46 per cent in a similar period. However, Chirambo (2014) observes that to transition the country to a middle income economy and achieve the targets set in the power sector, Kenya will need an estimated total of between 18-23 billion USD by 2020, of which it has secured only 5 billion USD. Therefore, Pueyo et al. (2016) and Showers (2016) agree that to achieve generation, transmission, distribution, and off-grid electrification targets as set out in the country's power master plan, there is need to develop and support initiatives to address the financing gap. Moreover, with only 2295 MW of installed electricity and a growing population, Kenya remains an inadequate provider of power to its people.

Ebhota and Inambao (2016) observes that to meet the increasing energy demand and grow the economies, SSA countries, Kenya among them, have to expand to renewables. Africa 2030 analysis done by IRENA (2015) has identified modern renewable technology options across sectors, across countries, collectively contributing to meet 22% of Africa's total final energy consumption (TFEC) by 2030, which is more than a four-fold increase from 5% in 2013. Moreover, as reported in section 3.4 of this study, Kenya has remarkable renewable resources, as evidenced by its track record as one of the lowest cost developers and leaders in geothermal power in the world. Further MoEP (2017) reports that Kenya's installed capacity consists of 70% renewable sources, with enormous potential to expand that base. However, Tigabu, Berkhout and Beukering (2015) find that despite substantial investment of effort, the diffusion of renewable energy technologies in Kenya has been disappointing, leading to a search for more effective policies and approaches.

While deployment of renewables has increased across the world, in part due to advances in technology and engineering, Pohl, Jakob and Schlomer (2011) observe that these technologies and electricity from renewable energy remains generally more expensive than those from conventional fossil fuel sources. Jacobs (2016) find that this makes these investments in renewable energy technologies largely inaccessible, especially to poor and low-income countries. Mohammed, Mustafa and Bashir (2013) also observe that despite the increase in renewables deployment across the world, many African countries, Kenya among them still possess abundant renewable energy resources that remain largely unexploited. Research shows that a 680% increase in net renewables capacity deployment is required if Africa is to achieve the ambitious goal of 300 GW of renewable capacity by 2030 set by the African Renewable Energy Initiative (Ganda & Ngwakwe, 2014). The issue of concern to policy makers in Kenya, and indeed rest of Africa, is how to make these new technologies accessible in order to increase electricity generation.

Fortune and Collins (2014) report that one of the major obstacles in harnessing the enormous renewable energy potential in many African countries has been accessing finance. Sanni et al. (2014) also observes that, while renewable energy is capable of overcoming the challenges of energy access in Africa because of its abundant, the diffusion of clean energy technologies has been hampered by a lack of finance. Mohammed et al. (2013) find that many financial do not recognize the sustainable development aspects of these projects, highlighting the sensitivity of renewable energy technologies to financing terms. As a result, they withhold finance to these projects, citing the risk return principle of finance. Park (2016) and Devinney, Markman, Pedersen and Tihanyi (2016) also find that many clean energy ventures, particularly those in the early stage and operating in the developing world, never get off the ground because traditional sources of capital like banks tend to shy away from sectors that seem unfamiliar or too risky. Large projects, such as those in geothermal generation, have high capital costs (LCPDP, 2013), making it hard for private sector companies without financial muscle to explore. However, Mohammed et al. (2013) finds that due to uncertainty surrounding implementation of the Power Purchase Agreement (PPA), coupled with poor financial viability of some projects, obtaining long term finance has been a tall order.

While costs of installing renewables have been falling, partly due to advances in technology, Chirambo (2014) and Pueyo et al. (2016) find that initial project development costs still remain a deterrent for project developers in Kenya. Yaqoot, Diwana and Kandpal (2016) find that renewable energy projects carry massive start-up costs while transaction costs for small decentralized renewable energy facilities make the projects very capital intensive. Further, equipment such as photovoltaic panels, wind turbines, and connectors are all expensive. Although Onguso et al. (2014) observe that the regulatory framework for renewables is sound, the 22 permits and licenses required from developers at the planning stage are a disincentive to investments. Mugo and Gathui (2010) and Hansen, et al. (2014) also report that feasibility studies (technical, environmental and financial), that need to be conducted before a project is considered for funding, often takes ages, due to lack of consultants which makes it also expensive.

Yadoo and Cruickshank (2012) report that the financial problems in renewables investing Kenya has been compounded by lack of commercial lending in the sector. Winkler et al. (2011) and Mohammed et al. (2013) report that commercial banks in Kenya have shied away from renewable energy project financing, partly because of the financial risks involved in the commissioning and completion of the projects. Further Kalkbrenner and Roosen (2016) finds that renewable energy resource availability is a major consideration for lenders, because they do not want to lend to a project whose cash flows may not payback on its investment. For this reason, Collier and Venables (2012) finds that many project developers in Africa lack the financial capacity, to carry on the projects to completion. While Kenya's banking system comprises of a number of local and international banks which may be interested in funding renewable energy projects, Kiplagat et al. (2011) find that their engagement has been modest up to date mainly due to lack of collaterals.

Although Kenya has leapfrogged in some renewable technologies such as those in geothermal and solar, Amankwah-Amoah (2014) observe that technological inadequacies remain a challenge in other strands of renewable energy. Showers (2016) find that the renewable energy sector in Kenya, despite the promising opportunities that it has, faces many problems such as limited data availability, limited local capacity to manufacture most of the projects' components and lack of qualified technicians to operate and maintain equipment used in the sector. Jebli et al. (2016) also find that there is a shortage of trained technicians, with many of them lacking the major competencies required to implement and maintain renewable projects. Barry, Steyn and Brent (2011) report that many African countries requires know-how and capacity to adapt, disseminate, and implement renewable energy technologies for practical applications, which is often lacking. Gudyanga (2011) asserts that this is part of the wider African problem of inadequate capacity in the area of science and technology, which extends to the poor development of RE technologies.

Fortune and Collins (2014) find that project developers in Africa have also to contend with the perennial challenge of doing business in Africa. This is because many investors in the power sector in many of these countries are either from the private sector, or a foreign country. Rugabera, Hwang and Kim (2013) observe that to attract private sector investment, a country has to maintain its political stability, commitment and determination, which will guarantee the private sector investment returns without interference. Mohammed et al. (2013) find that the Kenyan political environment, though stable has elements of risks as far new and capital intensive investments are concerned. Chirambo (2014) gives an example of the 60.8 MW Kinangop Wind Park, which ran into problems with politicians and local community. Another example is Ormat International, a US based geothermal exploration company, which had problems of acquiring the PPA from Kenya power for almost three years.

According to Sampedro, Arto and Gonzalez-Eguino (2017), fossil fuel subsidies constitute a big barrier to tackling climate change, as they encourage inefficient energy consumption and divert investment away from clean energy sources. Coady, Parry, Sears and Shanga (2017) find that the amount awarded for fossil fuel subsidies far outmatches the subsidies awarded to promote renewable energy in the world. According to IMF (2017), fossil fuel subsidies amounted globally to over USD 5.3 trillion in 2016, over four times the value of subsidies awarded to promote renewable energy. The IEA (2014b) and Coady et al. (2017) reports that where resources are good, renewables such as hydro, geothermal, wind and solar are cost competitive with new fossil fuel plants. However, Lambe et al. (2015) finds that inclusion of fossil fuel subsidies impairs the cost competitiveness, making renewable appear more expensive. For Kenya, the discovery of over 400 million tonnes of coal and 300 million barrels of crude oil, is likely to push back against the potential for cost-competitive renewables. The argument that coal is the solution to poverty and lack of access to electricity Africa (Lambe et al., 2015) and the implementation of the coal plant at Malindi is a direct affront to renewables deployment and climate change mitigation in Kenya.

Despite these challenges, the government of Kenya has an ambitious clean energy development plan, that will require an estimated 45billion USD by 2030, of which 60% will be on the generation side and remains on course (GoK, 2015). However, the achievement of the promising initiatives meant to mitigate risks and allow financiers to avail financing for renewables development will depend on how much is invested and the amount of power generated (GoK, 2011). Some of these initiatives are designed to stimulate access to long term and concessional rate financing, such as the Renewable Energy and Energy Efficiency Financing Programme, and The Regional Technical Assistance Programme (RTAP) (KEREA, 2015). Others are meant to promote clean energy and energy efficiency, such as the Energy and Environment Partnership (EEP), the Sustainable Energy Fund for Africa (SEFA) and the Kenya Climate Innovation Centre (World Bank, 2013). While the programmes could serve as a window of opportunity to scale up renewables, Chirambo (2014) observes that similar initiatives in the past have not born much fruits. But, according to

Amankwah-Amoah (2014), the regulatory framework and policies put in place by the government, such as the Climate Change Action Plan, the energy policy, the Energy Act, the Feed-in-Tariff, among others), are expected to be significant drivers for the deployment of clean energy at a national scale. Further, Kenya has adopted an approach to renewables that includes transparent, standardized and competitive programmes which reduce risks for developers and cost to governments (GoK, 2012).

To further mitigate the challenges of renewable energy investing, the Kenyan government, through its various laws and policies, recognized the need to invest in renewable energy in order to mitigate climate change (Yadoo & Cruickshant, 2012). Ebhota and Inambao (2016) report that the Vision 2030, the National Climate Change Response Strategy (NCCRS) and lately the Climate Change Act of 2016, all advocate for scaling up of renewables, as a means of reducing the impacts of climate change in the country's economy. In addition to power generation from renewables, Onguso et al. (2014) advance that some of these policies and laws, such as the Climate Change Action Plan, promote the development of renewable projects, as a means of attracting carbon finance in the country. Because renewables are primary candidates for carbon finance, and Kenya is a signatory of agreements that enable these finance to flow into a country, Lambe et al. (2015) observe that Kenya's renewable production ability could earn it enormous amounts of carbon finance. For instance, Kenya has been selected as a pilot country under the Scaling-Up Renewable Energy Programmes (SREP) in low-income countries programme and has been allocated over US$ 50 million to expand the geothermal development and mini-grid capacities (GoK, 2015; SREP, 2014).

Amankwah-Amoah (2014) and Lambe et al. (2015) report that Kenya continues to receive other forms of support for renewable energy generation. A good example of these plans is the Kenya Joint Assistance Strategy (KJAS), through which donor financing in the energy sector covering over 36 projects/programmes, with 20 donors / DFIs active and over KES 210bn (around USD 2.4bn) invested in the sector from 2005 to 2015. Studies also show that donors have deployed a range of financing tools including grants, mixed grants and loans and concessional lending for the Kenyan renewable sector (Mohammed et al., 2013; Burer & Wustenhagen, 2009). Further, Munang and Mgendi (2016) find that investments in renewables in developing countries are likely to be fueled by the unprecedented agreement among 195 countries, in Paris in December 2015, to act for zero net emissions in the second half of the century (UNFCCC, 2016). To meet the intended nationally determined contributions for greenhouse gas emission reductions, the signatories will have to resort to renewables. Coady et al. (2017) also observe that the sudden reductions in fossil fuel prices, causing distress to many companies involved in the hydrocarbon sector, coupled with adoption climate change policies and improving cost-competitiveness, is also likely to fuel more investments in renewables.

3.6 Carbon Finance and Renewable Energy

According to Buchner et al. (2014), financing the transition to a low-carbon and climate-resilient world has been a significant challenge, particularly for low and middle income countries. Newell et al., (2013) find that these countries, while not being historically culpable for climate change, they often lack the policy and financial capacity needed to spur the necessary investment. The global community, through the IPCC, established broad guidelines on how much climate finance is required and who would the contributors be as outlined in the Copenhagen and Cancun Agreements (COP 14 and COP 15). Since 2009, developed countries have been working to scale up climate finance for developing nations, with a goal to mobilize USD 100 billion per year from multiple sources, both public and private. However, OECD (2015c) observes that very little of this finance has trickled down to developing countries to help them implement their Nationally Appropriate Mitigation Actions (NAMAs).

While progress has certainly been made in carbon financial flows to the developing countries, Buchner et al. (2014) reports that world is still falling short of the finance required to re-orient global systems to a scenario consistent with a sub 2-degree future. CPI (2016) also observes that despite new finance commitments in Paris from governments and the private sector, there remains a vast shortfall in funding for clean energy, natural capital, and climate resilience. The IEA (2015) estimates that approximately USD 16.5 trillion worth of investments are required over the next 15 years in energy efficiency and low-carbon technologies to meet the Nationally Determined Contributions plus the additional investment required over the same time to limit global temperature increase to 2°C . According to CPI (2016), it is worth noting that global climate finance flows reached at least USD 391 billion in 2014 as a result of a steady increase in public finance and record private investment in renewable energy technologies.

Prior research shows that renewable energy deployment plays a crucial role in climate change mitigation (Trabacchi & Mazza, 2015). Evidence has been adduced in section ... of this study, on how generation of electricity from renewables helps reduce carbon emissions and hence global warming (Chiu, 2017). For this reason, renewables have been a primary candidate for accruing carbon finance, and major climate agreements recognize this fact. It is therefore not surprising that more than 80 percent of the total mitigation finance in the world has been directed to the deployment of renewables (CPI, 2014). For instance, in 2014, the Climate Policy Initiative reports that 81 percent of the USD 391billion mitigation finance went to renewables. Moreover, renewables have been targeted as a sustainable form of energy for the future, and many initiatives and programmes have been a focus in many world countries because of its emission reducing abilities (Kalkbrenner & Roosen, 2016).

While global carbon finance continues to increase as more promises are made, Africa's uptake still remains low. For a region that has contributed the least to global greenhouse gas emissions and remains among the most vulnerable to climate change, the less than commensurate uptake of carbon finance is worrying. Records from the CDM indicate that Africa has the least number of registered projects, at 3 percent, compared to other continents such as Asia and Latin America. Moreover, Silver (2015) estimates that only less than 45 percent of the approved funding for adaptation is ever delivered. However, Abdulla and Jeanty (2011) show that Africa is highly endowed with renewable energy potential, that could effectively transform its participation in the carbon markets. The fundamental issue is how to leverage on these potential to increase Africa's uptake of carbon finance.

Kenya, like the rest of Sub Saharan Africa, is highly vulnerable to the impact of climate change, particularly its main economic sectors. However, set against a background of political transition and ongoing governance and development challenges, climate change is not yet a driving force for development in Kenya. But Kenya, like many other countries in Sub Saharan Africa, has not been able to leverage its huge renewable potential to accrue more carbon finance (Nyambura & Nhamo, 2014). Sena (2015) reports that Kenya has been able to mobilize less than US$1 billion in carbon finance, since the ratification of the Kyoto Protocol in 2005. Despite being a signatory to major climate agreements, that permit the use of carbon trading for emission reductions, Kenya does not have a comprehensive carbon trading mechanism (GoK, 2015). However, the country has been able to sell carbon credits from a few of its renewable projects, signaling the country's desire to participate in the carbon markets. As the country embarks on a transition to a low carbon, climate-resilient growth path, Carbon Africa (2015) reports that finance will be indispensable and carbon finance is poised to play a greater role.

While small-scale renewables play an important role in mitigating climate change for low and middle income countries, Dogan and Seker (2016) find that financing options for smaller projects are not well suited to sector need. Moreover, the current Kyoto based mechanisms for mitigation and adaptation cover only a small number of renewable projects, and major sectors in which the potential in Kenya is large, such as land use being excluded (Burian & Arens, 2014). It is against this background that several proposals, both bilateral and multi-lateral have been suggested to raise more revenue for renewables in these countries (Nie et al., 2016). Some of these methods include; auctioning of assigned amounts or emission allowance (as provided in the Kyoto protocol) to generate revenue, applying carbon market based levies and floating climate bonds in international markets to raise capital for investing in renewables.

According to Silver (2015), there is unlikely to be sufficient climate finance available to fund all the clean-energy investments that are required to deliver low-carbon development across the globe, and especially in Africa. As evidence already shows, Africa and indeed Kenya, were largely by passed in the pre-2013 carbon markets, and were not able to gain much from the post 2012 period due to uncertainty surrounding the ends of the first commitment period. Armed with its developments in renewables Munang and Mgendi (2016) observe that African countries, such as Kenya are poised to accrue more benefits from the new mechanism proposed under Paris Accord.

3.6.1 Carbon Markets as sources of Carbon Finance

The emergence and growth of carbon markets with international offsets has made it possible for the world to reduce greenhouse gas emissions at the lowest cost possible for polluters. Carbon markets, created to buy and sell carbon credits, enable carbon finance to flow from one region, country or project to another through the structures and mechanisms set to govern this markets (Labbat & White, 2011). Through the markets, specified amounts of greenhouse gas emissions, measured in terms of carbon dioxide equivalent and known as carbon credits, can be traded. A carbon credit is permit that allows the holder to emit the equivalent of one metric tonne of CO_2

equivalent and are awarded to countries or groups that have reduced their emissions below an assigned quota (Aldy & Stavins, 2012). These credits can be exchanged between businesses or bought and sold in international carbon markets at the prevailing market price.

Lohmann and Sexton (2010) observe that carbon markets, with international carbon offsets, have been a key driver of channeling finance and investment to projects that reduce greenhouse gas emissions in developing countries since 2005, when the Kyoto Protocol came into effect. Ervine (2014) observes that though the carbon finance associated with the sales of these credits has contributed to meeting the incremental costs of green investments, the volatility experienced in the carbon markets has cast doubt to their utility in climate change mitigation. Moreover, poor countries were unable to immediately take the opportunity offered by the carbon markets, because of pressing priorities of their scarce resources, suggesting rich countries to provide large scale carbon finance to the poor countries (Michaelowa, 2014). However, Hepburn (2010) finds that the international carbon finance flowing through the markets has acted as a cost containment device, providing relatively low-cost opportunities to prevent lock-in of fossil-fuel-based production and consumption in the world.

This section of the study discusses the two types of carbon markets; the regulatory compliance and the voluntary markets. The compliance market is used by companies and governments that by law have to account for their GHG emissions while in the voluntary market, the trade of carbon credits is on a voluntarily basis.

3.6.2 Regulatory Compliance Markets (Mandatory Cap-and-Trade Systems)

The compliance or regulatory carbon market is regulated by mandatory national, regional or international carbon reduction regimes. The market is underpinned by major agreements that have been adopted by the international community: The United Nations Framework on Climate Change (1992), the Kyoto Protocol (which entered into force in 2005) and lately the Paris Climate Accord of 2015. The agreements have created flexible mechanisms that provide the legal framework for the trading of carbon credits, placing a price on emissions and thereby providing incentives for people, companies and countries to emit less. According to Wood et al. (2016), it is by far the biggest carbon offsets market, with over 80% of all carbon trading taking place through the three Kyoto Protocol mechanisms: Clean Development Mechanism (CDM), Joint Implementation (JI) and the Emission Trading System (ETS). The market offers growth prospects for business and positive impacts for GHS emission reductions, finance for clean and sustainable development and renewable energy.

According to Wang (2010), emission trading in the compliance market takes place in two forms, either under the Kyoto Protocol or a regulatory regime that is outside of the protocol. Under the Kyoto Protocol, a cap-and-trade system is used that imposes national caps on the greenhouse gas emissions of developed countries that have ratified the Protocol (called Annex B countries). Under the rules of the protocol, each participating country is assigned an emissions target and the corresponding number of allowances-called Assigned Amount Units, or AAUs. To meet their set targets, countries can either reduce their own emissions or trade their emission allowances with those who have a surplus. Prior research shows that the end of the first Kyoto commitment period led to carbon price volatility in the market to a devastating carbon crisis in the wider global carbon market (Ervine, 2014). Shishlov et al. (2016) also find that the extension of the Kyoto protocol to 2019 at Doha has not done enough to bring back the market enthusiasm experienced in the early years of the trading. Clemencion (2016) observes that the replacement of the protocol by a fundamentally different Paris Climate Accord has made buyers and developers to adopt a wait and see approach.

Freitas, Dantas and Lizuka (2012) report that carbon offset trading outside of the Kyoto is operated in countries such as the United States, which have not legally accepted the Kyoto Protocol, but have other legally binding state and regional GHG reductions targets. However, Newell et al. (2013) notes that they involve an offset component similar to that created by the Kyoto Protocol, but they rely heavily on standardized approaches, for which additionality is not highly contentious. These markets perform an important carbon emission reduction role in the countries that lack a cap and trade mechanism and include markets such as the New South Wales Greenhouse Gas Reduction Scheme (NSW GGAS) and the Regional Greenhouse Gas Initiative (RGGI). Prior research also shows that dissatisfaction with the bureaucracies of the Kyoto mechanisms and the lack of environmental integrity of its offsets have contributed to the growth of this market segment (Ervine, 2014; Shishlov et al., 2016).

Of the three market mechanisms created by the Kyoto Protocol, the CDM enables developing countries, such as Kenya, to sell their carbon credits to industrialized countries that could not meet their Greenhouse gas targets (Newell et al., 2013). However, Wood (2016) cast doubt to the ability of the mechanism to accrue tangible environmental benefits to these countries. He finds that the CDM fails to fill any financing gap for least developed countries, appearing to sustain uneven development patterns overlooking those countries that are most in need. For instance, CDM board reports that out of the total 8814 projects registered by CDM, only 261 are from Africa, a mere 3.0%, against a total population of over 900 million, a small fraction compared to Latin America and Asia pacific that hold 95%. Bond, Sharife and Castel-Branco (2012) also find that African countries have benefited little or nothing from the much talked about sustainable development gains of the mechanism, because of the perception that most African countries are unattractive locations for CDM investments.

While the compliance market remains the biggest carbon market (over 80 percent of the carbon trade), the premises on which it has been built have fundamentally been altered by the signing of the Paris Climate Accord in 2015. The Kyoto Protocol established binding emission limits, which readily lend themselves to market approaches, but the new climate regime requires all parties to undertake nationally determined contributions of their own choosing (Bodansky, 2016). Serious concerns have been expressed pertaining to the credibility of the non-binding pledges, and their effectiveness in producing outcomes in the future of the climate change (D'Monte, 2015). These concerns have necessitated increased focus and scrutiny on domestic institutional, legal, policy and political arrangements put in place by each country, and how it will affect the ability of countries to deliver on their commitments (Mahapatra & Ratha, 2017). Moreover, there are apprehensions over how equitable the Paris agreement is, and whether particular developed and developing countries are contributing equitably to the response to climate change (Boyd, Fergus & Nicholas, 2015).

Like its predecessor the Kyoto Protocol, the Paris agreement is silent on the use of markets to meeting emission targets (Mansell, 2016). However, the agreement recognizes the use of carbon markets by countries using internationally transferred mitigation outcomes to implement their Intended Nationally Determined Contributions (INDCs) (Rogelj et al., 2016). Moreover, questions relating to carbon markets have arisen primarily in the context of emissions accounting. According to Mansell (2015), many parties believe that, in a regime lacking the top-down architecture of the Kyoto Protocol, markets have to play a role to minimize the potential for double counting. Further, there is increased recognition that market-based approaches are important to future emission reduction, as many world governments are increasingly pursuing market-based approaches to reduce their greenhouse gas (GHG) emissions (Christoff, 2016). Moreover, several Parties stated in their INDCs that the level of commitment they are putting forward is conditional upon having access to international carbon markets in the 2015 Agreement (Shepherd & Knox, 2016). Market access through bilateral and international linkages or through new crediting mechanisms can enable countries to put forward stronger commitments with better economic performance, going beyond their domestic capabilities (Bodansky, Hoedl, Metcalf & Stavins, 2016). Alternatively, a common accounting procedure could be agreed internationally to account for market transfers between countries.

Kenya, and indeed Africa's strengths in the Paris deal lies in several key sectors, capable of boosting social-economic developments. The agreement calls for the increased allocation of funds for adaptation and climate mitigation needs of developing countries, through sectors such as agriculture, food production and clean energy (Munang & Mgendi, 2016). Kenya is endowed with huge renewable energy potential (Abdullaha & Jeanty, 2011; Kiplagat et al., 2011) which it could leverage to scale up participation in the future carbon markets. There are also plenty of opportunities for carbon sequestration from land use through climate-smart agriculture and reforestation and deforestation (REDD) activities (Nyambura & Nhamo, 2014). However, the extent to which African countries, Kenya included, have used these opportunities to gain from international carbon markets have been limited (Mulugeta, 2012). Going forward, the expected market mechanism under the new agreement should benefit Africa more, if the continent were to harness its enormous agricultural and renewable energy potential to achieve sustainable development (Munang & Mgendi, 2016). The World Bank (2015) projects that harnessing Africa's agro-value chains can reduce poverty two to four times faster than any other sector. While Kenya has substantial investments in renewable energy investments, its participation in the international carbon markets has been limited (Ellis, Lemma, Mutimba & Wanyoike, 2013). However, it remains to be seen whether the country can leverage these investments to increase access to the carbon markets.

Fitting market approaches into this new landscape of climate change, created by the Paris Climate Accord, poses a different set of challenges for countries. There is still no clarity on how the intended nationally determined contributions are linked to the core text and the mechanisms for transparency, accountability and compliance (Mahapatra & Ratha, 2017). For an international carbon market to work, countries will have to build institutional and legal infrastructure, similar to the one required under Kyoto Protocol. It calls for country-specific legal, policy and political support for climate change, in order for the necessary emission reduction targets to be enforced (Bodansky et al., 2016). While the agreement recognizes that parties may choose to pursue voluntary cooperation in implementing their INDCs, it agrees that these cooperative approaches may involve the use of internationally transferred mitigation outcomes. For this mitigation outcomes to work, a robust accounting shall be used to avoid double counting, which requires strong institutions with authority between the participating parties to govern the emissions accounting process (Mansell, 2016). For African countries like Kenya, this will require a strengthening of climate change policies and laws, in order to create robust institutions.

Beyond the UNFCCC approaches, other forms of policy coordination can play an important role, in the absence of an agreed market mechanism under the agreement (Van Asselt, 2016). Linking of carbon pricing mechanisms through agreements between governments (such as Australia and EU ETS) or at the sub-national level (such as California and Quebec) could bind together different emissions trading schemes into a common market (Dion & Laurent, 2015). These linked emissions-reduction markets offer several advantages for governments seeking to take action on climate change such as the creation of a common carbon price between jurisdictions that could alleviate some of the economic competitiveness concerns about uneven abatement costs faced by businesses (Bodansky et al., 2015; Hughes et al., 2018). However, bilateral linking requires requiring prior coordination to make the accounting standards used to measure emissions consistent (Mansell, 2016; Rajamani, 2016).). This calls for strong guidance on the kind of transfers that are acceptable, through a robust institutional framework (Van Asselt, 2016). Further, for the efficient and effective design of an international climate policy architecture, such as the Paris Agreement to work, it must support climate policies at the regional, national, and sub-national levels for the member countries (Bodansky et al., 2016).

Africa remains particularly vulnerable to climate change, both in terms of environment and people's needs. The past climate regime under the Kyoto Protocol hasn't been good for Africa, especially in terms of its treatment of land use emissions, which are prominent for Africa. Scholars and policymakers agree that much more needs to be done to ensure that the Paris Agreement works for Africa and other developing countries (Bulkeley et al., 2014). While African countries where ambitious in terms of their NDCs, many of them lack resources, capacity and mechanisms for implementation, even where the political will is present and consistent (Rajamani, 2016; Dion & Laurent, 2015). One particular area of weakness is adaptation, often neglected in national and international policy development (Clemencon, 2016). The current institutional and policy frameworks in many African countries, Kenya among them, are not designed to cope with the cross-cutting nature of climate change (Falkner, 2016). Lack of capacity is, therefore, a big hindrance for many countries in delivering on their Paris agenda. Munang and Mgendi (2016) suggest that there is need to establish a coordinated approach both within and between African countries, as well as build enough capacity in form of finance and skills required towards the climate agenda.

While the CDM presents a huge potential for Kenya, evidence shows that the mechanism has not taken off in the Africa Continent as much as it has in others continents, even if important growth trends have been observed in recent years (Wood et al., 2016). However, Kenya's policy and regulatory environment are sufficient to promote participation in the regulatory market, as evidenced by number of projects registered by the CDM board (NEMA, 2016). Lambe et al. (2015) report that laws and policies aside, there is a relatively good capacity in carbon project development and transaction management available in Kenya, mostly in the private sector. As Kenya awaits the new clean development mechanism from the Paris Climate Accord, it seems to have positioned itself to gain sufficiently from the Kyoto CDM, which is expected to expire in 2023. But the results of the legal and political environment created for the development of projects under this mechanism have not been promising (Lambe et al., 2015).

3.6.3 Voluntary Carbon Offset Markets

Unlike the Clean Development Mechanism that sets a comparatively detailed set of rules and procedures for approval of carbon offset projects, the structure of the voluntary market is much more diverse and flexible (Hickman, 2016). The trading of carbon offsets in the voluntary market is not regulated, making it less bureaucratic and with lower transaction costs (Peters-Stanley & Hamilton, 2012). Hickman (2016) see the voluntary carbon market as an illustration of a good example of a privately created governance mechanism with the potential to mitigate climate change, largely outside of state action. Hamilton et al (2010a) observe that the growth of the voluntary carbon market was largely due to the threat of governmental regulation and compliance targets set for non- Kyoto companies. However, while carbon buyers running away from the bureaucracy of the compliance markets have set base in the voluntary market, Lovell (2010) observes that it offers different private carbon standards whose credibility is not guaranteed.

The voluntary market is divided into the compliance based voluntary markets and a purely voluntary (Hamilton et al., 2010a). In the compliance-based voluntary market, members comply with certain constraints with regard to GHG emissions for example, the Chicago Climate Exchange. The pure voluntary carbon markets, on the other hand, is driven by "pure" voluntary buyers seeking to offset emissions. Hamilton, Chokkalingam, Bendana and Jenkins (2010a) also observe that these buyers are increasingly sophisticated, seeking specific credit types from specific locations. However, Sabitova (2012) find that there are minor differences between the two, and as long as there is a price on carbon, voluntary offsetting will thrive. Bumpus and Liverman (2010) find that voluntary programs also have tremendous upside in development benefits and have a big opportunity to provide additional value within carbon markets.

Prior research gives several reasons why project developers participate in the voluntary market. Michaelowa (2014) find that project developers in developing countries, including Kenya, pursue the voluntary markets in instances where there is no applicable CDM methodology in the project type, for example in the case of land use. Others are motivated by their own desire to be socially responsible individuals or corporations, including enhanced public image and enhanced environmental accountability (Sy & Tinker, 2010; Newell & Patterson, 2010). Hamrick and Goldstein (2015, 2016) report that concerned citizens, corporations, and sub-national governments voluntarily purchase carbon offsets from projects that do have sustainable development benefits such as forest protection and renewable energy. But to meet practical needs of developers, voluntary standards will need to get leaner and meaner while at the same time reducing the complexity of certification in order to compete with compliance markets (Hamrick & Gallant, 2017).

While the voluntary market has grown in size and structure over the years, it has not matched the compliance market. However, Hamrick and Goldstein (2016) find that what the voluntary carbon markets lack in size is made up for by its flexibility in spinning off innovations in project finance, monitoring, and methodologies that also influence regulatory market mechanisms. Hamrick and

Gallant (2017) report that on average, prices have been decreasing in the market. But the voluntary market is stimulated by policy and voluntary offsetting, therefore project developers are expected to continue their involvement in the market. According to the State of Voluntary Carbon Markets report (2017), as of 2016, offsets equivalent to 1.1 billion metric tonnes of carbon dioxide emissions (BtCO2e) had been transacted through the voluntary carbon market– through sales to governments, companies, and individuals as well as intermediary brokers. However, Hamrick and Gallant (2017) find that the demand for offsets did not meet the supply and transaction volumes on the voluntary markets shrank 24% from 2015 to 2016, leaving 56.2 MtCO2e were left unsold. However, Bodansky (2016) reports that the convergence of the climate negotiations at Paris in 2015 is likely to drive further demand for credits, as the private sector engages in projects with sustainable development benefits.

The extent to which the voluntary carbon markets have helped shape climate change mitigation has lately come into focus, with the confusion that reigned at the end of the first commitment period of the Kyoto protocol. Held et al. (2014) and Hamrick and Goldstein (2015) find that citizens, corporates and governments have drawn extensively on voluntary project methodologies and market frameworks to support emerging carbon pricing regimes, for example, California's cap-and-trade carbon market and South Africa's upcoming tax-and-trade carbon pricing. Hickman, (2016) also finds that the voluntary has become a fertile testing ground for the concept of payments for performance because private buyers typically only pay if emissions reductions are verified to a pre-determined standard. But for the market to survive the volatility that befell the compliance market, Hamrick and Goldstein (2016) find that it needs to be more innovate. Project developers are devising new ways of demonstrating value for credits with sustainable development benefits and the market must meet their expectations. It is also possible that the role of the voluntary market could be bolstered under the Paris agreement, as countries struggle to meet their emission commitments targets and a new clean development mechanism that is not yet agreed upon (Bodansky et al., 2016).

While Kenyan developers have shown more affiliation to the compliance market (Harmsen, 2018), the voluntary market has provided a good testing ground for their offset sales. Wang and Corson (2015) find that Kenyan project developers have been pursuing the voluntary markets for projects that do not have an applicable CDM methodology, such as those in land use and reforestation.

Voluntary buyers also generally place a premium on projects with sustainable development benefits, demonstrating more preference for forestry projects over other types of projects and thus majority of the voluntary carbon projects in Kenya are in the forestry sector. Carbon Africa (2015) reports that 9 out of the 16 Kenyan projects in the voluntary markets are in the forestry sector, such as the Kasigau Corridor REDD Project Phases I & II, the International Small Group & Tree Planting Programme (TIST) and the Aberdare Range/Mt. Kenya Small Scale Reforestation Initiative, among others.

Luxmore et al. (2013) also find that many projects in the renewable energy in Kenya front do not meet the size and additionality requirements for CDM, making them move into the voluntary market. However, there are projects such as the Lake Turkana Wind projects, which do meet the size requirements but are pursuing parallel registration in the voluntary market in order to achieve price premiums in voluntary market as well. Kenya also boasts the world's first agricultural soil carbon project, which has inked an agreement with the World Bank's BioCarbon Fund (World Bank, 2014). As a demonstration of the voluntary market potential, and its prospects for future growth in the country, there are currently 14 Gold Standard Verified Emission Reduction (VER) projects in the pipeline, of which six are registered. To actualize this potential, the country will however need to scale up its renewables and overcome the greater problem of access to the carbon markets.

3.7 Uptake of Carbon Finance in Renewable Energy in Kenya

Renewable energy projects have been shown elsewhere in this study to be strong candidates for carbon financing because of their emission reducing capabilities. Prior research has also documented other benefits of renewables, such as poverty alleviation through job creation and healthier leaves by improving air quality (Lacerda & van den Bergh, 2014; Kalkbrenner & Roosen, 2016). Moreover, due to population growth and economic growth demands, Oji et al. (2016) has shown a serious need for power in developing countries, a void that renewables can fill. The World Bank (2014) reports that many developing countries face unprecedented power shortages, which are increasingly hindering the opportunity to fulfil their potential economic development. While many developing countries have recognized renewables as an option to increase their installed power, Oji et al. (2016) and Olang et al. (2017) report that the utilization of this source of power in many other countries remains low.

Kenya, as a low and middle income country, faces a similar problem as far as power production is concerned. Compared to countries like South Africa with over 40,000 MW of electricity, Kenya lags behind in the amount of installed electricity, at only 2296 MW. However, most of the installed electricity in Kenya comes from renewables, which is an environmental advantage. But as reported elsewhere in this study, Kenya has a huge renewable energy potential, capable of generating a combined estimate of over 40,000 MW of electricity (Olang et al., 2017). The concern, therefore is why such a huge gap exists between the potential and the installed power capacity in the country, for a country that is just on a takeoff to economic development. Some of the problems Kenya and other low and middle income countries in Africa face in deployment of renewables have been clearly documented in section 3.5 of this research, including financial constraints, political environment and technological challenges, among others.

Luxmore et al. (2013) observe that the emergence of carbon finance as a mode of financing renewables was received with a lot of enthusiasm in the African continent. However, Wood et al. (2016) and Jakob et al. (2015) report that because of the difficulties of accessing these resources, this interest has recently waned and many African countries remain indifferent to the use of carbon finance. Evidence adduced elsewhere in the study proves that unlike other continents, such as Asia and Latin America, Africa's use of carbon finance mechanisms has been very limited. While the flexible mechanisms of the Kyoto, particularly the CDM offers countries engaging in clean energy production an avenue of selling credits generated by their projects, Kenya and indeed most other African countries seem not to have taken up the opportunity (Wood et al., 2016). Studies such as Allam and Nwankwo (2014), Rugabera et al. (2013) and Sanni et al. (2014) show that the high investment risk commensurate with many African economies may result in undervalued CERs and reduced financial incentives for the investors in CDM.

The CDM website shows that renewable energy project developers had registered 21 projects and 16 Programme of Activities (PoAs) with the board as at 2017 (*see appendix iii and appendix iv).* Of the 21 projects registered with the CDM, 16 are in renewable energy, signaling the importance of renewable deployment in Kenya's access to carbon finance while 6 out of 16 PoAs are also in renewables. Nyambura and Nhamo (2014) report the first CDM project registered in Kenya as the "35 MW Bagasse Based Cogeneration Project" by Mumias Sugar Company Limited in September 2008. Major renewable project developers in Kenya, such as Kenya power generating company, Kegan report a forecasted annual carbon revenue of over USD 11 million form all its registered projects. NEMA (2016) reports that a small number of CDM projects in Kenya are pursuing parallel registration under voluntary market standards to achieve price premiums, such as the Lake Turkana 310 MW Wind Power Project and the Nairobi River Basin Biogas Project.

Lambe et al (2015) reports that most Kenyan projects in the CDM pipeline have produced little or no carbon revenues since their inception. Moreover, Nyambura and Nhamo (2014) also find that many project developers are not aware of the carbon revenue benefits, resulting into many projects not to pursue any type of carbon revenues. They find that many of the Kenyan projects are either in the pipeline, seeking registration or incomplete. This scenario makes it almost impossible to quantify the carbon emissions from the country, as a result of which the total carbon revenues accruing to Kenya become difficult to predict (Carbon Africa, 2015). Besides the large renewable projects, Kenya has over 400,000 small scale projects spread across the country, making it a rich portfolio of projects to attract carbon finance. As a leading country in RE generation (Kenya is ranked 46 in the world in renewable energy generation), Nyambura and Nhamo reports that Kenya has not leveraged its renewable potential to attract climate finance.

Besides the projects and programmes for renewables registered under CDM, Kenya has benefited from other carbon finance arrangements. Harmsen (2018) reports that the World Bank Carbon Funds, which support 59 CDM projects in International Development Association (IDA) countries, includes support for Kenyan projects for geothermal development, Eburru and Baringo Silali projects. Cookson and Kuna (2017) also report that the Carbon Initiative for Development (Ci-Dev), a World Bank carbon fund dealing with sustainable development projects, has been supporting KTDA projects for registration for CDM. Munang and Mgendi (2016) also report that the UNEP has also been supporting low carbon activities in Kenya, including renewables and sustainable biomass production. But evidence is lacking as to whether these initiatives have born any fruits for the renewable sector in Kenya. Lambe et al. (2015) report that the volatility experienced in the carbon markets in the 2010s, in the aftermath of the global financial crisis, halted the enthusiasm for Kenya’s access to the lucrative EU market.

Prior research shows that Kenya has variously used the voluntary carbon market to accrue carbon finance for its projects (Nyambura & Nhamo, 2014; Wang & Corson, 2015). The voluntary carbon market allows developers in Kenya to pilot new approaches to emission reductions, such as reduced emissions from deforestation and forest degradation (REDD). Cookson and Kuna (2017) also finds that it helps project developers in the country to pre-register their carbon credits, before launching them into the compliance market. However, the number of projects registered under the voluntary market shows that the country has not yet embraced the benefits that accrue from this market. Harmsen (2018) also reports that as of 2017, there are 14 Gold Standard Verified Emission Reduction (VER) projects in the pipeline which are expected to deliver emission reductions of over 2 million tonnes of carbon dioxide equivalent per annum (*see appendix vi).* As Wang and Corson (2015) reports, Kenya being a carbon sink because of its extensive forest should have been a greater beneficiary of the voluntary market.

Onguso et al. (2014) finds that Kenya has recognized the need to decarbonize environmental challenges through renewables, by putting in place legal and policy instruments to enable it accrue carbon finance from its renewables. The Energy Act of 2006, for example, provides explicitly for the ministry of energy to use CDM and carbon trading to promote renewable energy. Vision 2030, Kenya's development plan to transform the country to middle-income status by the year 2030, includes a goal under environmental management to attract "at least five Clean Development Mechanisms (CDM) projects per year in the next five years" (MoE, 2013; Vision 2030). However, the myriad of laws and policies that have not been properly delineated have resulted to a policy incoherence, affecting the deployment of carbon projects in the country (Onguso et al., 2014). Carbon Africa (2015) observes that, for instance, the Vision 2030 does not provide measures of how the attainment of five CDM projects would be implemented. Moreover, the country also lacks the requisite technical potential to achieve these targets (Porras et al., 2015).

While the management and exploitation of renewables has been recognized as central to sustainable development (Cucchiella, D'Adamo & Gastaldi, 2015), government schemes and incentives to promote its use have not been forthright for many developing countries. Wang and Corson (2015) find that countries with significant endowment of renewable energy resources such has Kenya must address factors that are necessary for the successful implementation of renewable energy depending not only on different countries experience, but also on the different sources and technologies for renewables. While Kenya has taken the necessary steps to address these factors, evidence adduced show that the steps have not been sufficient (Dong, 2017). Although there is uncertainty in the carbon markets over the outlook of the new clean mechanism under the Paris

Accord, Kenya and other developing countries can expand their renewable energy production by tapping into these resources (Cucchiella et al., 2015). Besides the envisaged carbon finance flows from the carbon markets, the market for renewables has been inundated with other forms of financial support, from groups such as the REN Alliance.

3.7.1 Empirical Studies on Carbon Finance in Kenya

Most of the available empirical studies in Kenya have dwelt more on aspects of carbon trading than exploring the determinants of carbon finance uptake in renewable energy deployment. Several studies have been carried out in Kenya that connect carbon finance to renewable energy, albeit indirectly. A study by Kippra (2011) explored the implications of the developments in the international carbon markets on Kenya's carbon finance policy. While the study finds opportunities for Kenya in the challenging carbon market conditions, it warns of risks of over reliance on future flows from carbon markets for Kenya and other low and middle income countries. It particularly singles out the closing of the European Union Emission Trading System for Kenyan credits, the general challenges of supply-demand balance in credits to be traded. The study does not specifically address the issues leading to the supply-demand challenge, but cautions over the plummeting of carbon offset prices for Kenyan offsets. However, it proposes use of alternative crediting mechanisms, such as the voluntary carbon markets, to market Kenya's high quality offsets.

Atela (2012) investigated how politics has shaped use of carbon finance in agriculture, using a case study of an agricultural carbon finance in Kenya. Using fieldwork, interviews and document analysis, he explores the empirical interplay between complex sociopolitical histories including prior donor interventions and problems of poverty and environment. The study finds that the dominant narrative by the west on the benefits of carbon finance does not resonate well with local circumstances in Kenya. The study also finds that Kenyan farmers are more concerned with food security through maize farming, and have little awareness of carbon income. While the study does not look at the larger scenario of carbon finance use across all climate mitigation sectors, it serves to highlight the case for lack of awareness on carbon finance in Kenya's local settings.

Nyambura and Nhamo (2014) explored the state of CDM projects and their impact on sustainable development, using Kenya as a case study. While the study does not only look at renewable energy projects, it identifies 14 CDM projects in Kenya, which all happen to be in renewable energy.

Their study identifies four parameters as indicators of sustainable development; environmental, social, economic and technology. Using a Multi-Attributive Assessment model that utilized data and information from registered CDM project design documents (PDDs), they find that none of the CDM projects registered in Kenya contributed to sustainable development. However, the study did not dwell on the factors that determine carbon finance inflows into the projects.

Sena (2015) explores how carbon credit schemes, both the compliance and voluntary have affected indigenous peoples' rights to land use and afforestation in Kenya, on an empirical bias. He argues that carbon credit schemes will play an important role in both climate change adaptation and mitigation in Kenya, but the projects that produce these carbon credits should not result in the abuse of indigenous peoples' rights. He does not examine the project characteristics that lead to acquisition of these carbon credits, but finds that the indigenous people can benefit from the protection of carbon projects in order to earn credits.

Lambe et al. (2015) explore the role of carbon finance in transforming household energy markets in Kenya. Their study focuses on cook stove projects and programs in Kenya, and gathered data through project design documents. Their analysis reveals that carbon finance can help build a vibrant market for improved cook stoves by attracting international actors and technologies. But they find risks that could prevent the projects from meeting the expectations of the developers, such as potential mismatch between cheap and efficient technology. While the study focuses on cook stove projects, it could be applied to the wider renewable energy sector to accrue more carbon finance in the projects. The study also explores the low carbon technology used in the cook stoves, and its cost element, as factors in the sale of the carbon credits.

Cookson and Kuna (2017) use a case study of the Lake Turkana Wind Project, Africa's largest wind farm located in Kenya to study how low emission strategies undertaken through renewable energy projects can benefit low and middle income countries. While the projects can accrue many benefits such as job creation and electricity stabilization, they find that project developers face many financial challenges to complete the projects. Although the project used in the case study is registered for CDM, they did not explore the role carbon finance could play to mitigate the financial challenges identified for the project.

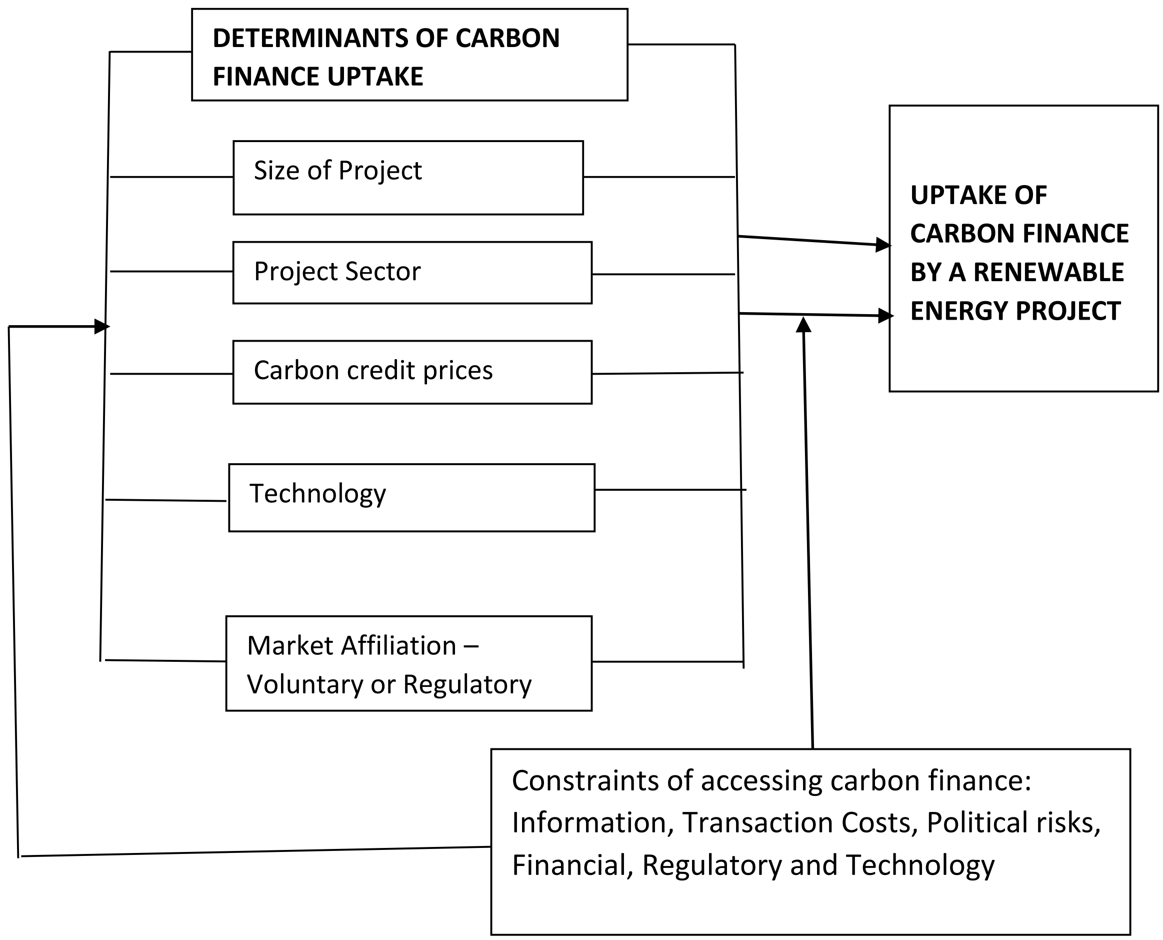
3.9 Research Gaps

A review of literature on the subject of carbon finance from local and foreign settings reveals several knowledge gaps that this study seeks to fill. Firstly, the studies reviewed conceptualize the determinants of carbon finance uptake at a country level and very few studies explore these determinants at a project level. In addition, the reviewed literature present contradicting accounts on how each of the determinants affect carbon financial flows into a project. These studies also fail to explain the significance of these determinants on carbon finance uptake in renewables. Secondly, most of the studies on carbon finance dwell on what kinds of carbon credits buyers want to fulfil their cap requirements. They do not focus on how these credits are to be developed but only provide developers with the requirements of the markets. By focusing on what determines how much and when carbon revenues will accrue to the project, and the constraints that developers have to endure, this study seeks to fill that gap. Thirdly, most of the empirical evidence does not explore the relationship between carbon revenues accrual and deployment of renewables. Rather, most of the focus on the structure and forms of carbon markets and adapt the markets to the projects, not the other way round. Lastly, contextual differences abound as findings from most of the studies on carbon finance and renewables based in foreign markets may not be easily extended to the setting of low and middle income countries, and indeed the Kenyan situation. Therefore, there is need to explore how uptake of carbon finance can contribute to renewables development in a setting that can be expanded to cover many of these low and middle income countries.

3.10 Conceptual Framework of the Study

The conceptual framework of a study explains the key factors, concepts and variables to be studied and their presumed relationship between them (Ravitch & Riggan, 2017). It provides a visual representation of how the research variables are linked to each other. The conceptual framework for this study has been developed from the determinants of the uptake of carbon finance for renewable projects while the constraints of accessing the carbon finance act as intervening variables. The independent variables are the hypothesized determinants; size of the renewable energy project, the sector the project is developed in, the prevailing carbon offset prices, the level of low carbon technology used in the project and the market in which the carbon offsets from the projects are inclined, either the compliance of voluntary carbon market. These factors are curtailed by the individual constraints a project could have to accessing carbon markets. The independent variable is the uptake of carbon finance for a renewable energy project. The conceptual model is presented in Figure 4 below.

Figure 4: Conceptual Framework



Independent variables **Intervening variables** **Dependent variable**

The hypotheses for the relationships in the model have been proposed in chapter four.

3.11 Summary of the Chapter

A review of academic literature reveals little attempt to investigate the concept of carbon finance and its effect on renewable energy deployment in the context of low and middle income countries. Empirically, the review shows few studies from this context that could help the research build a strong foundation to enable more scrutiny of the variables. While the review helps to identify the variables and form a basis for derivation of the research hypotheses, it does not help that the findings of the importance of these variables in accrual of carbon finance is not directional. The scrutiny of empirical literature on the challenges of investing in renewable energy also helps form a foundation for in-depth scrutiny of these variables.

CHAPTER FOUR
DEVELOPMENT OF RESEARCH HYPOTHESIS

4.1 Introduction

This Chapter presents the development of the hypotheses that were tested to fulfil the requirements of the study. Based on the gaps in empirical literature identified under section 3.9, and the conceptual model of the relationships between the variables under section 3.10, several testable hypotheses were developed to help meet objective three of the study. The results of the tests of the hypotheses are presented in chapter six. The chapter is arranged as follows; section 4.2 presents the derivation of the hypotheses on renewable energy project size and carbon finance. Section 4.3 derives the hypothesis on the influence of project sector on carbon finance. Section 4.4 develops hypothesis on the influence of prevailing carbon offset prices on carbon finance uptake for a project. Section 4.4 develops the hypotheses on low carbon technology and carbon finance while section 4.5 is on influence of the carbon market affiliation of a project and its influence on carbon finance. Finally, section 4.6 provides the chapter summary.

4.2 Development of the Hypotheses on Determinants of the Uptake of Carbon Finance.

Prior research shows that carbon markets have been a key driver of channeling finance and investment to projects that reduce greenhouse gas emissions in developing countries since 2005 when the Kyoto Protocol came into effect (Lohmann & Sexton, 2010). Whereas the uptake of carbon finance in Asian and Latin America countries, such as China and Brazil respectively is high, Africa's participation in the carbon market has been low (Pfeifer & Stiles, 2009; Muzee, 2011; Carbon Africa 2012). This begs the question of why is Africa's use of carbon finance low, despite the availability of these finance in the international carbon markets, and abundance of renewable energy resources in the continent. While studies have tried to analyze this scenario (Luxmore et al., 2013; Woods et al., 2015), gaps exist as to why carbon financial flows have remained elusive to low and middle income countries in Africa, including Kenya. Based on these gaps, several hypothesized relationships were derived as below;

4.2.1 Size of Renewable Energy Projects and Carbon Finance

Studies show that buyers of carbon credits prefer large scale projects emission reducing projects to smaller ones, as they help them fulfil their cap requirements in a more cost effective way (Del Rio & Linares, 2014; Michaelowa, 2014). Investors in carbon emission reducing projects have also been shown to prefer large projects, as they enjoy economies of scale and reduce more greenhouse gases (Abbasi & Abbasi, 2011). Other scholars have enumerated the obvious benefits of large scale project, when it comes to compliance with carbon market requirements, such as the number of carbon credits generated and lower transaction costs (Hultman, Pulver, Guimaraes, Deshmukh & Kane, 2012). Moreover, there is the assertion by some investors that small scale projects usually have relatively high overheads and transaction costs, making them unattractive to financiers (UNEP, 2014). But policy makers and scholars have argued that, without ignoring the benefits that large projects confer, avenues should be created to increase the number of small scale projects entering the CDM pipeline (Cormier & Bellassen, 2013).

The Marrakech Accord of the UNFCCC (2014) attempted to provide a level playing ground for small scale projects under CDM. The accord argued that small scale projects have considerable sustainable development benefits, and would further advance the interests of developing countries participating in CDM. This led to the relaxation of some procedural requirements such as baseline selection, elimination or simplification of project cycle steps, reduction of time needed for the remaining steps and also adopting strategies such as bundling of projects (UNFCC, 2016). This made small scale projects more attractive, and as such many of them would be developed (Weitzel et al., 2015). However, the size requirement continues to haunt many developing countries, as the capital and other resources needed to invest in big projects is not available.

Many renewable energy projects have been left out of the CDM pipeline in Africa because of the size requirement. Kiplagat (2011) reports that many project developers in Africa are unable to afford huge capital intensive projects and hence they are left to invest in small scale projects of less than 5 MW. Whether this is why African countries have low participation in CDM, it remains to be determined. Several studies also note that renewable energy projects tend to suffer in CDM because many times capacity addition tends to be small and incremental (Luxmore et al., 2013; Seres et al., 2009; Sutter & Parreno, 2007). However, many small scale projects have also found a ready market in the voluntary markets, where the cost of compliance with the market requirements is low. Still, the CDM rules do not provide a clear threshold for a small scale project that should be allowed to enter the pipeline, arguing that any additional reduction of GHG is welcome (Olsen & Fenhann, 2008). Moreover, small-scale sinks projects from low-income communities are now permitted in the clean development mechanism (Boyd et al., 2015). However, the threshold of attracting carbon finance into a project is still not clear, and more research is needed to determine the role of project size in the war against carbon emissions. This research attempts to find out how important size is to project developers, and if there are preferable sizes when it comes to using carbon finance. This is formally stated in the hypothesis below, which tests the relationship between the size of the renewable energy project and the amount of carbon finance it can attract, controlling for the project costs.

H_1: size of the renewable energy project influences carbon finance inflow into a project

4.2.2 Sectoral Scope of the Projects

According to Ellis et al. (2013), the development of the CDM portfolio as well as the achievements of the CDM since its inception has increased both the private and public flows of investment into developing countries. However, Wood et al. (2015) observe that although CDM finance was meant to complement traditional energy access for low Least Developed Countries (LDCs), the implementation seems to suggest otherwise. Karakosta et al. (2013) also observe that the envisaged benefits of CDM to developing countries in Africa have not been forthcoming.

While Annex A of the Kyoto Protocol (2005) lists the sectoral scopes whose projects are eligible for the sale of carbon credits, the power sector remains an important avenue to reduce greenhouse gases. Schneider et al. (2010) observes that although different greenhouse gas (GHG) mitigation technologies can be implemented under the Clean Development Mechanism (CDM), renewable energy technologies (RETs), in particular, are often viewed as one of the key solutions for achieving the CDM's goals of sustainable development and cost-efficient emissions reductions. Of the sectoral scopes within the energy sector, energy industries (both renewable and non-renewable), energy distribution and energy demand, the renewable energy scope stands out as more likely to contribute to emission reduction than the others (Dechezlepretre, Glachant & Meniere, 2008).

Wood et al. (2015) observe that the focus on renewable energy for emission reduction in LDCs is because of the relative availability of the sources of renewable energy. Bode (2006) also finds that renewable energy helps low and middle-income countries to meet their energy targets in a less costly way and also help support developing countries in getting on to a more sustainable energy supply track. However, Dolsak and Crandall (2013) argue that the costs of generating power using renewable energy are too high for these countries, and hence the abundance of resources that are yet to be exploited. But because developed countries have set indicative targets for emission reductions in the new climate agreement, the flow of carbon finance into renewable energy projects in Africa is set to increase (Clemençon, 2016).

In accordance with the procedural guidelines under the CDM, 15 sectors have been selected, with guidelines on how project development under each sector should be implemented. It is imperative to note that renewable energy is the first sector in the list, underscoring the importance of renewable energy to CDM. The voluntary offset market, in particular, has been promoted for the possibility of broader participation, enabling those unregulated sectors or countries that have not ratified the Kyoto Protocol, such as the US, to offset their emissions (Kollmuss et al., 2008).

However, the debate has raged as to why there should be a difference when offsets are sold from any sector or market, as the contribution of any offsets amounts to the same; reduction of GHGs from the atmosphere (Freitas et al., 2012). Crowe (2013) also postulate that the sectoral affiliation of an emission reducing project should not negate the benefits of emission reduced by other sectors, instead, they should complement each other. Though this study was based on emissions reduced by renewable energy projects, the respondents, such as carbon business stakeholders cut across the other sectors, for example, regulators. The wide scope of the projects eligible under the power sector, including energy industries, energy demand and distribution, requires some research to find out how renewable energy fairs in comparison. It was, therefore, necessary to find out whether renewable energy developers find it more lucrative in the carbon markets when they sell their offsets. This was tested using the hypothesis below;

H_2: the sectoral affiliation of the project positively influences the uptake of carbon finance

4.2.3 Prevailing Carbon Offset Prices

Carbon offsets are produced and sold under the international climate change regime and also within the voluntary offset market in which companies and individuals can voluntarily opt to compensate for their greenhouse gas emissions (Lovell, 2010). Whereas the volume of offsets produced in both markets has increased over the years, their prices have fluctuated based on a number of factors. Jacobsen (2011) find that carbon offset prices tend to vary based on the project type, its location, the market demand and the stringency of the offset program requirements. Other carbon market researchers also report that the offset prices tend to be driven primarily by the supply of and demand for offsets and allowances (Newell et al., 2013; Bushnell, 2011). Carbon buyers are driven into the compliance market because of the validation that offsets go through, making them of a better quality than those of the voluntary markets. Gillenwater, Broekhoff, Trexler, Hyman and Fowler (2007) finds this to be the reason why offsets from the mandatory market fetch considerably higher prices than voluntary offsets.

According to the State of the Voluntary Carbon Markets report of 2016, more than two dozen voluntary carbon standards have emerged in the last five years, and the prices those standards garner vary widely. The report and other researchers find a multiplicity of factors that affect this prices. Conte and Kotchen (2010) find that prices in the voluntary markets depend on whether a project is located in a developed or developing country, with those in developed countries fetching higher prices. These findings are similar to Bayon, Hawn and Hamilton (2012), who also tend to agree with them, arguing that it is due to the high cost of programs in developed countries as well as a heightened demand for supporting local initiatives. Lohmann and Sexton (2010) and Linacre, Kossoy and Ambrosi (2011) find that offsets prices are not only stratified by the type of standard, but also by the type of projects, and sometimes, the story behind the project where buyer seeks to support projects with social, environmental and often local benefits. In total, prices for voluntary carbon standards have ranged from a low \$2/tCO2e (American Carbon Registry, 2011) to a high of \$17.3/tCO2e for Canada's Pacific Carbon Trust, 2013 (World Bank, 2014). Average prices vary highly within the various types of project and the stages of project development (Pacific Carbon Trust, 2012).

The fluctuations in carbon offsets prices are not confined to the voluntary market. Prices of offsets in the compliance markets gained momentum in the early days of the Kyoto Protocol, to trade at an average price of USD12 per tonne of CO2 equivalent by 2009 (Ellerman et al., 2010; CDM Board, 2012). The reigning turbulence in the carbon markets in the 2010s brought the prices tumbling to a low of less than a dollar by 2013 (Yu & Mallory, 2014). The significant drop in compliance offsets prices affected the overall carbon markets, with the effect that investor enthusiasm was seriously curtailed. Researchers such as Lohamman (2010) and Nazifi (2013) report that these incidences earned carbon credits the tag of the worst performing global commodity of the 2010s.

Researchers have identified several factors influencing the prices of emission allowances in the carbon markets including policy and regulatory issues; market fundamentals, including weather and production levels; together with technical indicators (Carraro & Favero, 2009; Ellis & Kamel, 2007; Del Río & Linares, 2014). The variation of international carbon prices is a major determinant of how much a project could garner in carbon revenues. According to Carbon Africa, the poor performance of carbon credit markets has demotivated investors and the government in undertaking green investment. This is after the price of carbon has tumbled to trade at less than a dollar globally per tonne, compared to over USD12 in 2009, four years after the enforcement of the Kyoto Protocol (carbon Africa, 2015). However, many of the studies to determine why the drastic drop in offsets prices have been done in the developed world (Lohamman, 2010; Lovell, 2010 and Bayon et al., 2012).

The drastic variation in offset prices has affected the flows of carbon finance across countries and it is worthwhile to examine how it has affected emission reducing project developers in Kenya. Further, without a readily available metric for consumers to determine either how the price of offset credits sold in the voluntary market is determined, or the role the offset price has on the quality of the offset purchased (Yu & Mallory, 2014), more research is needed to determine the effects of this changes on the development of carbon emission reducing projects. This study seeks to determine how this fluctuation in carbon offset prices in the international carbon markets has affected inflows of carbon finance into renewable energy projects in Kenya. It is formally stated in the hypothesis below, which tests the relationship between fluctuating carbon prices and the carbon finance inflows into a project.

H_3: prevailing carbon offset prices have a positive association with the uptake of carbon finance in a renewable energy project.

4.2.4 Type of Low Carbon Technology used in the Project

The Clean Development Mechanism of the Kyoto Protocol was introduced with the aim of decreasing CO2 emissions in developing countries while giving buyers in developed countries more flexibility in achieving reduction requirements (UNFCCC, 2007). Although it has no explicit objective to transfer knowledge, equipment and technology to developing countries, the technology transfer envisaged under CDM was meant to bring advanced low-carbon technologies to Annex II countries by connecting partners from developing and developed countries (Kriegler et al., 2014). Although Technology transfer has often been mentioned as an ancillary benefit of CDM, this fact has never been researched or substantiated (De Coninck, Haake & Van Der Linden, 2007). In addition, revenues from selling carbon credits might finance more advanced technologies that would not have been otherwise viable. CDM can thus reduce financial barriers to adopting costly foreign technology (Smith et al., 2009). Moreover, De Coninck et al. (2007) and Mathews, Hu and Wu (2014). Mathews (2014) agree that technology transfer is important for both the developing countries who need new technology and knowledge and for industrialized countries, as it provides the export potential for climate-friendly technologies. Schneider et al. (2010) also observe that the viability of emission reduction projects like RETs is technology and country specific.

Researchers have identified four groups of project specific determinants of technology transfer. The first group consists of three basic project characteristics: project size, whether it is a small-scale project that is characterized by more simple documentation procedures and whether it is a unilateral project, started without foreign partners (Martin et al., 2014). The second group of project-specific determinants considers time effects while industry dummies are considered as the third group of determinants, to investigate possible industry effects on the presence of technology transfer in CDMs (Cormier & Bellassen, 2013). The fourth determinant of technology transfer is the potential agglomeration effect of CDM projects, which considers the technology in use by the existing project, and its effect on the project of concern (Martin et al., 2014).

It has yet to be determined as to whether CDM has succeeded in transferring the much-needed technology to developing countries in Africa (Bond et al., 2012). Proponents of CDM argue that technology transfer in CDM can bring new low-carbon technologies to developing countries and thus not only reduce emissions but also foster development (Byigero, Clancy & Skutsch, 2010). For low and middle-income countries in Africa, such as Kenya, these transfer of technology cannot be ascertained (Weitzel et al., 2015; Bond et al., 2012). However, there is a consensus among researchers and policy makers that a broad range of intensive research and development is urgently needed to produce technological options that can allow both climate stabilization and economic development (Popp, 2011; Pegels, 2010).

Advances in renewable energy technologies have led to significant reductions in carbon emissions (Wang, 2010). However, for low and middle-income countries, such as Kenya, the problem is that new and emerging technologies often struggle to secure investments, hampering their development and market uptake (Martin et al., 2014). Though more advanced technology is better rewarded for its potential to increase emission reduction, the costs of such technology are often prohibitive for low-income countries. It is not clear how mitigation options such as energy intensity improvements, carbon capture and storage (CCS), solar and wind power and bioenergy technologies have helped climate mitigation in Africa (Kriegler et al., 2014; Weitzel et al., 2015). It is, therefore, necessary to find out if the technology transfer (TT) that was designed to play a key role for Annex II countries in achieving greenhouse gas emission reductions, has been of help to carbon reducing projects in Africa.

Research also shows that price setting measures for carbon offsets must create incentives for technological progress if the carbon markets are to achieve their objective (Yang et al. (2016). They postulate that if the carbon price is not high enough, the pressure on technological development will not be sufficiently strong. However, there has been varying opinions as to how much technology transfer is possible, and where it is likely to flow. Dechezlepretre (2008) show that the likelihood of technology transfers increases with the size of the project and the country where the project is implemented, with the likelihood increasing with the large size of projects and projects implemented in Annex I countries respectively. Similarly, Zhang and Yana (2015) show that technology transfers are more likely to occur in large-sized projects with higher CER incomes, but also adds the increase in likelihood for another parameter such as in projects with international participants, and in projects involving fuel substitutes, in comparison to projects involving renewable energy. Whereas studies such as UNFCCC (2008), Bye and Jacobsen (2011) show that technology transfer occurs in regions with lower technology capabilities and low energy consumption, no study has been carried out to explore how technology transfer in renewable energy projects has occurred in Africa and Kenya in particular, since the inception of the carbon markets. For a country that imports most of the equipment and knowledge on renewable energy investments, it is imperative to find the connection between the use of technology and uptake of carbon finance. This leads to the hypothesis formulate below;

H_4: Use of low carbon technologies positively influences the uptake of carbon finance

4.2.5 Carbon Market Affiliation of the Renewable Energy Project

Carbon markets exist both under compliance schemes and as voluntary programs. Compliance markets are created and regulated by mandatory national, regional or international carbon reduction regimes (Newell et al., 2013). Mandatory systems require regulated emission sources, by national, regional or provincial law, to achieve compliance with GHG emission reduction requirements (Lovell, 2010). For regulated emissions sources, offsets serve as an alternative compliance mechanism to allowances or direct emissions reductions that emission sources can use to meet these requirements. In most cases, these sources are regulated under cap-and-trade emission trading schemes, such as the Regional Greenhouse Gas Initiative (RGGI) or the EU ETS. The two international mandatory project-based offset mechanisms established under the Kyoto Protocol, the CDM and JI, were established in 2001 and began issuing registered offsets in 2005 (UNFCCC, 2007).

The voluntary offset market includes a wide range of programs, entities, standards and protocols. Offsets generated through voluntary markets, known as Verified or Voluntary Emissions Reductions (VERs), have been promoted as an opportunity for experimentation and innovation. They have the general advantage of lower transaction costs than offsets generated for use in mandatory compliance programs. However, the lack of standardized quality criteria has generated concern from the wider offset market. The voluntary carbon market, which functions outside of the compliance market, enables businesses, governments, NGOs, and individuals to offset their emissions by purchasing offsets that were created either through the CDM or in the voluntary market. However, the proliferation of standards, protocols and other programs reflects the significant flux and experimentation in today's voluntary offset market. At the same time, because of the differing objectives of many voluntary and pre-compliance market participants, especially with respect to the local impacts and benefits of offset projects, multiple standards and programs are likely to remain lasting features of the voluntary market.

The voluntary carbon markets function outside of the compliance market. They enable businesses, governments, NGOs, and individuals to offset their emissions by purchasing offsets that were created either through the CDM or in the voluntary market. The latter are called VERs (Verified or Voluntary Emissions Reductions). Compared to the compliance market, trading volumes in the voluntary market are much smaller because demand is created only by voluntary buyers (corporations, institutions and individuals) to buy offsets whereas, in a compliance market, demand is created by a regulatory instrument. Because there is lower demand and because VERs cannot be used in compliance markets, VERs tend to be cheaper than those credits sold in the compliance market such as the CERs.

The carbon finance uptake of a project will depend on which of the two markets it is traded. Conte and Kotchen (2010) find that the large variability in voluntary carbon offsets depend on where the providers are located. They find that that provider located in Europe sell offsets at prices that are approximately 30% higher than providers located in either North America or Australasia. However, contrary to their expectations, offset prices are generally higher, by roughly 20%, when projects are located in developing or least-developed nations.

Carbon offsets that are certified under the Clean Development Mechanism, which qualify for emission reductions under the Kyoto Protocol, sell at a premium compared to those in the voluntary market. This makes CDM popular, though access to such offsets is not easy due to the rigorous CDM methodology requirements. Moreover, all CDM projects should be hosted in a developing country. The reason as to why many developing countries have found refuge in the voluntary market. Further, the voluntary has no price per tonne for carbon credits generically, every project and vintage has a different pricing for example, African Stoves and Gold Standard credits generally fetch the highest pricing – up to $11 a tonne dependent upon the project size, its location, how much finance is put into the sustainable development outcomes (Hamilton, Sjardin, Peters-Stanley & Marcello, 2010b; Wara & Victor, 2008). Moreover, some projects, though registered under CDM, have also sought to sell credits in the voluntary markets. This leaves questions of which of the two market is more suitable for project developers in Kenya, and where are they likely to find more benefits, leading to the hypothesis below;

H_5: Selling carbon credits in the CDM markets positively influences the uptake of carbon finance

4.3 Summary of the Chapter

The development of the research hypotheses was based on the review of theories and past literature on the uptake of carbon finance in renewable energy projects. The determinants were based on what scholars had identified as determining the flow of carbon finance into renewable energy projects across the regions. However, these determinants had not been empirically tested in the context of a low and middle-income country in Africa, such as Kenya. The factors that determines these flows into emission reducing projects variously include the level of low carbon technology adopted by a project, the prevailing carbon offset prices in the internal carbon markets, the sectoral affiliation of the project, and the carbon market affiliation of a project and the size of the renewable energy in terms of power megawatts. Whereas the factors have been examined elsewhere, albeit individually and not as a combination, they have not been examined for Kenya. Moreover, an assessment of these factors together was necessary to derive a statistical model to help advice on carbon finance uptake in low and middle-income countries, as the world gears towards another mechanism under the Paris Climate Agreement.

CHAPTER FIVE

RESEARCH METHODOLOGY

5.1 Introduction

The use of an appropriate methodology is the primary basis of achieving objective results for a research problem (Creswell & Plano Clark, 2011). This chapter explains the research methodology employed to achieve the objectives of the study and is arranged as follows; Section 5.2 describes the philosophy of carbon finance research. Section 5.3 explains the research design and the rationale for its choice while 5.4 explains how the study population was sought. Section 5.6 explores the data and data collection methods employed as well as how the study ensured reliability and validity of the data collected and the research instruments used. It also presents the ethical considerations in data collection in subsection 5.6.4. Finally, section 5.7 explains how data collected from respondents and secondary sources was operationalized and analyzed to achieve the objectives of the study.

5.2 Research Philosophy

The approach to any research should involve philosophical assumptions as well as distinct methods and procedures that the researcher wishes to take to resolve the study problem (Cresswell, 2014). The philosophy adopted by a research describes how knowledge will be developed in order to achieve a deeper and wider perspective of the study objectives. To mount a competent enquiry and achieve a better understanding of the subject of carbon finance in Kenya, this study embraced the post-positivistism philosophy. Under the post-positivist philosophy, the methods were chosen for data collection and analysis, which could achieve objective and quantifiable findings on how carbon finance affected renewable energy development in Kenya.

According to Creswell (2014), post-positivists hold a deterministic philosophy which helps in finding a causal relationship between carbon finance and renewable energy. He underscores that the philosophy is also important in situations where the researcher began with a theory, collects data that either supports or refutes the theory and then makes the necessary revisions and conducts additional tests to prove or disapprove the theory. The inclination to the post-positivist philosophy was also justified by an examination of an existing body of knowledge by reviewing literature from previous carbon finance related studies, such as Descheneau (2012), Hogarth (2012) and Ma

(2014). The ontology and epistemology of the philosophy adopted by the research are explained below.

5.2.1 Ontological Approach

According to Crotty (1998), the basic foundations underlying any research is its assumptions as to the nature of the reality being investigated (ontology) and how this reality can be known (epistemology). Burrell and Morgan (2005) observe that the ontology of the research is based on whether the reality being investigated is external or internal to the individual. Further, Crotty (1998) postulate that ontological questions concerned with our conception and understanding of the world can be considered from two world views; an objective world view where there exists objective, absolute and unconditional truths (Lakoff & Johnson, 1999) and a constructivist worldview where realities are local and specific in the sense that they vary between groups of individual or are subjective (Guba & Lincoln, 1994). Crotty (2003) observes that the adoption of either an objective or a constructivist view is dependent on the methods, methodology and the theoretical perspective the researcher will approach the research from.

Based on the nature of the investigations carried out in the study on carbon finance, the study adopted a realistic ontology. The study assumed that the concept of carbon finance exists in reality, and went out to seek the causal relationship between carbon finance uptake and renewable energy. The study further, in accordance to Crotty (2003), sought to objectively extract the truths on the subject of carbon finance from the various stakeholders. In examining the understanding of carbon finance among the stakeholders, the study sought to find out the socially constructed reality on the subject. The methodology employed in the research was also based on a systematic and objective enquiry into philosophical problems about the facts of existence and practice of carbon finance.

5.2.2 Epistemological Approach

The epistemology of a research determines the information that should count as adequate and legitimate knowledge about a phenomenon, and how it should be acquired and interpreted Crotty (1998). There are two epistemological approaches or continuum available for a researcher, positivism and interpretivism. Positivism deals with verifiable observations and measurable relations between those observations, while interpretivism focuses on details of a situation and rejects absolute facts, suggesting that facts are based on perception rather than objective truth

(Morgan & Smirmich, 1980; Vasilachis, 2009). Prior research shows that the adoption of a particular epistemology leads the researcher to use methods that are in tandem with the position, which eventually leads to the adoption of a particular research design (Guba & Lincoln, 1994).

This research adopts a point in the methodological continuum, leaning more towards positivists (more quantitative tests of the uptake and determinants of carbon finance) and less interpretivism (little use of qualitative analysis on the opinions of stakeholders on the uptake of carbon finance). Because of the ontology of reality adopted for carbon finance, this research calls for an epistemological stance that allows for different research approaches as ways of generating knowledge. While aspects of collecting data such as the use of in-depth interviews are on the interpretivism extreme, the use of questionnaires to collect data for hypothesis testing is, for example, on the positivist extreme. The adoption of a particular epistemology also implies a particular ontology and vice versa (Crotty, 1998). Therefore, the study combines both interpretivism and positivism as the concept of carbon finance lends itself to social reality, with real variables to be examined and that links to multiple players including government agencies, renewable energy developers and climate change activists.

5.3 Research Design

The research design refers to the overall strategy that a researcher chooses to integrate the different components of the study into a coherent and logical manner to ensure that the research problem is effectively addressed (Creswell & Plano Clark, 2007). To effectively meet the objectives formulated for the research, the study employed three research designs; exploratory, descriptive and explanatory research designs. Because the subject of carbon finance has not been fully studied in Kenya, the study employed an exploratory research design. Creswell (2014) observes that exploratory research is useful where the subject has not been clearly and fully studied and development of operational definitions is intended. This aim of exploratory research augurs well for the study objective of examining the meaning of carbon finance among developers of renewable projects in Kenya. to this end, exploratory research was useful to discover ideas and insights on carbon finance uptake and provide information and reduce bias on determinants that were important for its uptake, that were addressed by the study.

To gather more information and increase knowledge in the subject of carbon finance, the study also employed descriptive research. Sekaran and Bougie (2013) observe that descriptive research is necessary in situations where the research intends to document and collect a large amount of data, which can be analyzed quantitatively to meet the objectives of the study. Combining empirical and descriptive techniques helped the study obtain and explore data on carbon finance at the project level, in order to make sense of the carbon finance uptake in these projects. To explain the relationship between the uptake of carbon finance and renewable energy deployment, the study employed an explanatory design. Creswell (2014) posits that explanatory research helps to connect ideas in order to explain a problem or a situation in form of causal relationships. To explore the causal relationship between carbon finance uptake and renewable energy deployment, the use of explanatory research was inherently useful in examining the variables identified through descriptive research.

To meet the objectives of the study, both quantitative and qualitative data was collected. To this end, convergent mixed methods, comprising of exploratory, descriptive and explanatory designs was used. Teddlie and Tashakkori (2011) observe that use of the convergent mixed methods enables the research to achieve a better understanding of the research problem by analyzing both qualitative and quantitative datasets, merging the results of the two sets and then comparing the results. By combining quantitative and qualitative data, the convergent mixed methods ensure a better understanding of a phenomena than either method alone.

5.4 Target Population

The population sought for this study comprised of renewable energy developers in Kenya. The rationale for examining the uptake of carbon finance by renewable energy developers is because prior research shows them to be the primary recipients of carbon finance, with over 80 percent of all climate mitigation finance accrues to them (Labatt & White, 2011). Renewable energy generation has been shown to play an important role in carbon emissions reduction, which all inflows of carbon finance aim to achieve. The choice of Kenya as a context was meant to ensure homogeneity of data and that it is a developing country, and thus eligible to host CDM projects. Prior research has also inventoried a large potential for renewable energy resources in the country (Kiplagat et al., 2013).

The target population for the study was developed from the register of renewable energy projects maintained by the Ministry of Energy and Petroleum, the principal authority that licenses renewable energy projects in the country. To ensure uniformity of responses and meet objectives set forth for the study, renewable energy projects for inclusion in the study were expected to be registered in the Feed-in-Tariff scheme of the ministry. The FiT scheme allows power producers to sell all the generated electricity to the principal distributor of electricity in the country, the Kenya Power and Lighting Company. To be able to sell power, a developer has to sign a Power Purchase Agreement (PPA) with KPLC. The PPA is necessary because, under the scheme, different power sources accrue different prices, based on their ability to reduce carbon emissions. Further, projects included were those implemented between 2005 and 2016. The reason for the choice of such a window is that Kenya ratified the Kyoto protocol in 2005 and carbon emissions reductions from projects before then are deemed non-additional, and hence did not qualify for carbon finance. The projects were also required to have a power production capacity of more than 1MW. Prior research shows that their size and the amount of carbon emissions reductions they can contribute is such that it does not make economic sense to pursue CDM registration or access in the voluntary carbon markets (Cormier & Bellassen, 2013).

The rationale for the choice of Renewable energy projects under the FiT scheme was that they possessed the characteristics sought for the study; ability of the project to reduce additional and quantifiable carbon emissions, thus making it eligible for accessing carbon finance. Furthermore, these renewable energy projects were considered front-runners in accessing carbon finance as prior research has enumerated the value of renewable energy on carbon emission reductions. Only 68 renewable energy projects met the criteria for inclusion in the study; registration in the FiT, signed or pursuing a PPA, implemented after 2005 and producing or purposing to produce more than 1 MW of electricity. For this reason, the study carried out a total population sampling. The rationale for the choice of total population sampling was that the entire population fulfilling the above characteristics was relatively small. Also, non-inclusion of some of the projects could have effect on the ability to explain the carbon finance situation for renewables in Kenya. Furthermore, these projects shared the uncommon characteristic of the ability to access carbon finance, unlike all small scale projects littered across the country. The projects were distributed across the various strands of renewable energy as below;

Table 5.1: Projects in the FiT Scheme as at December 2016.

	PROJECTS	NUMBER
1	Hydro power projects	24
2	Wind power projects	12
3	Geothermal power projects	14
4	Solar power projects	13
5	Biomass cogeneration projects	6
	Total	69

Source: Ministry of Energy and Petroleum, 2015

To collect comprehensive data that could shed more insights into the topic of carbon finance uptake in Kenya, triangulation of data sources was used, with more data collected from other carbon business stakeholders. Carbon business stakeholders were defined as organizations involved in the carbon finance supply chain, either as promoters of low carbon activities, carbon credit buyers and regulators of carbon trading in the country. The rationale for including this group was because they possessed pertinent information on carbon finance uptake in Kenya. The list of these organizations was acquired from the National Environmental Management Agency (NEMA), which is the Designated National Authority for CDM. NEMA also provides advisory services on carbon matters to the developers. Table 5.2 below lists the other carbon business stakeholders that were included as respondents for the study.

Table 5.2: Carbon Business Stakeholders in Kenya

	Stakeholder	Number
1	Government ministries and agencies	5
2	International organizations dealing with low carbon activities in the country	5
3	Carbon buyers	6
4	Carbon developers/Advisors	10
	Total	26

Source: NEMA, Ministry of Environment, 2015

5.5 Data Collection Method and Instruments

Data for the study was collected using questionnaires, interviews and desk research. The rationale for the triangulation of methodology was used to ensure additional sources of information were used to give more insight into the topic of carbon finance. Prior research shows that inventories of carbon finance were inadequate in the country, hence the need to use multiple sources in order to obtain comprehensive data. Denzin (1978) posits that triangulation is an important approach when a researcher needs to enhance confidence in the findings as it helps to easily recognize any inconsistencies in the data sets. This study employed the between (or across) triangulation method, popularized by Denzin (1978). Questionnaires were used to collect data from managers of renewable energy projects signed onto the FiT scheme. From this group, data on carbon finance uptake, registration for CDM and any access to the voluntary carbon markets was collected.

Data required to fulfil the objectives of the study was collected from renewable energy developers and other carbon business stakeholders, such as carbon buyers, regulators and promoters of low carbon activities. Data was collected on the levels of awareness and understanding of carbon finance concepts among renewable energy developers, the size of the renewable energy projects and their carbon emission reductions, type of low carbon technologies employed in the projects and the carbon market the project was affiliated to. Data was also collected on the prevailing carbon offset prices, as well as carbon revenues the projects had generated from sale of credits.

5.5.1 Data Collection Instruments

The methods and instruments used to collect data for the study are described below;

(i) Questionnaires

Data for the study was collected using a self-administered questionnaires delivered to the sampled renewable energy project location. In this group, the respondent was the manager of the renewable energy project. For business stakeholders, the questionnaire was delivered to the head office of the organization, and the respondent was the person in charge of the specified carbon business activity. Questionnaires were appropriate for this study because large amount of information on carbon finance use was required. Moreover, as observed by Johnson et al. (2007), collection of quantitative data through questionnaires makes it possible to create a new theory or test a hypothesis, as was done in the study. Questionnaires were administered to the managers of the renewable energy projects, as well as those in charge of all the identified stakeholders as attached in the appendix (i) and appendix (ii). To ensure a higher response rate, the questionnaires were clearly designed, adequately piloted and tested.

Compared to other data collection instruments, questionnaires have several strengths that aided the study. They help avoid bias among the respondents due to the similar framing of questions to all respondents, are less intrusive than a face-to-face interview, less expensive and are more scalable when it comes to large audiences (Cresswell, 2014). However, Creswell and Plano Clark (2011) caution before using a questionnaire, the researcher needs some training to avoid differences in understanding and interpretation among the respondents. Cooper and Schindler (2014) also highlight several weaknesses of a questionnaire including accessibility of respondents, incomplete responses and their inability to convey feelings. This study ensured that questionnaires were dropped and picked, in order to clarify any misunderstanding by the respondent and avoid incomplete responses.

(ii) Interviews

Semi structured, in-depth interviews were carried out with carbon buyers, carbon regulators and promoters of low carbon activities regarding the uptake of carbon finance in Kenya. The chosen interviewees were actively involved in carbon activities in the country, and were offered an opportunity to talk freely about their interactions on the subject of carbon finance. In some cases, to gain a better understanding of carbon finance status, the researcher, alongside the questionnaire, also conducted interviews with managers of renewable energy projects as well. Use of interviews, as observed by Kimberlin and Winetrstein (2008) helps the research to seek more clarification from the respondents in a way a questionnaire could not be able to. Therefore, interviews were used to clarify positions regarding carbon finance uptake and also extract the stakeholders' opinions as to the outlook and future of carbon financed renewable energy deployment in Kenya. To ensure some level of uniformity in the responses and clarify responses, interviewers were trained and an interview guide used (see Appendix ii).

(iii) Desk research

The study utilized desk research to collect information from several secondary sources regarding the uptake of carbon finance in Kenya. As a relatively new field of finance, Luxmore et al. (2013)

reports that there is dearth of information on the subject of carbon finance, particularly among low and middle income countries such as Kenya. For this reason, online desk research was used to collect more information from the website of the Clean Development Mechanism website, the World Bank carbon funds and published data from the government ministries involved in regulating carbon activities. Of particular importance to the study were project design documents for renewable energy companies registered with the CDM board, which were collected from the CDM website. Desk research was also used to collect published data on carbon finance from international organizations such as the Intergovernmental Panel on Climate Change (IPCC) and the UNFCCC. Desk research has the advantage of extracting information that has been disseminated by leading experts without much cost. However, the study exercised caution on use of information from unauthenticated sources, as Czarniawska (2014) warns this may affect the credibility of a research outcome.

5.5.2 Pilot Survey

A pilot survey is a strategy used to test the questionnaire using a smaller sample compared to the planned sample size (Creswell, 2014). In this study, the questionnaire was administered to 7 respondents, representing a small percentage of the total population. The pilot was used to explore the usability of the questionnaire and their appropriateness for administration to the target population. It was also used to test the correctness of the instructions to the respondents and provide information on the usability of the survey in fulfilling the purpose of the study. It also provided the researcher with ideas, approaches, and clues regarding the approach to the respondents, the management of geographical distances and the issues of non-response to the questionnaires. The questionnaires used are presented in the appendices (i) and (ii).

5.5.3 Research Instrument Reliability and Validity

The key indicators of the quality of a measuring instrument are the reliability and validity of the measures Reliability and validity are ways of demonstrating and communicating the rigour of research processes and the trustworthiness of research findings (Creswell, 2014). The study focused much effort in the development and validation of the research instruments, in order to reduce errors that could occur in the process of collecting the data. The reliability of an instrument is the consistency with which it measures what it is intended to measure while the validity is the accuracy and meaningfulness of inferences, based on the research results (Kimberlin & Winetrstein, 2008).

Reliability of the instruments in this research was investigated using Cronbach's alpha and the KMO & Bartlett's test, which is best suited to measure the internal consistency or the consistency of results across items (Williams, Onsman & Brown, 2010). The Cronbach's alpha measures how homogeneous and reflective a tool is in relation to the underlying constructs and a Cronbach's Alpha of 0.70 or above is considered good reliability (Lee & Greene, 2007). Because the study employed factor analysis to identify the latent variables that constrain the use of carbon finance in Kenya, Kaiser Meyer Olkin (KMO) and Bartlett's Test of Sphericity were used to measuring the adequacy of the sample. The KMO measures how suitable the data is for factor analysis and measures the sampling adequacy while the Bartlett's Test of Sphericity relates to the significance of the study, thereby showing the validity and suitability of the responses collected to the problem being addressed (Kaiser, 1974). While the KMO ranges from 0 to 1, studies show that the accepted index is over 0.6 (Kaiser, 1974; Ledoit & Wolf, 2002). For factor analysis to be recommended suitable, the Bartlett's Test of Sphericity must be less than 0.05 (Dziuban & Shirkey, 1974; Williams et al., 2010).

Creswell (2014) posits that validity ensures that the data collected reflects what is being studied and has four types; content validity, criterion validity, construct validity, and face validity. The content validity examines whether a given measure incorporates all aspects or content of a construct under study, criterion validity demonstrates the accuracy of the measure. Construct validity provides the researcher with confidence that a survey actually measures what it is intended to measure while face validity is the evaluation of the instrument by the study participants to determine if they believe that an instrument measures what it is intended to measure. The content validity of the research instruments in this study was evaluated through a pilot test, which provided feedback that helped modify the instruments. The pilot run also helped to determine the suitability of the research instrument and the challenges of non-response. The external validity, the extent to which the results of a study can be generalized from a sample to a population (Ghauri & Gronhaug, 2010), was evaluated using representative questions from each of the sections of the questionnaire and evaluating them against the desired outcomes. The external and content validity of the instrument was also measured using statistical tests.

5.5.4 Ethical Consideration in the Research

To adhere to the aim of this research of imparting objective knowledge devoid of falsification and errors, the study adopted several ethical considerations. The proposal and the questionnaires were subject to the university's ethics review board; to ensure they did not interfere with the respondents' privacy or consent to provide information freely. All respondents were knowingly, voluntarily and intelligently recruited and gave consent to their participation in the study. The study also respected their confidentiality or wish to remain anonymous, whenever they chose to be so. The study also ensured that data analyzed was collected from the respondents, as a guard against the fabrication or falsification of data and therefore, gain wide acceptance of the findings.

5.6 Data Analysis

The study utilized questionnaires, interviews and desk research collect both quantitative and qualitative data for the study. For this reason, qualitative and quantitative approaches were used to analyze data, which enhances the realistic ontology assumed by this study, as it provides a better understanding of research problems than either approach alone. Both approaches are explained below;

5.6.1 Quantitative Analysis

Analytical techniques, comprising of logistic regression, factor analysis and correlational analysis was employed to measure the relationships between the variables comprising carbon finance uptake in renewable energy deployment. The techniques employed, the objectives they addressed, together with their weaknesses and strengths are explained as below;

(i) The Binomial Logit Regression model

The study used the Binomial Logit Regression model to meet the requirements of objective three of the study on the determinants of the uptake of carbon finance among renewable energy developers. Allison (2014) finds that the model is suitable in modelling the influence of several independent variables on a single dichotomous outcome variable. The study sought to find the influence of several determinants on carbon finance uptake, making the model ideal for the study. Hosmer Jr, Lemeshow and Sturdivant (2013) also posit that the independent variables in binomial logistic regression need to be identified in advance in order to enhance the effectiveness of the model. Hence, in the study, the independent variables of project size in megawatts of power production, the project sector, the prevailing carbon offset prices, the use of low carbon technology and the carbon market affiliation were derived from latent literature. Binomial logistic regression was suitable in estimating their influence on the uptake of carbon finance.

Whereas the logistic regression attempts to predict outcomes based on a set of independent variables, Hosmer and Lemesbow (1980) argue that the inclusion of the wrong independent variables reduces the predictive power of the model. To achieve this, and enhance the usefulness of a logistic regression model, the relevant independent variables first were identified first, which is one weakness of the model. Hair et al. (2006) also confirm that the logistic regression generates the coefficients (and its standard errors and significance levels) of a formula to predict a logit transformation of the probability of the presence of the characteristic of interest. The choice of logistic regression was also appropriate in this study because, rather than choosing parameters that minimize the sum of squared errors, like in ordinary regression, estimation in logistic regression chooses parameters that maximize the likelihood of observing the sample values.

(ii) Evaluation of the model.

Some of the critical questions in modelling data using a logistic regression model is to find out how well the model fits the data, which predictors are most important and if the predictions are accurate (Hair et al., 2006; Harrell, 2015). Allison (2014) and Hair et al. (2006) find that the approaches to address these concerns fall into two categories: measures of predictive power (like R-square) and goodness of fit tests (like the Pearson chi-square). Measures of predictive power helps a study to measure how well one can predict the dependent variable based on the independent variables while goodness-of-fit tests, which help to decide whether the model is correctly specified. The study utilized the Cox-Snell R^2 to measure of predictive power of the model used. While there is no consensus on the best measure of R^2 from the many methods that are available, Hosmer and Lemesbow (1980) report that Cox-Snell is the optional R^2 reported by most binomial logistic regression studies.

The goodness-of-fit tests, which help to decide whether the model is correctly specified, include the Pearson chi-square and the Hosmer-Lemeshow test. According to Allison (2014), these are formal tests of the null hypothesis that the fitted model is correct, and their output is a p-value, a number between 0 and 1 with higher values indicating a better fit. The study utilized the Pearson chi-square measures to gauge how well the observed distribution of data fits with the distribution that was expected if the variables were truly independent. The Hosmer–Lemeshow test is used to determine if there were problems with the model, by examining if the lack of fit was significant.

The Binomial Logit Regression model used was expressed thus:

$$\mathbf{Log\ (P/1\text{-}P)} = \beta_0 + \beta X_1 + \beta X_2 + \beta X_3 + \beta X_4 + \beta X_5$$

Where;

P - Probability of using carbon finance in the emission reducing project

$\mathbf{X_1}$ - Project size, was measured by the power capacity of the project in electricity megawatt

$\mathbf{X_2}$ - Project sector, the sectoral scope of the project within the energy sector

$\mathbf{X_3}$ - Carbon offset prices denotes the prevailing offset prices in terms of carbon credit prices in the international carbon markets at the time of the carbon credit sales from the project

$\mathbf{X_4}$ - Technology, is the level of advancement in technology that is used in implementing the project.

$\mathbf{X_5}$ - Market affiliation is the type of market in which the carbon credits generated from the project are sold, either the compliance market or the voluntary market. Market is which the project has been selling carbon credits.

(ii) Factor Analysis

To meet objective four on the challenges faced by renewable energy developers in implementing their projects, the study employed exploratory factor analysis. Use of factor analysis also helps to reduce a large number of observed variables into fewer numbers of latent or unobservable factors in order to identify the most important variables in explaining the phenomena. Brown (2014) identifies two types of factor analysis, exploratory and confirmatory factor analysis. The exploratory factor analysis measures the underlying factors that affect the variables in a data structure without setting any predefined structure to the outcome while confirmatory factor analysis reconfirms the effects and correlation of an existing set of predetermined factors and variables that affect these factors. The rationale for use of exploratory factor analysis was to explore and identify the most important variables constraining the deployment of these projects. Exploratory factor analysis was also used to identify the constraints of accessing carbon finance among the developers in Kenya, as part of objective three on the determinants of carbon finance uptake. The aim was to weight and reduce the underlying constraints that renewable energy developers in Kenya face in accessing carbon finance in order to identify the more important factors in accessing carbon finance from the international carbon markets.

5.6.2 Qualitative Analysis

To give more insight into the concept of carbon finance uptake, a triangulation of data sources was used in this study. To this end, text data was collected from carbon business stakeholders to increase the credibility for the findings under objective one and two. To analyze these text data, content analysis was employed. Content analysis describes analytical approaches that are used to make replicable and valid inferences by interpreting and coding textual material (Duriau et al., 2007). It involves coding and classifying data, and then categorising and indexing with the aim of making sense of the data collected and highlight the important messages, features or findings (Holsti, 1969). There are three distinct approaches to content analysis; conventional, directed and summative (Hsieh & Shannon, 2005). In conventional content analysis, coding categories are derived directly from the text data. Under the directed approach, analysis starts with a theory or relevant research findings as guidance for initial codes with the aim of validating or extending conceptually a theoretical framework or theory. A summative content analysis involves counting and comparisons, usually of keywords or content, followed by the interpretation of the underlying context (Hsieh & Shannon, 2005).

The study employed conventional content analysis, which is generally applicable with a study design aimed at describing a phenomenon such as carbon finance uptake. As Kondracki and Wellman (2002) observes, the approach is useful where existing theory or literature on a phenomenon is limited, as was the case in this research on the theory and literature on carbon finance uptake in the Kenyan context. Further, Hsieh and Shannon (2005) find that the approach most useful where text data is collected primarily through interviews and open-ended questions. Both of this methods were used to collect text data from carbon business stakeholders on their perceived awareness and opinions on the uptake of carbon finance in Kenya.

Using the text data collected through interviews and open-ended questionnaires, the study identified categories of the responses based on opinions and views of the stakeholders on carbon finance uptake. Four categories were identified based on the opinions of carbon business stakeholder; the level of carbon finance awareness and uptake in the country, incentives from the government for carbon development, the potential for carbon markets growth in the country and the perceived role of carbon finance in renewable deployment in the country. Based on the coding from this categories, quantitative analysis was then carried out and results interpreted as presented in section 6.8.5 of the study. In the interpretation of the findings, concurrence of the relationships between categories were identified.

While conventional content analysis helps in gaining insightful direct information from study participants, the challenge of this type of analysis is failing to develop a complete understanding of the context, thus failing to identify key categories (Hsieh & Shannon, 2005). This challenge was mitigated by insuring internal validity of the instrument, through a pre-test done through a pilot. Further, in recommendations of Lincoln and Guba (1985), the credibility of the information was established through prolonged engagement, persistent observation and triangulation of the data collected. As opposed to other qualitative analysis methods like phenomenology and grounded theory, the study limited itself to conventional content analysis by describing the experiences of the stakeholders. Content analysis has also become a valuable method in organizational research because it allows researchers to recover and examine the nuances of organizational behaviours, stakeholder perceptions, and societal trends (Teddlie & Tashakkori, 2011).

5.7 Operationalization of Research Variables

The study was informed by five variables, which have been identified from literature as important in determining carbon finance accrual to an emission reducing project. These variables are; size of the renewable energy project in electricity megawatts, the sector in which an emission reducing project is developed, prevailing carbon offsets prices, level of low carbon technology used in the project and the carbon market affiliation of a renewable energy project. The indicators and the measurement criteria for each of the variables is presented in the table below.

Table 5.3: Operationalization of Research Variables

Variable	Indicators	Measurement
Size of renewable project	Size of the project in electricity megawatts and expected carbon emissions reductions from project	**Closed end question**s on project size in megawatts, initial capital costs of the project, amount carbon emissions reduced
Project Sector	Sectoral affiliation of the project, Regulations from the sector and baseline measurement in the sector	**Five point likert scale** enquiring on influence of aspects of the sector on carbon finance uptake from developers.
Carbon Offset prices	Amount of carbon revenue earned, Difficulties in guaranteeing sufficient cash flows from the project, Uncertainties over Carbon Financing credits	**Closed end questions** on prices at which offsets were sold.
Low Carbon Technology	Renewable energy technologies used in the project, dependence of technology on weather changes, carbon emissions reduced by the technology and technology costs	**Five point likert scale** on the influence of aspects of technology used on carbon emissions and hence carbon finance.
Carbon Market affiliation	Carbon market where carbon offsets from the projects traded in either the CDM or voluntary market, Transaction costs to meet requirements in the market	**Closed end questionnaire** on carbon markets project is leaning to and the type of carbon standard used.

5.8 Summary of the Chapter

The methodology of a research study is important in helping the researcher to explain and describe the subject of the study. Underlying the methodology of this study is the deterministic philosophy of post positivism and a realistic ontology and a positivist learning epistemology. This philosophy supports the use of a convergent mixed methods design which uses both qualitative and quantitative data, to meet the objectives of the research. The use of both qualitative and quantitative data helps this study to ensure that findings of the study can be applied in other real life scenarios. Further, the collection of data using a variety of instruments and methods helps meet the objectives in a more comprehensive way and from all the envisaged scenarios.

CHAPTER SIX

DATA ANALYSIS, PRESENTATION AND TESTS OF HYPOTHESES

6.1 Introduction

This chapter presents an analysis of the data collected and test of the research hypotheses formulated in chapter four. The analysis involved the computation of descriptive statistics and use of analytical methods, specifically regression analysis, to uncover the nature of the relationship between carbon finance and renewable energy deployment. It also presents the factor analysis results for the constraints of accessing finance and challenges of renewable energy investing in Kenya. The chapter is arranged as follows; section 6.2 provides an analysis of the preliminary data, which includes a section on data treatment and the response rate for study. Sections 6.3 through 6.8 presents the analysis showing how each objective of the study was achieved. Finally, section 6.9 presents the results of the tests of the hypotheses and a summary of the chapter is presented thereafter. To enhance readability and facilitate understanding, the major results are briefly summarized in each subsection before being discussed in the next chapter.

6.2 Preliminary Data Analysis

The section presents the preliminary data analysis that involves editing and coding data in order to prepare it for further analysis. It also contains demographic data on the respondents of the study, as well as variables relating to these demographics.

6.2.1 Editing and Coding

Data collected for this study was collected using questionnaires, interviews and desk research. To provide answers to the research questions, the vast amount of data collected from renewable energy developers and carbon business stakeholders was processed through classification and summarization, to make it amenable to analysis. The processing involved scrutiny for errors, omissions and incompleteness through editing. To carry out regression and factor analysis, it was also necessary to code the data. Coding is the assignment of numerals or other symbols to the categories of responses (Cresswell, 2014). Although editing and coding are important preliminary steps to data analysis, Cooper and Schindler (2014) caution that they should not be treated as constituting the totality of the analysis and should be used to ensure that the data portrays a clear message from the researcher.

6.2.2 Response Rate in the Study

The population of this research comprised of developers of renewable energy projects and other carbon business stakeholders in Kenya. Of the renewable energy developers, responses were obtained from 62 projects out of a possible 68 while 23 carbon business stakeholders out of the sought 26 responded. The implication for the response rate is that the received responses were adequate to draw valid and credible conclusions of the study objectives.

Table 6.1: Response Rate.

Category	Response	Population
Renewable energy Projects	62	68
Carbon business Stakeholders	23	26
Total	85	94

Because financial viability of a renewable energy is critical to its access to carbon finance, the study also sought to find out if the projects were commercially viable. Commercial viability allowed the implementation of a project, and it's the first step towards achieving carbon emission reductions. The responses on the estimated ability of the project to recoup its initial investments and provide some returns to the project developers, as a measure of its viability are presented in the table below;

Table 6.2: Commercial Status of the Renewable Energy Project

Category	Frequency	Valid Percent	Cumulative Percent
Commercially unviable	11	17.7	17.7
Commercially viable	51	82.3	100.0
Total	62	100.0	

Of the 62 projects respondents, 82.3 % were commercially viable as the time of collecting data while 17.7 % had not recouped their investment outlays at the time of the study. The outcome means that majority of the projects were commercially viable and thus profitable for implementation. Carbon buyers and low carbon buyers must be assured of the feasibility, viability and risks of projects, in order for them to have confidence in developing carbon credits from them. The implication for these findings is that most of the renewable energy projects in the country are viable, and hence in a position that can accrue carbon finance.

6.3 Understanding of the term Carbon Finance among Renewable Energy Developers

The first objective of the study was to establish the understanding of the term carbon finance among renewable energy developers in Kenya. From literature review, the study picked constructs and elements of carbon finance, on which questions were framed and presented to the respondents. Respondents were asked to rate their knowledge on key concepts of carbon finance; carbon credits, carbon trading, carbon standards used in carbon markets, carbon emissions, climate change as well as international agreements that created the concept of carbon finance. The results for each are presented in the following sections.

6.3.1 Carbon Emissions and Carbon Offsets

The study sought to know from the respondents how well they were versed with basic elements of carbon finance use and climate change. A likert scale of between 1(for very low levels of awareness and 5(for higher level of awareness) was used. The mean and the standard deviation of the responses were computed as presented in table 6.3 below.

Table 6.3: Descriptive Statistics on Respondents' Knowledge on Climate Change, Carbon Offsets and Carbon Emissions

	N	Mean		Std. Deviation	Skewness		
	Statistic	Statistic	Std. Error	Statistic	Statistic	Std. Error	CV (%)
Climate change	62	3.01	.162	1.276	.684	.304	49.737
How Greenhouse gases cause global warming	62	2.44	.175	1.374	.765	.304	56.436
Carbon offsetting	62	2.63	.165	1.296	.593	.304	49.298
Carbon offsets and carbon emissions reduction	62	2.50	.170	1.340	.613	.304	53.592
Carbon offsets and climate change mitigation	62	2.61	.155	1.219	.625	.304	46.670

The descriptive statistics for the responses on knowledge levels on climate change show that whereas the respondents are indifferent to the concept of climate change (at 3.01 out of 5.00), their understanding on how carbon emissions cause climate change is low (at a mean of 2.44 and a standard deviation of 1.374). Similarly, their understanding of the carbon offsetting process, and how offsets are used in climate mitigation is equally low, all with means of below 3.0 in a scale of 1.0 to 5.0. The analysis also reveals wider dispersion of the responses for each concept, as shown by their coefficients of variation. Overall, these responses serve to show that the levels of understanding of these basic elements of carbon finance; climate change, greenhouse gases, carbon offsets and climate change mitigation, are all low among renewable energy developers in Kenya.

6.3.2 Carbon Credits, Carbon Trading and Carbon markets

The concept of carbon credits trading in a carbon market is the basis on which carbon revenues can be generated for an emission reducing project. The study sought to know from the respondents what their understanding of the various concepts of carbon credits generation and carbon trading. The responses were captured on a likert scale of between 1(for very low levels of awareness and 5(for higher level of awareness) was used. Table 6.4 below presents results for the developer's knowledge on carbon credits generation and carbon trading

Table 6.4: Descriptive Statistics on Developer's Knowledge on Carbon Credits and Carbon Trading

Descriptive Statistics							
	N	Mean		Std. Deviation	Skewness		
	Statistic	Statistic	Std. Error	Statistic	Statistic	Std. Error	CV (%)
Generation of carbon credits	62	2.77	.165	1.298	.343	.304	46.803
Trading of carbon credits	62	2.74	.163	1.280	.504	.304	46.666
Trading of carbon credits in Regulated markets	62	2.76	.168	1.327	.419	.304	48.103
Trading of carbon credits in voluntary markets	62	2.32	.151	1.190	.262	.304	41.922
Use of cap and trade mechanism in carbon trading	62	2.15	.177	1.392	.351	.304	49.903
Additionality of a carbon emission reducing project	62	1.89	.164	1.292	.172	.304	47.131
Leakage in a carbon emission reducing project	62	1.64	.171	1.349	.284	.304	46.979

The results reveal low levels of understanding of carbon credits, carbon trading and carbon markets as elements of carbon finance. Understanding for carbon credits generation is higher with a mean of 2.77, followed by CDM at 2.76. The respondents also show low levels of knowledge on the concepts of trading in the voluntary markets and use of cap and trade mechanism, an important concept when it comes to determining how much carbon credits to buy or sell in a project. The concepts of additionality and leakage in carbon emission reducing projects, though central to accruing carbon finance, are rated poorly at 1.89 and 1.64 respectively. Overall, the ratings of these elements of carbon finance are below the average level of 3.0 out of the possible average of 5.0.

To further establish the level of understanding of the markets for carbon credits, the study sought to find out the markets for carbon credits used by those developers who had in one way or another, accessed the carbon markets. They were asked to state which of the two markets, the voluntary and the compliance markets they had used for their carbon credits. The responses are as presented in the table below.

Table 6.5: Type of Carbon Markets where Credits for the Project are sold.

		Frequency	Percentage
Valid	Voluntary Market	5	21.7
	Compliance market	18	78.3
	Total	23	100.0

The compliance or CDM market was the most used market for selling carbon credits at 78.3 % while the voluntary market was used by 21.7 % of the respondents. That Kenyan project developers prefer the compliance market can be explained by the ability of the country to host CDM projects and also participate in carbon credit sales to other compliance markets, such as the European Unions' Emission Trading System.

6.3.3 Carbon Offset Standards used in Carbon Trading.

Carbon offset standards are the basic units that are used in measuring and verifying greenhouse gas emission reduced by a project. The standards also provide guidance on how these reductions should be achieved. Therefore, any carbon emission reduced by a project is measured using an offset standard, and developers must be aware of which standard they are targeting to achieve in their project. The aim of this section was to gauge the familiarity of Kenyan developers with carbon offset standards used in both the voluntary and compliance carbon market. Knowledge of carbon finance must be preceded by an understanding of the basis on which trading takes place, which is basically by using the offsets. Results of the rating for the carbon standards presented to the respondents are as below;

Table 6.6: Descriptive Statistics on Developers' Knowledge on Carbon Offset Standards used in Carbon Trading.

Descriptive Statistics							
	N	Mean		Std. Deviation	Skewness		
	Statistic	Statistic	Std. Error	Statistic	Statistic	Std. Error	CV (%)
CDM Gold Standard	62	2.92	.174	1.371	-.087	.304	46.950
Climate , Community and Biodiversity Standard	62	1.81	.128	1.006	1.604	.304	55.664
Verified Carbon Standard	62	2.29	.144	1.136	.991	.304	49.617
Chicago Climate Exchange	62	1.79	.140	1.103	1.794	.304	61.634
Climate Action Reserve	62	1.53	.064	.503	-.133	.304	32.829

The results reveal low levels of familiarity or understanding from developers on carbon market standards. The CDM Gold Standard seems to be more popular among the developers in Kenya, with a mean of 2.92, possibly because of the number of CDM projects in the country and the efforts of the Designated National Authority office at the National Environmental Management Authority to promote CDM projects in the country. The Verified Carbon Standard (VCS) used in voluntary carbon trading follows closely, showing more interest from developers. Since attaining CDM registration is increasingly become difficult for many projects, partly due to its bureaucracies and difficulties in proving additionality, project developers are moving to the voluntary market. Some project developers register their projects for both CDM and voluntary carbon standards, so they can gain from the lucrative validated credits under CDM and at the same time take advantage of the less rigorous climate of the voluntary market. The other standards, the Climate, Community and Biodiversity Standard, the Chicago Climate Exchange and the Climate Action Reserve are rated low at 1.81, 1.79 and 1.53 respectively, signifying lack of knowledge on these standards. The low level of understanding of these standards, therefore, puts carbon developers in the country at a disadvantage.

The study also sought to establish, among the respondents who had accessed carbon revenues, which type of carbon standard they had used in their projects. Only three standards emerged to have been used by developers in the country, as presented in the table below.

Table 6.7: Type of Carbon Credits used by the Project Developers

Type of carbon credit	Frequency	Valid Percent
CDM Gold Standard	18	78.2
Voluntary Carbon Standard	4	17.3
Climate, Community and Biodervisty Standard	1	4.3
Total	23	100.0

The CDM Gold Standard was used by 78.2 % of the respondents, while 17.3 % used the Voluntary Carbon Standard. Only 4.3 % used the Climate, Community and Biodervisty Standard. The implication for this percentages are that majority of the developers are inclined to the compliance market. As a developing country, the DNA is actively promoting the implementation of CDM, hence the skew towards these market.

6.3.4 Carbon Funds as sources of Carbon Finance

Carbon finance is operationalized through carbon funds, each targeting a specific sector or segment of the market. Renewable energy developers were presented with carbon funds which have an element of renewable energy development in their structure. They were asked to rate their level of understanding on these funds, in a likert scale of between 1 and 5. The responses, together with their means and standard deviation are as presented in the table below.

Table 6.8: Descriptive Statistics for Developer's Knowledge on Carbon Funds as sources of Carbon Finance

Descriptive Statistics							
	N	Mean		Std. Deviation	Skewness		
	Statistic	Statistic	Std. Error	Statistic	Statistic	Std. Error	CV (%)
Green Climate Fund (GCF)	62	2.29	.146	1.151	.735	.304	50.243
Global Environmental Facility	62	2.12	.133	1.049	.578	.304	45.499
Prototype Carbon Fund	62	1.86	.160	1.260	1.053	.304	54.994
Community Development Carbon Fund	62	1.97	.137	1.080	.723	.304	46.834
BioCarbon Fund	62	1.65	.134	1.057	.955	.304	44.900
Carbon Initiative for Development	62	2.35	.137	1.082	.852	.304	44.116
Carbon Partnership Facility	62	1.87	.142	1.118	.705	.304	47.461

The results reveal that there are low levels of familiarity with mainstream carbon funds among the developers. While the carbon funds target specific emission reducing projects, an understanding of the wider carbon funds from which projects can accrue funds is necessary. The Carbon Initiative for development fund is slightly rated higher. The reason for this rating was revealed to be the use of Ci-Dev by 8 projects under the Kenya Tea Development Authority programme of activity, to prepare for CDM requirements form Ci-Dev. Moreover, the dispersion of the responses for Ci-Dev were also the lowest, as denoted by a coefficient of Variation of 44.11, compared to the rest of the funds. It was followed by the Green Climate Fund at a mean of 2.29, which is also low but slightly more than the others. The rest of the funds, apart from the global Environment Facility are poorly rated, resulting in means of less than 2.0., signifying low levels of their understanding and use by developers. The low rating of carbon funds by the developers implies low levels of knowledge and awareness on their use. Emanating from these findings, it could as well be that the lack of awareness could be the reason developers haven't sought carbon finance access for their projects, contributing to the low levels of uptake in the country.

6.3.5 Climate Agreements and their use in Climate Change Mitigation

Prior research has established that international climate agreements under the auspices of the UNFCCC played a central role in the development of carbon finance architecture in the world (Boyd et al., 2015). Therefore, to understand how these agreements had shaped the carbon finance climate in Kenya, respondents were specifically asked to rate their level of understanding on elements of the Kyoto protocol and its predecessor, the Paris Climate Accord. The responses were captured on a likert scale of between 1(for very low levels of awareness and 5(for higher level of awareness). The results of their rating are as presented below;

Table 6.9: Climate Agreements and their use in Climate Change Mitigation

Descriptive Statistics							
	N	Mean		Std. Deviation	Skewness		
	Statistic	Statistic	Std. Error	Statistic	Statistic	Std. Error	CV (%)
Kyoto Protocol	62	2.44	.167	1.313	.706	.304	53.932
use of CDM in climate mitigation	62	2.79	.149	1.175	.486	.304	42.124
use of Joint Implementation in climate mitigation	62	2.61	.148	1.164	.683	.304	44.565
Use of Emission Trading in climate mitigation	62	2.66	.151	1.187	.636	.304	44.587
process of acquiring CDM registration	62	2.63	.151	1.191	.526	.304	45.286
Paris Climate Accord	62	2.46	.159	1.250	.582	.304	50.998

The results show the descriptive statistics for the renewable energy developers on the climate agreements on which carbon finance is anchored. From the analysis, there are low levels of knowledge on the Kyoto Protocol and its mechanisms of CDM, joint Implementation and Emissions Trading at means of 2.79, 2.61 and 2.66 respectively. Awareness on the protocol and its predecessor, the Paris Climate Accord are also low at 2.44 and 2.46 respectively. The dispersion of the responses is shown to be higher for the Kyoto protocol and the Paris Accord, at 53.93 and 50.99 respectively. The implication of the lower dispersion for the elements of the protocol (CV of below 44) implies that developers have some awareness of the CDM, JI and ETS, but little knowledge of where they originated from. The implication for these variation is that knowledge on climate agreements is sparse among the respondents, which agrees with prior studies such as Sena (2015). The results also mean that levels of awareness on the overall climate finance architecture among the developers is low, in agreement with Wood et al. (2015).

6.3.6 Meaning of Carbon Finance among Renewable Energy Developers

The study also sought to know from the developers what carbon finance as a concept of funding meant to them. The respondents were presented with a range of descriptions of carbon finance, and they were asked to rate the extent to which each of them described their understanding of what carbon finance is. The rating was done on a likert scale of between 1(for poor description) and 5(for best description) of carbon finance. The responses were captured and the mean and standard deviation calculated as presented in the table below.

Table 6.10: Carbon Finance Understanding among Renewable Energy Developers

Descriptive Statistics							
	N	Mean		Std. Deviation	Skewness		
	Statistic	Statistic	Std. Error	Statistic	Statistic	Std. Error	CV (%)
Financing channeled by national, regional and international entities for climate change mitigation and adaptation projects and programs	62	3.14	.125	.983	.922	.304	40.895
Financial flows for climate change mitigation and adaptation in developing countries.	62	2.34	.132	1.039	.809	.304	44.438
All finances used in the reduction of greenhouse	62	2.87	.146	1.148	.982	.304	50.463
Compensation paid by greenhouse producers to those who clean the environment	62	2.40	.146	1.152	.876	.304	48.000

From the results, carbon finance as financing channeled by national, regional and international entities had the highest mean at 3.14. It was followed by carbon finance as all the finances used in the reduction of greenhouse gases at 2.87 while Carbon finance as financial flows for climate change mitigation and adaptation for developing countries had a mean of 2.34. Carbon finance as the compensation paid by greenhouse gas producers to those who clean the environment had a mean of 2.40. The descriptions of carbon finance are all low, signifying the level of understanding of the respondents on the concept of carbon finance. The implication for these findings is that developers find carbon finance to mean all funds channeled by national, regional and international entities for projects and programmes that reduce carbon emissions. This definition is also backed by the lower rate of dispersion on the responses on this definition, which was 40.89, much lower than those of other definitions.

6.4 The Level of Uptake of Carbon Finance among Renewable Energy Developers in Kenya

The second objective of the study was to determine the level of uptake among renewable energy developers in Kenya. To access carbon finance, a baseline showing that carbon emissions reduced are beyond the business-as-usual scenario has to be established. Therefore, the study sought to identify the basis on which the project's baseline was established, before determining whether the greenhouse gases reduced were additional or not. Section 6.4.1 explores the baseline selection and 6.4.2 examines the additionality. The technology employed in a project determines the carbon emissions reductions a project could achieve, a key parameter on the carbon finance that accrues to a project. Therefore, section 6.4.3 sought to explore the basis on which technology chosen for the project was established. After establishing whether the projects carbon emission reductions, the study then undertook to find out the actual uptake of carbon finance by the projects as presented in section 6.4.4 and section 6.4.5. The analysis for each of the sections and their implications are presented below.

6.4.1 Parameter used to establish the Project's Baseline

The first aspect in the quest to accrue carbon finance is to establish a project's baseline, which determines whether the carbon emissions reductions form the project are beyond a business as usual scenario, and hence additional. The respondents were asked to identify the parameters that the project had used to establish its baseline and the results are as tabulated below;

Table 6.11: Parameter used in establishing the Project's Baseline

		Frequency	Valid Percent	Cumulative Percent
Valid	Technology	47	74.1	74.1
	Common practice within the sector	14	24.1	98.3
	Market share of the product	1	1.7	100.0
	Total	62	100.0	

Technology was the most applicable basis for establishing the baseline with 74.1 % of the projects while the common practice within the sector was the second with 24.1 %. Market share of the product, being the renewable energy produced by the product was least used at just a little less than 2 %. The establishment of the projects' baseline did not mean that the project was able to access carbon finance immediately. However, it provided a basis on which the project would in future prove its additionality. Therefore, even projects that had not gained any carbon revenues were able to establish some baseline.

6.4.2 Use of Carbon Finance by the Projects

Carbon finance uptake was measured at two levels. The first level was access to carbon finance by the developer during the initial stages of the project or during implementation, and the second was sales of carbon credits after the project was operational. Developers were asked to provide information regarding whether they had used carbon finance at any stage in the development of the project. Further, they were asked to provide information regarding the amount of finance, if any, which they had received, because of carbon emissions reduced by the project.

Table 6.12: Projects use of Carbon Finance

		Frequency	Percent	Cumulative Percent
Valid	Non User	39	62.9	62.9
	User	23	37.1	100.0
	Total	62	100.0	

The results show that 39 projects out of 62 projects in the study had not used or accessed any form of carbon finance, while 23 projects (37.2 per cent) did use carbon finance at some stage of their development. While the results show that a significant number of projects accessing carbon revenues, the form of access and the amount accrued from any source of carbon finance was not apparent. Moreover, a further scrutiny on the type of carbon finance received shows many of these projects had not sold any carbon credits.

6.4.3 Analysis on Renewable Energy Projects registered for CDM

Data on Kenyan renewable energy projects registered with the CDM board as possible recipients of carbon revenues was also collected from secondary sources including the CDM website, national Environmental Management Authority and the Ministry of Environment. The Project Design Documents (PDDs) of all renewable energy projects were obtained and data collected on their projected emission reductions and their power capacity. The data was used to establish a relationship between the carbon emissions, power capacity in megawatts and carbon finance uptake, albeit at conservative carbon credit prices. The projects registered for CDM and the function derived for the relationship between their carbon emissions and power capacity as picked from the PDDs is presented in Table 6.13 below.

Table 6.13: Projects that have sold Carbon Credits or used other forms of Carbon Finance

	Project	**Type**	**Power MW**	**Carbon Finance generated by project**	
				Carbon credits sold	**Carbon Revenues from other sources**
1	Olkaria I Units 4&5 Geothermal Project	Geothermal	140	Registered Sold carbon credits	**None**
2	Olkaria II Geothermal Expansion Project	Geothermal	115	Registered No credits sold	**None**
3	Olkaria III Phase 2	Geothermal	100	Registered No credits sold	**None**
4	Olkaria IV Geothermal Project	Geothermal	140	Registered No credits sold	None
5	Optimisation of Kiambere Hydro Power Project	Hydro	165	Registered Sold carbon credits	None
6	Corner Baridi Wind Farm	Wind	50	Registered No credits sold	None
7	Kinangop Wind Park Project	Wind	60	Registered No credits sold	None
8	Likoni Improved Cook Stove Project.	Biomass	6.2	Registered No credits sold	None
9	“35 MW Bagasse Based Cogeneration Project	Biomass	35	Registered Carbon credits sold Kshs 22 Million	None
10	Kipeto Wind Energy Project	Wind	50	Registered No credits sold	None
11	Lake Turkana Wind Power Project	Wind	310	Registered , No credits sold	None
12	Olkaria IV Geothermal Project	Geothermal	140	Registered No credits sold	None
13	Karan Biofuel CDM project	Biomass	24	Registered No credits sold	None
14	Redevelopment of Tana Hydro Power Station Project	Hydro	20	Registered Sold carbon credits	None
15	Nairobi River Basin Biogas Project	Biomass	33	Registered No credits sold	None
16	Wind Electricity Generation at Ngong Hills, Kenya.	Wind	5.1	Registered No credits sold	None
17	KTDA Small Hydro Programme of Activities	Hydro	14 MW	Registered No credits sold	Development of project documentations

Source: CDM website (2017)

It is worth noting from the analysis that 23 projects had accessed some form of carbon finance while 39 had not. while registration for CDM or voluntary market was deemed to denote access to finance, further scrutiny reveals that only four projects had managed to sell carbon credits; 3 projects from Kenya Power Generating Company and 1 project from Mumias Sugar Company. The rest of the registered projects had received support for registration for CDM and to help them prove their additionality, which is a preliminary step towards sale of credits. The implication for these findings is that despite the many projects registered by CDM in Kenya, the actual sales of carbon credits is low. An examination of the records and information provided by Kengen and Mumias Sugar Company confirm that both companies had received Kshs 270 million and Kshs 22 million respectively for the credits sold. The amount of carbon credits sold and the projects registered with CDM but have not yet sold any credits show that overall, the uptake of carbon finance in the projects is low. In agreement with Nyambura and Nhamo (2014), the findings confirm that renewable energy developers have not sufficiently utilized the available carbon finance mechanisms to promote their investments. The following section explores the sources of project finance for renewable energy developments, as captured from the respondents.

6.4.4 Relationship between Power Capacity (MW) and Carbon Emission Reductions (tCO_2e) for Kenyan Projects registered with CDM

The amount of carbon credits that a project can generate depends on the greenhouse gas emissions it can reduce, which must be proved to be additional. As part of objective two, on the establishing the level of uptake of carbon finance in Kenya, this section uses secondary data obtained from the CDM Board, to examine how much greenhouse gas emissions Kenyan renewable energy projects are projected to reduce over their lifetime. The carbon finance uptake is based on the amount of carbon emission reductions, and the prevailing price per tonne of carbon dioxide equivalent. To explore the relationship between power capacity and carbon emissions for all the registered projects, the study develops a function to help predict the amount of carbon finance that Kenya could earn, if only at conservative carbon prices, if all the projects registered with the CDM board were to be implemented to completion.

To enhance the understanding of the relationship between the power capacity of the project (measured in megawatts) and the carbon emission reductions (in tCO_2e), a regression was run and the Pearsonian correlation computed. According to Nachmias and Nachmias (1996) the Pearson product-moment correlation is a measure of the strength and direction of association that exists between two variables measured on at least an interval scale. A Pearson's correlation attempts to draw a line of best fit through the data of two variables, in this case power capacity and emission reductions, and the Pearson correlation coefficient, r, indicates how well the data points fit this model/line of best fit (Zikmund, 2003). Table 6.14 below presents the projects registered with CDM, their power capacity and projected carbon emission reductions collated from the data in the CDM website. The pearsonian correlation is presented in table 6.15.

Table 6.14: Emission Reductions from Renewable Projects registered for CDM

	Project	Type	Power MW	Date of PDD	Crediting period	Annual Estimated GHG reduction tCO2e	Total estimated GHG reduction tCO2e
1	Olkaria I Units 4&5 Geothermal Project	Geothermal	140	7/11/2012	7	635,049	4,445,343
2	Olkaria II Geothermal Expansion Project	Geothermal	115	14/10/2014	7	140,682	984,772
3	Olkaria III Phase 2	Geothermal	100	30/09/2013	7	250,970	1,756,789
4	Olkaria IV Geothermal Project	Geothermal	140	7/11/2012	7	651,349	4,559,443
5	Optimisation of Kiambere Hydro Power Project	Hydro	165	14/9/2012	10	41,204	412,040
6	Corner Baridi Wind Farm	Wind	50	05/12/2012	7	111,224	778,567
7	Kinangop Wind Park Project	Wind	60	11/01/2012	7	121,036	847,252
8	Likoni Improved Cook Stove Project.	Biomass	6.2	23/12/2010	7	4,924	34,470
9	"35 MW Bagasse Based Cogeneration Project	Biomass	35	13/11/ 2006	10	95,521.57	955,215.68
10	Kipeto Wind Energy Project	Wind	50	12/12/2012	7	254,125	1,778,876
11	Lake Turkana Wind Power Project	Wind	310	7 /1/ 2011	7	736,615	5,156,304
12	Olkaria IV Geothermal Project	Geothermal	140	7/11/2012	7	651,349	4,559,443
13	Karan Biofuel CDM project	Biomass	24	20/09/2012	10	43,699	436,990
14	Redevelopment of Tana Hydro Power Station Project	Hydro	20	17/04/2014	10	28,505	285,050
15	Nairobi River Basin Biogas Project	Biomass	33	11/06/2012	10	35,949	359,486
16	Wind Electricity Generation at Ngong Hills, Kenya.	Wind	5.1	05/05/2014	10	9,941.11	99,411.10
	Total		1392.5				27,449,451

Source: CDM website (2017)

From the CDM website, a total of 16 Kenyan renewable energy projects have been registered with a total combined power capacity of 1392.5 MW and a total estimated GHG reduction of 27,449,451 $tCO2_e$

Table 6.15: Pearsonian Correlation and Regression for the relationship between Power Capacity (MW) and Carbon Emission Reductions (tCO_2e)

Correlations

		emissions	mw
Pearson Correlation	emissions	1.000	.772
	mw	.772	1.000
Sig. (1-tailed)	emissions	.	.000
	mw	.000	.
N	emissions	16	16
	mw	16	16

Model Summary[b]

					Change Statistics				
Model	R	R^2	Adjusted R^2	Std. Error of the Estimate	R^2 Change	F Change	df1	df2	Sig. F Change
a1	.772[a]	.596	.567	1211413.97887	.596	20.666	1	14	.000

a. Predictors: (Constant), mw
b. Dependent Variable: emissions

Coefficients[a]

	Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B		
Model	B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	
1	Constant	182229.25	453313.410		.402	.694	-790031.3	1154489.825
	Mw	17683.76	3889.99	.772	4.546	.000	9340.548	26026.9

a. Dependent Variable: emissions

Table 6.15 above shows results of the correlation and multiple regression analyses of the relationship between the power capacities of a project ant its carbon emission reduction for Kenyan projects. Correlations were computed for two variable scales for data on 16 projects. The Pearson correlation coefficient value of 0.772 confirms that there appears to be a positive correlation between the power capacity of a project and the carbon emission reductions. The p-value of 0.000 shows that the correlation is statistically significant.

The multiple regression model with two predictors produced $R^2 = .596$, $F = 20.666$, $p < .001$. The R^2 value indicates that the total variation in the dependent variable, carbon emissions reductions, can be explained significantly by 60% of the changes in the independent variable, megawatts of power produced.

The Coefficients table gives the values that are needed in order to write the regression equation. It provides the necessary information to predict carbon emission reductions from the megawatts of power capacity for the projects. At $p < 0.000$, the power capacity in megawatts contributes significantly to the model. Using the analysis on table 6.20, the relationship between the power capacity (MW) and the carbon emission reductions ($tCO2_e$) can be expressed in the form of the equation below;

Carbon Emissions Reductions ($tCO2_e$) = 182229.257 + 17683.765(MW)

According to Montgomery, Peck and Vining (2012), the expression can be used to predict the amount of carbon emissions reductions, given the power capacity of the project. Based on this prediction, against the prevailing carbon offset prices, it would be possible to project the amount of carbon finance that a project would accrue, if only at conservative figures.

6.5 Determinants of Carbon Finance Uptake in Renewable Projects in Kenya

This section focused on examining the key determinants of carbon finance uptake in renewable energy development in Kenya. The scrutiny of determinants formed objective three, which was analyzed in two parts. First, responses from the developers on characteristics of the aspects of each identified determinant were captured in a likert scale. The rating of each characteristic relating to a given determinant were captured according to the assigned code. Because the outcome of the uptake was determined to be a binary variable, which is projects that had used carbon finance and those that had not used, a binomial logistic regression model was used to model the determinants. The aim of binomial logistic regression was to identify the best fitting, yet biologically reasonable relationship between the independent variables of project size, project sector, carbon offset prices, low carbon technologies and market affiliation with the uptake of carbon finance, the dependent variable. Second, results of the hypotheses tested on the identified determinants are presented in chapter seven of the study. The results for the regression are provided in section 6.5.1 below.

6.5.1 Regression Analysis for the Determinants of Carbon Finance Uptake

Logistic regression was performed to ascertain the effects of project size, project sector, prevailing carbon offset prices, low carbon technology and carbon market affiliation on the uptake of carbon finance. The log odds of the use of carbon finance were expressed in the model below;

$$\textbf{Log (P/1-P)} = \boldsymbol{\beta_0 + \beta X_1 + \beta X_2 + \beta X_3 + \beta X_4 + \beta X_5 + a}$$

Where P – probability of using carbon finance

X_1 - Project size

X_2 - Project sector

X_3 - Carbon offset prices

X_4 - Technology

X_5 - Market affiliation

a - Random variable

The logit transformation is defined as the logged odds:

$$odds = \frac{p}{1-p} = \frac{probability\ of\ presence\ of\ characteristic}{probability\ of\ absence\ of\ characteristic}$$

And

$$\boldsymbol{logit(p) = \ln\left(\frac{p}{1-p}\right)}$$

The output of the binomial logistic regression; tests of the model coefficients, the model summary, the classification table and the variables in the equation tables are presented and explained as below;

6.5.2.1 Omnibus test of Model Coefficients

The Omnibus Tests of Model Coefficients was used to test the explanatory power of the independent variables on the dependent variable in the model. The test was used to examine whether inclusion of explanatory variables improved the ability of the model to predict the ability of the variables to explain the uptake of carbon finance. It used chi-square tests to find if there is a significant difference between the Log-likelihoods (specifically the -2LLs) of the model with the variables included. The test results are presented in the table 6.16 below.

Table 6.16: Omnibus tests of Model Coefficients and Model Summary

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	45.947	5	.000
	Block	45.947	5	.000
	Model	45.947	5	.000

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	35.827[a]	.523	.714

a. Estimation terminated at iteration number 7 because parameter estimates changed by less than .001.

The Omnibus test of the coefficients is consists of three different versions; Step, Block and Model (Mernard, 2002). The Model row always compares the new model to the baseline, while the Step and Block rows are only important if you are adding the explanatory variables to the model in a stepwise or hierarchical manner. All the three explanatory variables in this data were added in one block and as such, there is only one step, giving same chi-square values for step, block and model. The chi-square is highly significant (chi-square=45.947, df = 5, p<.000) showing that the model is significantly better in predicting the uptake of carbon finance than the baseline.

The model summary table shows the **Cox & Snell R Square** and **Nagelkerke R Square** values, which are both methods of calculating the explained variation. The R^2 values tell us approximately how much variation in the outcome is explained by the model (Cox & Snell, 1989). The values, sometimes referred to as *pseudo* R^2 values, have lower values than in multiple regression but the interpretation does not change. However, caution must be exercised in the interpretation of these values. With reference to Cox & Snell R^2, the explained variation in the dependent variable based on the model is 52.3 per cent while with Nagelkerke R^2 it is 71.4 per cent. The Nagelkerke R^2 is a more preferable value to report because it is modification of Cox & Snell R^2, which usually cannot achieve a value of 1. According to Field (2005), a Nagelkerke R^2 of over 70 per cent shows a strong explanatory power of the independent variables over the dependent variable. Thus, in this data, over 71.4 per cent variation in the uptake of carbon finance is explained by variation in the independent variables of size, sector, offset prices, technology and market affiliation.

6.5.2.2 Binomial Logistic Regression Equation

The dependent variable, uptake of carbon finance was regressed against the independent variables of the size of the projects; the project sector; the prevailing carbon offset prices; the use of low carbon technology and the market affiliation. the classification table was used to gauge the predictive ability of the model while the log-odds, for the logistic regression equation for predicting the dependent variable from the independent variable is presented in the variables in the equation below;

Table 6.17: Classification Table and Variables in the Equation.

Classification Table[a]

	Observed		Predicted		
			Use of Carbon Finance (Projects)		Percentage Correct
			Non User	User	
Step 1	Use of Carbon Finance (Projects)	Non User	34	5	87.2
		User	4	19	82.6
	Overall Percentage				85.5

a. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	X1_1	2.407	1.005	5.739	1	.017	11.105	1.549	79.602
	X2_1	2.065	2.804	.543	1	.461	7.887	.032	1920.36
	X3_1	.624	1.072	.339	1	.561	1.866	.228	15.257
	X4_1	5.339	1.627	10.772	1	.001	208.295	8.591	5050.50
	X5_1	-4.284	3.191	1.802	1	.179	.014	.000	7.175
	Constant	-22.687	7.654	8.785	1	.003	.000		

a. Variable(s) entered on step 1: X_1_1, X_2_1, X_3_1, X_4_1, X_5_1.

The classification table shows that the percentage accuracy in classification (PAC) is 85.5 per cent, which is above the cut value of 0.50, showing the strong predictive power of the model in predicting the adoption of carbon finance, from a combination of the five variables. The sensitivity of the model, its ability to predict the uptake of carbon finance is calculated to be 82.6 per cent (True Positive/ (True Positive + false Negatives). The specificity measures the ability of a test to correctly predict the non-use of carbon finance among non-users is 87.2 per cent (true negatives/ (true negative + false positive). These values, together with the overall percentage accuracy in classification show that the model is strong enough to predict the use of carbon finance.

The variables in the equation is used to predict the probability of becoming a user of carbon finance, based on a unit change in any one of the five independent variables when all other independent variables are kept constant. From these results, it can be seen that the project size ($p= 0.017$) and the use of low carbon technologies ($p= 0.001$) added significantly to the model/prediction but project sector ($p= 0.461$), prevailing carbon offset prices ($p=0.561$) and the market affiliation ($p= 0.179$) did not. The Odd Ratio for project size indicate that for each one-point increase in the scale for project size, the odds of up taking carbon finance increase by a factor of 11.05.

For every one unit change in the project sector, we expect a 7.887 increase in the log-odds of using carbon finance, holding all other independent variables constant. A one-unit increase in the prevailing carbon offset prices increases the log odds for the uptake of carbon finance increase by 1.866 times. Use of low carbon technologies has the highest increase in log odds at 208.295 times for every unit increase while carbon market affiliations is the smallest with log odds increase of only 0.14 times.

The variables in the equation for the model reveal the following information for each variable;

i) Project size

The model reveals that the size of a renewable energy project is a significant determinant of the uptake of carbon finance (X_1, $p= 0.017$). Because of the capital costs required and the need to enjoy economies of scale, many renewable energy developers tend to invest in large projects, especially in cases where the renewable energy resource is adequate (Abbasi & Abbasi, 2011). However, with many small scale projects entering the CDM pipeline, the prominence of size as a determinant of carbon finance has been put to question (Hultman et al., 2012).

The project size as a determinant was construed from the differing positions taken by various authors on its ability to determine the uptake of carbon finance. Luxmore et al., (2013) observe that the size of the project can be important when considering the cost of the credit issued and how much return a project could earn, while the current CDM programme of activities pursues the benefits of aggregating small scale projects, to achieve emission reductions. The dependence of a project's scale on the targeted methodology has also enhanced debate on the importance of size in emissions reduction (Michaelowa, 2014). The spurring between large-scale and small-scale projects is complicated by the fact that small scale projects are more expensive to implement and produce fewer carbon credits. Even if the credits were to be sold for higher prices, the total amount garnered makes it harder to reimburse the implementation costs of the projects.

Many of the projects that have been included in the Feed-in-Tariff are projects that are targeted to produce more than 1 MW of power. The analysis in this study show that majority of Kenyan projects have not used or accessed carbon finance. The findings on size could possibly resonate with the finding that only large renewable energy projects, such as those developed by the Kenya Power Generating Company and Mummies Sugar Company's bagasse project have tangibly sold carbon credits. The results from this model are do attest to the commonly held mantra in carbon projects that the bigger the project, the better.

ii) Low-Carbon Technology

The results of the analysis also reveal that the use of low-carbon technology is also significant in determining the uptake of carbon finance (X_4, $p= 0.001$). For a developing country like Kenya, the finding on technology is important because technology transfer is one of the ancillary benefits under CDM (Conick et al., 2007). Schneider et al. (2010) also that the potential to mitigate climate change is improved as technology on emission reductions advances. Moreover, offsets prices may vary within the same project type and this can often be related to the methodology used for the project (Yang et al., 2016). While Kenya has a relatively low carbon economy, indicated by per-capita emissions of less than 1.26 $MtCO_2eq$ compared to the global average of 7.58 $MtCO_2eq$, the country's carbon emissions have been increasing (SNC, 2015). Adopting low carbon technology will transition the country to develop without hurting the environment, and earn more revenues in terms of carbon revenues.

iii) Project Sector

The outcome for the analysis on the project sector show that the sectoral scope of a renewable energy project does not significantly influence the use of carbon finance in a project (X_2, $p= 0.461$). While renewable energy based projects have been the most successful in achieving CDM approval, some types of renewable have been shown to reduce more carbon emissions than others (Dechezlepretre, 2008). It primarily centres on the per capita costs of installing, for instance wind and solar power, as compared to hydro. The finding on the project sector are perhaps because all the projects that were subject of the research were in one sector. However, the aim was to explore between the types of renewable energy, which was much better in influencing carbon finance than the other. The sectoral scope is also important for project accreditation under CDM.

Because the key factor influencing the price of the carbon offset was the quality of the project, the sectoral scope of a project is necessary in the achievement of carbon finance. Moreover, the project's quality is assessed through the carbon standard by which it is certified. While, in turn, the project's quality is also determined by the sector of the project.

iv) Carbon Offset Prices

The results reveal that the prevailing carbon offset prices are not significant in determining the carbon finance use in a project (X_3, p=0.561). The results could be explained by the fact that despite the fluctuations in offsets prices since 2010, the trading of offsets in both the voluntary and carbon markets have been going on. However, it is important to note that not many of the developers in the Kenyan market have sold carbon credits, the more reason as to why prices could not have been important to them. While carbon offset prices determine how much a project can generate in terms of carbon revenues, there are many factors that determine the prices at which they can be sold. Factors that drive carbon prices are much more complicated than traditional commodity markets, which are typically governed by supply and demand (Carraro & Favero, 2009). While these market forces certainly play an important role in carbon pricing, the regulatory regimes also seem to play a role. Sometimes, prices can vary within the same project type, depending on the technology used (Sjardin, 2010). The uncertainty about future policy developments is also indeed a major determinant of carbon prices and so is the age of the carbon offsets. These multiplicity of competing factors in offset price determination brings some level of uncertainty as to the role of carbon prices in the carbon finance uptake.

v) Carbon Market Affiliation

The results from the analysis reveal that the carbon market in which the offsets are sold, either the compliance or the voluntary market does not influence the carbon finance uptake in a project (X_5, p= 0.179). These findings could also point to the fact that many project developers are not inclined to any of these markets in Kenya, with some being registered in both markets, such as the35MW Bagasse Cogeneration project owned by Mumias Sugar Company. Hamilton et al. (2010b) report that the rigorous requirements of the CDM markets has driven many carbon developers into the voluntary market. However, Kenya, a developing country is eligible to participate in the CDM markets, with evidence showing that credits form this market are more preferred by buyers, because of their rigorous validation and verification process. These findings could not be surprising since the more popular CDM Gold Standard is also applicable to the voluntary carbon market (Bayon et al., 2012).

The Model:

From the variables in the equation table, the column B, which is the value of the coefficients, helps to translate the binomial logistic regression expression;

$$\text{Log (P/1-P)} = \beta_0 + \beta X_1 + \beta X_2 + \beta X_3 + \beta X_4 + \beta X_5 + a$$

Into the equation;

$$\text{Log (P/1-P)} = -22.687 + 2.407X_1 + 2.065X_2 + .624X_3 + 5.339X_4 + 4.284X_5$$

The estimates of the relationship between the five independent variables and the dependent variable, uptake of carbon finance, with the dependent variable being on the logit scale show that only two independent variables are significant in predicting the odds of up taking carbon finance; the project size (2.407) and use of low carbon technology (5.339). The coefficients show the amount of increase (or decrease, if the sign of the coefficient is negative) in the predicted log odds of up taking carbon finance = 1 that would be predicted by a 1-unit increase (or decrease) in the predictor, holding all other predictors constant. This, according to the significant level of the Wald values, shows that the project sector, prevailing carbon offset prices and the market affiliation are not able to determine the adoption of climate finance.

6.6 Constraints of Accessing Carbon Finance

Recent research has enumerated certain constraints or limitations that many developing countries face, in their quest to accrue carbon finance (Halimanjaya, 2015; Whitley et al., 2014). However, the identified research gaps show that these constraints haven’t been scrutinized for Kenya

(Nyambura & Nhamo, 2014). Research objective three also required an identification of these constraints. To establish the constraints, questions derived from literature review on the constraints of accessing carbon finance were put forth to both the renewable energy developers and carbon business stakeholders. Carbon business stakeholders were deemed to be more knowledgeable on the issue of accessing carbon finance, the reason for their involvement in this question. Factor analysis was used to reduce the factors into the most pertinent in the access and the results are presented below;

6.6.1 Factor Analysis for the Constraints of Accessing Carbon Finance

Questions relating to constraints of accessing carbon finance among renewable energy developers in Kenya were factor analyzed using principal component analysis with Varimax (orthogonal) rotation. The adequacy of the sample was tested using Kaiser-Meyer-Olkin Measure of Sampling Adequacy while Bartlett's test was used to test of sphericity, testing the null hypothesis that the correlation matrix is an identity matrix. The tests are presented in tables 6.18 and 6.19 below;

Table 6.18: KMO and Bartlett's Test for Constraints of Accessing Carbon Finance

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.611
Bartlett's Test of Sphericity	Approx. Chi-Square	313.770
	df	78
	Sig.	.000

The Kaiser Meyer Olkin (KMO) measure of sampling adequacy test statistic of 0.611 was observed when the data was subjected to two pretest requirements using factor analysis as in table 6.23, which was above the commonly recommended value of 0.6, according to Cerny and Kaiser (1977) and Lee and Greene (2007).

Barlett's test of sphericity, which tests whether the correlation matrix is an identity matrix, was also significant ($\chi2$ (78) = 313.77, $p < .05$), indicating that the factor model was appropriate.

Table 6.19: Factor Variation among on Constraints of Accessing Carbon Finance

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.017	23.209	23.209	3.017	23.209	23.209
2	2.544	19.566	42.775	2.544	19.566	42.775
3	1.332	10.246	53.021	1.332	10.246	53.021
4	1.230	9.460	62.481	1.230	9.460	62.481
5	.985	7.574	70.055			
6	.893	6.866	76.921			
7	.715	5.499	82.419			
8	.522	4.013	86.432			
9	.509	3.914	90.346			
10	.408	3.139	93.486			
11	.372	2.860	96.346			
12	.262	2.016	98.362			
13	.213	1.638	100.000			

Extraction Method: Principal Component Analysis.

Principal components analysis was used because the primary purpose was to identify and compute composite scores for the factors that constrain the access to carbon finance among renewable energy developers in Kenya. Initial Eigen values indicated that the first four factors explained 23%, 19.6%, 10.2 % and 9.5 % of the variance respectively. Only factors with an eigenvalue of 1.0 and above were retained. In total, four factors contribute 62.481% of the total variance while the rest of nine factors contribute 37.519% of the variance in the data.

Table 6.20: Component Matrix for Constraints of Accessing Carbon Finance

	Component			
	Information	Financing	Costs	Knowledge
Lack of awareness on carbon finance availability	.682	-.337	.250	.373
Lack of information on climate finance acquiring procedures from government	.580	-.202	.081	.092
Higher project development costs	.021	.407	.764	.162
High transaction costs to meet carbon credits generation	.105	.658	.579	-.044
Size of project not attractive to carbon credits buyers	.537	.203	.031	-.502
Lack of sufficient finance to develop the project to required size	.216	.693	-.208	-.431
Lack of financial instruments in local financial institutions to stimulate renewable energy projects	.155	.752	-.180	.150
Lack of knowledge on climate finance products from local banks	.019	.669	-.236	.525
Insufficient knowledge on project proposal development	.549	-.233	.037	.548
Private investors consider the risk for investments in renewable energies still high compared to alternative investments	.563	.388	-.317	.089
Unpredictable policies and regulatory uncertainty on renewable energy production	.600	-.189	.202	-.468
Lack of consultants to help in meeting the CDM requirements	.564	-.124	-.004	.467
Lack of technology to develop renewable energy projects to standard required by investors	.740	-.035	-.263	.032

The factorability of the 13 constraints was examined. Several well-recognized criteria for the factorability of a correlation (Beavers et al., 2013; Williams et al., 2010) were used. Firstly, it was observed that all the items correlated at least 0.3 with at least one other item, suggesting reasonable factorability. Secondly, the Kaiser-Meyer-Olkin measure of sampling adequacy was .611, above the commonly recommended value of 0.6, and Bartlett's test of sphericity was significant (chi-square = 313.77, $p < .05$). Given these overall indicators, factor analysis was deemed to be suitable with all the items.

Information

Eight items loaded onto factor 1. All the eight items as highlighted in table 8.25 relate to the availability of information on the access to carbon finance to the renewable energy developers. These items include lack of awareness on carbon finance availability, lack of information on climate finance acquiring procedures from government, insufficient knowledge on project proposal development and information on the risks of renewable energy investing.

Because information is important for decision making, the implication is that lack of information on carbon finance processes and procedures contribute to low levels of uptake among the developers of renewables. Although this lack of awareness compounds the problem of access, project developers who are still aware of the existence of carbon finance are unable to access because of other factors. The problem of information is also compounded by the institutional constraints, including DNA underperformance, which also restrict project development.

Financial Constraints

Five items relating to financial constraints loaded into the second factor. The items revolved around high project development costs and transaction costs relating to carbon credits generation. Items that had higher factor loadings of 0.6 and above related to lack of sufficient finance to develop the project to required size, non-availability of financial instruments in local financial institutions to stimulate renewable energy projects and lack of knowledge on climate finance products from local banks.

Due to the risks involved, financial institutions set up restrictions for loans in projects in which those risks are more likely to happen. Renewable energy investments are perceived by investors to be high risk (Porras et al., 2015). Financiers are not sure of the viability and sustainability of the project, hence the indifference in availing capital to the project. Although renewable energy projects are eligible under CDM and voluntary carbon market for additional revenues to those from power sales, the major constraints for the CDM to effectively reach its objectives to promote projects which would not otherwise occur without the carbon credits, is exactly the timing of the payment for the emission reductions (UNEP, 2015). Without commercial bank lending on the renewables, it will be a difficult task to achieve financial closure on many of these projects, and hence access carbon revenues.

Cost Constraints

Only two items loaded onto the third factor on costs constraints to carbon finance access. Both of these, higher project development costs and high transaction costs to meet carbon credits generation related to costs of developing the project to the point of accessing carbon finance. The development costs include both the capital costs and the operational. The capital costs include cost of technology used in the project, equipment, machinery, land and buildings and depreciation. The project operational costs include cost of labour, raw materials, intermediary input, and other inputs to production. High CDM transaction costs also contribute significantly to the problem of access. These costs include cost for project document preparation, feasibility studies and other levies imposed by the DNA such as validation, verification and certification costs (Bode, 2013). Capital outlays, project operational costs and transaction costs required to meet CDM and voluntary market standards evidently form a significant barrier to carbon finance access among the developers.

Besides these costs, the transaction costs of meeting the requirements also increase the costs of accessing carbon finance. For this reason, some developers who have the necessary capital have chosen one reason or another (such as lack of risk appetite, other investment priorities) not to undertake CDM development.

Knowledge constraints

Three items load onto the knowledge, as a constraint of accessing carbon finance. This constraint, though similar to information factor, specifies the indigenous skills shortages on how to develop the projects and also access carbon finance. The items that load onto this factor are the lack of consultants to help developers meet CDM and voluntary carbon market’s requirements, lack of knowledge on the size of the projects that are attractive to carbon credit buyers, especially those wishing to fulfill their cap requirements and the lack of skills that are required to develop proposals that are needed to access carbon finance.

The shortage of consultants to help meet requirements have often led to mistakes in carbon development. For example, three potential CDM projects have failed in Kenya, before achieving registration, even after passing the validation stage. Because of the stringent requirements, projects have often faced delays and rejection for their inability to meet the requirements. As a major drawback to the achievement of carbon revenues, the absence of technocrats must be addressed, if more projects are to eventually get to financial closure. The UN-led CDM support programme in Kenya, and the Ci-Dev from the World Bank are poised to play a significant role in DNA capacity-building, awareness-raising among financial institutions, and enhancing selected potential project developers' technical expertise on CDM (Wood et al., 2015).

6.6.2 Descriptive Statistics for the Constraints of Accessing Carbon Finance

Descriptive statistics were used to summarize the relative strengths of the constraints as captured from the respondents and the Cronbach's alpha was used to measure of internal consistency between the likert questions. The aim of this section is to identify which constraints are more subtle in the accrual of carbon finance. The reliability, means and standard deviations for the responses are presented in tables 6.21 and 6.22 below.

Table 6.21: Reliability Statistics of the Constraints of Accessing Carbon Finance

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.702	.695	13

The reliability coefficients for all the study variables were above 0.7, which is acceptable according to George and Mallery's criteria (2003). The range of the responses was between very low and very high extent, which signifies a high level of internal consistency of the data collection instrument.

Table 6.22: Mean and Standard Deviation of the Constraints.

	Mean	Std. Deviation	N
Lack of awareness on carbon finance availability	3.3095	1.16139	84
Lack of information on climate finance acquiring procedures from government	3.4405	.97377	84
Higher project development costs	3.9762	.77578	84
High transaction costs to meet carbon credits generation	4.1429	.83800	84
Size of project not attractive to carbon credits buyers	3.2738	1.24524	84
Lack of sufficient finance to develop the project to required size	4.0476	1.00486	84
Lack of financial instruments in local financial institutions to stimulate renewable energy projects	4.3452	.79901	84
Lack of knowledge on climate finance products from local banks	4.3571	.88689	84
Insufficient knowledge on project proposal development	2.9762	.99367	84
Private investors consider the risk for investments in renewable energies still high compared to alternative investments	3.8690	.97905	84
Unpredictable policies and regulatory uncertainty on renewable energy production	2.5714	.94787	84
Lack of consultants to help in meeting the CDM requirements	2.7143	1.03634	84
Lack of technology to develop renewable energy projects to standard required by investors	2.7381	1.01932	84

From the descriptive statistics, factors relating to access to finance had the highest mean, signifying the problem of access to finance for most renewable energy developers in Kenya. For example, lack of knowledge on climate finance, such as green bonds by banks in Kenya had the highest mean of 4.35714, followed by lack of specific financial instruments to stimulate renewable energy investments form local banks at 4.3452. Lack of sufficient finance to develop the project to required size was also rated high with a mean of 4.0476, while high transaction costs to meet carbon credits generation was also a problem for developers at a mean of 4.1429.

The statistics show that constraints relating to costs of renewable energy investments were ranked high, signifying that high initial costs of renewable energy projects were an impediment for investors. High project development costs as a constraint was rated high with a mean of 3.9762 while risks of losing the investments should the project not get completed was also a factor hindering access with a high mean of 3.8690. In relation to awareness or information on climate finance availability, respondents were moderate, showing that awareness may not be the main problem that the uptake of carbon finance is low among renewable energy developers. For example, lack of awareness on carbon finance availability had a mean of 3.3095 while lack of information on climate finance acquiring procedures from government was also moderate at 3.4405. Factors relating to regulatory environment and meeting requirements for accessing carbon finance had low ratings by the respondents signifying that the regulations on renewable energy development were not a hindrance for developers. For instance, unpredictable policies and regulatory uncertainty on renewable energy production had a mean of 2.5714. It is also worth noting that though CDM requirements are strenuous, lack of consultants to help developers meet these requirements is not rated as a big problem at a mean of 2.7143. It imperative that lack of technology to develop renewable energy projects to the required size had a mean of 2.7381, showing technological issues cannot be totally dismissed as a constraint.

6.7 Challenges faced by Renewable Energy Developers in Kenya

Objective four of the study sought to establish the challenges that renewable energy developer's face in Kenya, in an effort to implement their projects. The aim was to determine what specific challenges hinder the completion of renewable energy projects, because incomplete projects cannot sell carbon credits. Renewable energy is integral in ensuring that adequate, quality, cost effective and affordable supply of energy through use of indigenous energy resources in order to meet development needs, while protecting and conserving the environment. The descriptive statistics and the factor analysis for these challenges are presented below.

6.7.1 Factor Analysis of the Challenges faced by Renewable Energy Developers in Kenya.

Challenges faced by developers in Kenya were measured using sixteen items, which were factor analyzed using principal component analysis with Varimax (orthogonal) rotation. The adequacy of the sample was tested using Kaiser-Meyer-Olkin Measure of Sampling Adequacy while Bartlett's test was used to test of sphericity. The tests, together with the descriptive statistics are presented in tables 6.23 and 6.24 below;

Table 6.23: KMO and Bartlett’s Test on Challenges of Renewable Energy Deployment

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.653
Bartlett's Test of Sphericity	Approx. Chi-Square	733.671
	df	84
	Sig.	.000

The Kaiser Meyer Olkin (KMO) measure of sampling adequacy was observed as 0.653, well above the recommended value of 0.6, while Barlett’s test of sphericity, which tests whether the correlation matrix is an identity matrix, was also significant (chi-square = 733.67, $p < .05$), indicating that the factor model was appropriate.

Table 6.24: Eigen Values on Challenges of Investing in Renewable Energy

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.297	26.854	26.854	4.297	26.854	26.854
2	3.373	21.078	47.932	3.373	21.078	47.932
3	1.908	11.925	59.857	1.908	11.925	59.857
4	1.415	8.846	68.703	1.415	8.846	68.703
5	1.031	6.442	75.145	1.031	6.442	75.145
6	.945	5.908	81.053			
7	.735	4.596	85.649			
8	.527	3.295	88.945			
9	.444	2.772	91.717			
10	.369	2.309	94.026			
11	.258	1.613	95.639			
12	.208	1.303	96.941			
13	.187	1.167	98.108			
14	.158	.989	99.097			
15	.074	.460	99.557			
16	.071	.443	100.000			

Extraction Method: Principal Component Analysis.

Principal components analysis was used to identify and compute composite scores for the challenges that hinder or affect renewable energy projects development in the country. Initial Eigen values indicated that the first five factors explained 26.85 %, 21.08 %, 11.93 %, 8.85 % and 6.44 % of the variance respectively. Only factors with an eigenvalue of 1.0 and above were retained. In total, four factors contribute 75.15 % of the total variance while the rest of eleven factors explain the remaining 24.85 % of the variance in the data.

Table 6.25: Component Matrix on Challenges of Investing in Renewable Energy

	Component			
	Regulatory	Technical	Financial	Political
Regulations surrounding independent power producers hinder RE project development	.838	.134	-.042	.147
Implementation of energy efficiency regulations affect project development and revenues	.854	.267	-.069	.122
Regulations of renewable energy not well developed	.851	.238	-.143	.182
Insecure legislation in the renewable energy sector	.800	.349	-.074	.099
Renewable energy technologies not developed in the project location	-.105	-.577	-.122	.726
Renewable energy technologies not mature for the location	-.148	-.662	-.007	.616
RET so much dependent on weather	-.123	.445	-.537	.310
RET not reliable for integration in the national grid	-.577	-.325	-.433	-.186
Lack of financial instruments in local financial institutions to stimulate RE projects	-.308	.726	.154	.283
Lack of sector know how and unwillingness to invest in renewable energy	-.441	.573	.505	.196
Fear of the financier getting their investment back should be an aspect of the project failure or underperform	-.269	.615	-.122	-.033
Lack of collateral to support startups in renewable energy	-.432	.223	.677	.154
Difficulties in guaranteeing sufficient cash flows from the project	-.527	.371	-.131	.164
Undefined government role in the process	.454	-.169	.723	.121
Public acceptance issues against the project	.053	.606	-.108	-.047
Political instability and long term restrictions	.291	-.462	.286	-.335

Extraction Method: Principal Component Analysis.

The items from the questionnaire loaded into four factors; regulatory risks, technical risks, financial risks and political risks. Only loadings with more than 0.4, signifying the significance of the item in the factor were used.

Regulatory Challenges

Nine items loaded onto Factor 1, labeled as regulatory risk. The items that load into this factor include; the role played by the government in the renewable investment process, the legislative framework and its effects on renewable energy, the implementation of energy efficiency regulations and how they affect project development and revenues and how regulations surrounding independent power producers hinder renewable project development. Other items that load onto this factor are related to the regulatory framework, and how it's likely to affect the project implementation and completion. These items include the ability of the project to guarantee sufficient cash flows, the lack of collateral to support startups in renewable energy, lack of sector know how by the investors because sufficient awareness has not been created and unwillingness to invest in renewable energy because of its unreliability to be integrated in the national grid. The development of renewable energy regulations and security of the existing legislation are also items that increase the risks of investing in renewable energy.

The analysis shows that the creation of a conducive regulatory environment is key to the continued growth of the renewable energy sector. That Kenya has made some progress in creating an enabling environment for renewables development, such as the implementation of a Feed-in-Tariff, is an issue that was not revealed by the respondents. However, licensing of developments in renewables are still restricted for projects above 3MW and the number of licenses required are too many at 22 (MoEP, 2016).

Technical Challenges

Eight items loaded onto the second factor on technical risk including poorly developed renewable energy technologies in the project location, renewable energy technologies not mature for the location and dependence of technologies on weather, making them unviable throughout the seasons. Lack of financial instruments in local financial institutions to stimulate renewable projects and fear of the financiers getting their investment back, an aspect likely to lead to the project's failure or underperformance, also load into this factor, stressing the risks of technological failures affecting project funding. Lack of sector know how and unwillingness to invest in renewable energy and political instability and long term restrictions are the other items that loaded into this factor.

From the analysis, it shows that the technical capacity for implementing renewable energy projects is low or lacking in Kenya. Whereas the potential for renewable energy development is high, the technological and technical capacity affects its exploitation. For instance, the World Bank (2015) reports that Kenya's reliance on its renewables to increase its innovation, eco-tourism and supply energy to its people both on-and off-grid to stimulate economic development has been severely hampered by lack of technical capacity. However, there are efforts to build local expertise on renewable sector, such as the Energy Research Centre at Strathmore University, which is providing valuable technical training (SERC, 2016). Moreover, understanding the benefits of renewable, Kenya has integrated pro-renewable energy tools into its National Policy Documents and its long-term strategic plan for development Kenya Vision 2030 (MoEP, 2015). For the country to achieve a reasonable level of expertise on the renewables installation and generation, a multi-stakeholder effort is needed, combining the private and public sector working together to share and build expertise.

Financial Challenges

Five items load onto factor four on financial risks facing renewables deployment. The dependence of the renewable energy technology on the cyclical weather movements, which may lead to the financial unsustainability of the project and hence its reliability in the national grid are items that load onto this factor. The presence of these two items in a project will lead to fluctuations in the electricity generated, with obvious implications for the cash flows from the project. Moreover, the dependence on weather is likely to make investors shun the project, as the generation of cash flows is not guaranteed, hence the negative loadings. Lack of collateral to support startups in renewable energy, undefined government role in the process and lack of sector know how and unwillingness to invest in renewable energy also load onto this factor, showing their impact on the project financing.

The low completion rate of renewable energy projects in Kenya can be attributed to these negative loadings. For small scale projects, most of them armed with only viable feasibility studies, finding the funding for their projects is an uphill task. Moreover, there are no commercial banks in Kenya that are willing to lend to these start-ups, for fear that the projects many eventually not be completed, a fact confirmed by Rambo (2013) and UNEP (2012). Carbon finance can be a good alternative for financing these projects, if only the renewable energy schemes can be designed with the concept of carbon trading as their background, in order to maximize the reduction of carbon emissions.

Political Risks

Only two items, renewable energy technologies not developed in the project location and renewable energy technologies not mature for the location load onto the fourth factor on political risk, showing projects not mature could be started on some areas because of political reasons. Local stakeholder relations and land issues also pose political risks for many projects. The problems of acceptance by the local communities, and especially because renewable energy projects are likely to displace large populations, may lead to resistance to the project implementation. For instance, the Kinangop Wind Farm ran into serious opposition by the local community in the Kinangop area of Nyandarua County, leading to eventual abandonment of the project. Ensuring a project has local buy-in and the correct land access rights is critical, as hostility to the project from local communities can have grave consequences for the project.

6.7.2 Descriptive Statistics for Challenges faced by Renewable Energy Developers in Kenya.

The mean and standard deviation for the challenges were computed and the Friedman test was used to find the statistical significance of the ratings on the various attributes of risks facing renewable energy investors. The results are as presented below;

Table 6.26: Descriptive Statistics on Challenges of Investing in Renewable Energy

Challenges	Mean	Std. Deviation	Analysis N
Regulations surrounding independent power producers hinder RE project development	2.7867	1.22246	85
Implementation of energy efficiency regulations affect project development and revenues	2.6533	1.14483	85
Regulations of renewable energy not well developed	2.5467	1.49136	85
Insecure legislation in the renewable energy sector	2.5467	1.34861	85
Renewable energy technologies not developed in the project location	2.6133	1.11371	85
Renewable energy technologies not mature for the location	2.1467	1.08669	85
RET so much dependent on weather	4.0933	1.21002	85
RET not reliable for integration in the national grid	2.9600	1.08354	85
Lack of financial instruments in local financial institutions to stimulate RE projects	4.4267	.87261	85
Lack of sector know how and unwillingness to invest in renewable energy	4.3067	.86950	85
Fear of the financier getting their investment back should be an aspect of the project failure or underperform	4.5733	.66115	85
Lack of collateral to support startups in renewable energy	4.2000	.86992	85
Difficulties in guaranteeing sufficient cash flows from the project	3.9467	.83655	85
Undefined government role in the process	2.3067	.99964	85
Public acceptance issues against the project	4.2933	.76712	85
Political instability and long term restrictions	1.7067	.94115	85

The results indicate that financial risks were the main risk facing renewable energy developers at a total mean of 4.254. Among the attributes of financial risks, the fear of financiers recouping their investments in the event of failure in an aspect of the project was rated highly, showing the payback period of the projects was a major concern for investors. Investors also faced the risks of not getting financial support from local financial institutions as shown by the high rating of the factor at 4.4267, possibly due to lack of collateral for startups in renewable energy projects, which was also rated high with a mean of 4.2000. This is similar to Fortune and Collins (2014), who find access to finance as the main obstacle to harnessing the enormous renewable energy potential in many African countries. The investors were also worried that projects would fail to guarantee sufficient cash flows as show by its ranking and a mean of 3.947.

Technical Risks of implementing renewable energy projects were rated moderately by investors at total mean of 2.901. However, among the attributes of technical risk, the high dependence of most renewable energy projects on weather was highly rated, at a mean of 4.0933, showing the risk that investors fear to contend with of changes in climate patterns. Since most RE projects are implemented in locations where there is abundance of the renewable energy resource, the risk of RET being not mature for the location was low, at a mean of 2.147, which is similar to the findings by Kiplagat (2011).

Similar to studies by Mugo and Gathui (2010), the regulatory framework for renewable energy developers is enabling for project developers in Kenya, as shown by the low rating of regulatory risks, at an overall mean of 2.677. The main regulatory constraint for RE developers were regulations surrounding independent power producers at a mean of 2.787 while implementation of energy efficiency regulations after project development had a mean of 2.653. Regulations of renewable energy not well developed had a mean of 2.547, signifying that most developers and stakeholders were overall satisfied with the prevailing regulatory regime. The statistics are also calculated for the political risks that project developers in Kenya face. Though the overall mean for political risk is low at 2.719, the mean for public acceptance issues against the project, an attribute of the overall political risk, is high at 4.293. This is significant to Kenya because many huge renewable energy projects displace populations, leading to long term compensation problems and law suits. Yuko (2009) and Rambo (2013) also report that many RE projects run into public approval problems because of the nature of land ownership and compensation complexities. To show that the government does not impede the implementation of RE projects, the mean for political stability and long term restrictions on cash flows is low at 1.707.

Table 6.27: Friedman Test for Challenges of Investing in Renewable Energy

Test Statistics[a]

N	75
Chi-Square	510.130
df	15
Asymp. Sig.	.000

a. Friedman Test

Application of Friedman's test shows that there are some statistically significant changes in the rating of risks that affect renewable energy development in the country (X^2 = 510.13, df = 75, p = 0.004).

Table 6.28: Mean ranks for the Friedman Test on Challenges faced by Developers

Challenge	Mean Rank
Fear of the financier getting their investment back should be an aspect of the project failure or underperform	12.87
Lack of financial instruments in local financial institutions to stimulate RE projects	12.31
Public acceptance issues against the project	11.87
Lack of sector know how and unwillingness to invest in renewable energy	11.71
Lack of collateral to support startups in renewable energy	11.42
RET so much dependent on weather	11.33
Difficulties in guaranteeing sufficient cash flows from the project	10.37
RET not reliable for integration in the national grid	7.55
Renewable energy technologies not developed in the project location	6.81
Regulations surrounding independent power producers hinder RE project development	6.75
Regulations of renewable energy not well developed	6.22
Implementation of energy efficiency regulations affect project development and revenues	6.19
Insecure legislation in the renewable energy sector	6.13
Undefined government role in the process	5.56
Renewable energy technologies not mature for the location	5.19
Political instability and long term restrictions	3.71

From the table of mean ranks, it is observed that the fear of financiers recouping their investments capital was the highest ranked risk while political instability and long term restrictions was the lowest ranked risk. It is also observed that risks relating to access to fiancé and viability of the investments because of resource adequacy were rated above a mean of 10, signifying the importance of this risks to renewable energy investing.

6.8 Stakeholders Opinions on Carbon Finance Uptake and its role in Renewable Energy Development in Kenya

To triangulate the data and findings of this study, data was collected from other carbon business stakeholders in the country. Triangulation of data sources was aimed at bolstering the study findings, and minimize the inadequacies that come with a single data source. Other carbon business stakeholders, defined earlier in the study, were sought for their understanding of the carbon finance processes in the country and beyond. Out of this group, 23 stakeholders were assessed for their opinions on the uptake of carbon finance in the country, incentives for developers and their sufficiency, the future of potential of carbon markets in Kenya and the role of carbon finance in the deployment of renewable energy in the country. The text data from their responses was analyzed using conventional content analysis (explained earlier) and the results are presented in the sections below;

6.8.1 Stakeholder's Opinions on Uptake and Awareness on Carbon Finance among Renewable Energy Developers.

To better understand the role of carbon finance and its use in renewables, the study also sought to know the views of carbon business stakeholders. The carbon business stakeholders were assumed to have more knowledge on the workings of the carbon markets, and thus were in a position to gauge the awareness of the use of carbon finance by their developers, through their interactions. The stakeholders were asked for their opinions on the use of carbon finance by developers of renewable energy from their interactions with energy developers and their knowledge of the carbon market in Kenya. Their responses were based on their experience and interactions with developers, and the broader knowledge of carbon business in Kenya. These opinions were analyzed step by step, and fitted into categories that were carefully founded and revised, based on the feedback from the stakeholders. The categories were put into a cross tabulation table and the chi-square test of independence used to test the reliability of the responses.

Table 6.29: Cross tabulation on Stakeholders Opinions

	Opinion	Category	
		YES	NO
1	carbon finance is a complex subject with ever evolving rules	17	6
2	Many develop for sale of power, carbon finance is by chance.	12	4
3	No awareness created by government	14	4
4	Aware but very hard to access	5	13

The opinions of stakeholders as to the use and awareness on carbon finance among organizations producing renewable energy in Kenya were condensed into four categories as in table 6.29 above. From these categories of responses, the descriptive statistics and the chi square were computed and were as presented in table 6.30 below.

Table 6.30: Descriptive statistics for Stakeholder's Opinions on Carbon Finance Uptake

	N	Mean	Std. Deviation	Minimum	Maximum
Yes	4	.5000	1.29099	3.00	6.00
No	4	13.5000	1.29099	12.00	15.00

Ranks

	Mean Rank
Yes	1.00
No	2.00

Test Statistics[a]

N	4
Chi-Square	4.000
Df	1
Asymp. Sig.	.046

a. Friedman Test

The descriptive statistics indicates that the No responses had a mean score of 13.50 with the YES responses with 4.50. The mean ranking has YES with 1.00 and NO ranking with 2.00. The Chi-square test is statistically significant ($\chi^2 = 4.00$ and p=0.046) where it shows that there is less understanding or knowledge on carbon financing in Kenya. From the above analysis, many stakeholders were of the view that carbon finance is a complex subject with ever evolving rules, the reason as to why many developers do not understand the processes of its access. Many stakeholders also see renewable energy developers more interested in electricity sales and carbon finance only being an ancillary benefit. They are also of the opinion that the government has not invested much in creating awareness among the developers, as shown by the high number of opinions on creation of awareness by the government. The descriptive statistics and the chi-square test show that the mean for no understanding of carbon finance issues among project developers is the highest, with the conclusion that Kenyan renewable energy developers do not understand the function of the carbon markets, and hence are not likely to use carbon finance.

The deduction from the analysis is that the low levels of awareness as to how to access the carbon markets are to blame for the low levels of uptake. This can be evidenced by the low number of carbon projects registered in Kenya, against a massive renewable energy potential and an electricity generation that is based on renewable energy. Because of these low levels of awareness, Kenya has already missed a number of opportunities as it failed to capitalize on the first commitment period (2008 to 2012) of the Kyoto Protocol (Carbon Africa, 2015). The opinions also show that carbon revenue generation is a secondary consideration by many developers, a view shared by Yuko (2009), with most of the power generation geared towards electricity sales. The enthusiasm created by the implementation of the Feed-in-Tariff is a case in point. Carbon buyers in the stakeholders group confirmed that project designers do not put into consideration the revenue from carbon trading when designing their projects.

6.8.2 Incentives to Renewable Energy Developers in Accessing Carbon Finance.

In this section, views were sought on the existence and nature of incentives the government provides to developers in the country. The aim was to assess how the government, as the Designated National Agency(DNA), has promoted the use of carbon finance by creating awareness, support in the process of the meeting the CDM and voluntary market requirements and offering any financial aid to developers. A cross tabulation table and the chi-square test of reliability are provided in Table 6.31 below.

Table 6.31: Carbon Stakeholder's Opinions on Incentives to Carbon Developers.

		Category	
	Opinion	YES	NO
1	Clear rules and regulations from DNA for developers	11	5
2	Financial help for developers of emission reducing projects	1	15
3	Provision of consultancy services to help developers meet carbon finance organizations' requirements	5	11
4	Awareness creation for developers on sources of carbon finance	2	14

The analysis on government support for renewable energy developers to access carbon finance from the carbon markets is shown by in table 6.32 below, which shows an overall mean of 9.000 for no sufficient incentives, which is significant according to the chi-square test of independence (Chi square= 1.000, p< 0.50).

Table 6.32: Mean and Standard Deviation for Stakeholders Opinions on Carbon Finance Incentives for Carbon Developers

	N	Mean	Std. Deviation	Minimum	Maximum
Yes	16	4.2500	1.50000	3.00	6.00
No	16	9.0000	2.94392	4.00	13.00

Ranks

	Mean Rank
Yes	1.25
No	1.75

Test Statistics[a]

N	4
Chi-Square	1.000
Df	1
Asymp. Sig.	.017

a. Friedman Test

The descriptive statistics indicates that the overall response for no sufficient incentives is a mean score of 9.00 while those who think there are sufficient incentives have a mean response of 4.25. The mean ranking has YES with 1.25 and NO ranking with 1.75. The Chi-square test is statistically significant ($\chi^2 = 1.00$ and p=0.017). According to the stakeholders in the carbon business in Kenya, therefore, the government does not provide sufficient incentives to carbon developers in the country to access carbon finance.

It follows from the analysis of that financial incentives for developers, such as capital support for new investments, tax waivers and holidays on their investments and low interest credit facilities for investors in renewables are not available to help developers in the production of carbon credits for sale in the international markets. Also help in terms of processes, identification of carbon credits buyers and markets are not provided by the government. However, the stakeholders show that the rules and regulations relating to the acquisition of carbon finance are present and to some extent sufficient, probably because the DNA at the National Environmental Management Agency was fully operational and functional. But the government has not created sufficient awareness on issues surrounding carbon finance among the developers. Overall, the majority of the stakeholders agree that the incentives that the government has provided for carbon developers in the country are not sufficient to invigorate the growth of carbon trading in the country. Nyambura and Nhamo (2014) also agree that incentives are lacking for developers of carbon credits in Kenya, as compared to the other developing countries such as China (Lewis, 2010).

6.8.3 Opinion on the Potential for Carbon Markets growth in Kenya

To explore the view on the future of carbon markets in Kenya, carbon business stakeholders were asked for their opinions regarding the potential growth of carbon markets in Kenya. The responses were categorized into two, those for no and those for yes, and the explanations were condensed into four categories against the two categories. A cross tabulation matrix and a chi-square test of reliability are shown in Table 6.33 below.

Table 6.33: Stakeholders Opinions on the Potential for Carbon Markets

		Category	
	Opinion	YES	NO
1	High renewable energy potential	16	2
2	Renewable investors awareness on carbon finance	5	11
3	Problems in global carbon markets	6	10
4	Support from government on access to carbon markets	4	11

To examine the significance of the responses from these opinions, a chi-square test of significance was run, and the descriptive statistics of the responses calculated as presented in table 6.34.

Table 6.34: Mean and Standard Deviation for Stakeholders Opinions on Carbon Markets Potential

Descriptive statistics

	Mean	Std. Deviation	Minimum	Maximum
Yes	7.7500	5.56028	4.00	16.00
No	8.5000	4.35890	2.00	11.00

Ranks

	Mean Rank
Yes	1.25
No	1.75

Test Statistics[a]

N	4
Chi-Square	1.000
Df	1
Asymp. Sig.	0.317

a. Friedman Test

From the table on the descriptive statistics, some stakeholders paint a gloomy picture of the future of the carbon markets while others think otherwise. The mean ranking has YES with 1.25 and NO ranking with 1.75. The Chi-square test is not statistically significant ($\chi^2 = 1.00$ and p=0.317), which can be explained by the distributions between yes and no responses.

From the observations and statistics, there seems to be a convergent on the potential for renewable energy development, with almost all stakeholders thinking that the renewable energy potential of the country is high. However, the opinions on the future potential for carbon markets in Kenya is almost evenly split, with an almost even distribution between those who think there is potential for the growth of carbon markets and those who do not. Among those who think there is more potential, the existence of abundant renewable energy potential is the main explanation, with the potential to deploy more renewable energy projects being the result. The assertion for increased potential for carbon markets growth in Kenya is also supported by carbon Africa (2015), who report that the carbon market activity in Kenya has been increasing in terms of carbon projects developed, successful registration of carbon projects, carbon credit volumes, capital investment and diversification of sectors and sizes of projects. For instance, from 2011, over 11 new CDM projects and programmes have entered the CDM pipeline, with more projects position themselves for CDM consideration. KIPPRA (2015) also projects that CDM alone will facilitate project financing and investment of billions of dollar by 2018 while total revenue from certified emission reductions (CERs) should exceed $90 billion by 2020. Moreover, the enactment of the Climate Change Act of 2016 is further expected to increase awareness on carbon finance and could possibly deepen the carbon markets in Kenya.

There are other stakeholders who believe that the potential for carbon market growth is limited. For them, the problems in the global carbon markets (such as declining carbon offsets prices) and lack of awareness from carbon developers in Kenya, paint a gloomy picture in the carbon markets growth in Kenya. They also point to the fact that not many Kenyan companies have been able to actualize their carbon potential as a pointer to the declining fortunes of the country in the international carbon markets, a fact supported by Sena (2015) and Nyambura and Nhamo (2014). Similar to Muzee (2011), they also find that the government input in the helping developers' access the international carbon markets is also lacking. However, the proponents of the growth point to new developments in the enabling environment, such as the adoption of the Kenyan renewable energy Feed-in Tariff Policy in 2008, which was later updated in 2010, as a major government initiative to promote investments in projects that qualify for CDM or the voluntary carbon market

(MoEP, 2013). Moreover, though the uptake of carbon finance from these markets remains low as compared to the country's potential, Kenya is relatively ahead of many African countries and is poised to play a greater role in the regional carbon markets.

6.8.4 Opinion on the role of Carbon Finance in the Promotion of Renewable Energy Investments.

Based on their understanding of the carbon finance architecture and the carbon market in the country, the carbon business stakeholders were asked to give their opinions as to the role played by carbon finance in the promotion of renewable energy development. The opinions were condensed into three parameters; an insignificant role, a middle level role in renewables deployment and a significant role in renewables deployment. They were asked to give a reason for every role they though carbon finance had played. The opinions were as displayed in table 6.35 below.

Table 6.35: Condensed opinions on role of Carbon Finance in Renewable Energy Deployment

category	Level/Rank	Frequency	Reasons/why
Opinion on role played by carbon finance in renewable energy development in Kenya	Significant role in renewable deployment	0	No stakeholder believes such a role has been achieved
	Indifference in significance in renewables deployment	3	Kenya has more registered projects than many other African countries Projects in Kenya have already sold credits DNA office functional and operational
	Insignificant role in renewables deployment	20	Access to finance is a Political and institutional barriers to carbon finance access Mistakes in carbon development Lack of awareness of the CDM requirements High CDM costs and lack of funds/appetite to pay for such and take on CDM risks Availability of local finance to complete projects technical complexity of carbon finance rules

Condensed opinions from the stakeholders reveal that carbon finance has not played a significant role in renewables deployment in Kenya. There is agreement among this group that Kenya has not received carbon finance to match its potential in renewable energy. The 16 projects registered under CDM are significantly low by Kenya's standards, given the number of renewable energy projects implemented after 2005 when the country ratified the protocol. Moreover, among these projects, only two projects have been able to sell carbon credits, with the rest having merely achieved registration. That no project has been facilitated fully, from inception to completion by carbon finance in the county, either through CDM or voluntary carbon markets.

Whereas there is convergent of opinions from the stakeholders as to the role played by carbon finance in renewables deployment, there is divergent in opinions as to why this is so. Some believe that this insignificant role is as a result of factors external to the projects such as lack of awareness and capacity to meet CDM requirements, High CDM costs and lack of funds or appetite to pay for such and take on CDM risks, the uncertain investment climate in the country and the technical complexity of CDM rules and regulations. Other believe that it is the inability of the project developers to meet the requirements in their developments that denies them the much needed funding. Either way, the result is that investors in Kenya do rely on their own equities and borrowing to implement their projects, with no significant inflow from carbon finance to help in project delivery.

6.9 Tests of the Hypotheses

To meet objective three of the study, a set of hypotheses was developed in chapter four, in order to establish the determinants of the uptake of carbon finance among renewable energy developers in Kenya. The five hypotheses relate to the five identified major determinants of the uptake of carbon finance; size of the renewable energy project, the sectoral scope of the project, prevailing carbon offset prices, the low carbon technology used in the project and the carbon market affiliation. Having presented the regression analysis for the determinants, the tests of hypotheses establishes how individual determinants fared against the uptake of carbon finance. The tests were carried out using simple and step wise logistic regression analysis. The tests were done at 5% significance level (α =0.05). The evaluation focused on the hypotheses derived from the objectives three of the study. The effects of project size, project sector, carbon offset prices, low carbon technology used by the project and the market affiliation, either mandatory or voluntary, were each tested against the uptake of carbon finance. The results for each of the test of hypothesis are presented below;

6.9.1 Renewable Energy Project Size and Carbon Finance

Hypothesis 1 sought to establish the influence of the project size on uptake of carbon finance. The project size was operationalized through four parameters; transaction costs suffered due to size, emissions reduced by the project, suitability of project size to carbon buyers and the capital requirements for the project. The hypothesis was tested by regressing size on uptake of carbon finance, guided by the equation Y= $\beta_0+\beta X_1$, where X_1 represents project size and Y denotes uptake of carbon finance. To find the predictive ability of the model, classification of users as users and non-users as non-users, a classification table, which involves the observed and predicted classifications of the variables based on the characteristic, use of carbon finance was generated. The classification table for the model involving the dependent variable Y, the uptake of carbon finance and the independent variable X_1, the size of the project in terms of the power generated in megawatts is presented below;

Table 6.36: Omnibus tests of Model Coefficients and Model Summary for Project Size and Carbon Finance

		Chi-square	do	Sig.
Step 1	Step	21.415	1	.000
	Block	21.415	1	.000
	Model	21.415	1	.000

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	60.360[a]	.292	.399

Estimation terminated at iteration number 6 because parameter estimates changed by less than .001.

The Omnibus Tests of Model Coefficients, was used check whether there was a significant difference between the Log-likelihoods (specifically the -2LLs) of the baseline model and the new model. The chi-square test of independence was performed to examine the relation between project size and carbon finance uptake. The relation between these variables was is highly significant (chi-square=21.415 df = 1, p<.000) shows that the model is significantly better in predicting the uptake of carbon finance than the baseline. The model summary shows that the explained variation between the independent variable of project size and the uptake of carbon finance is 29.2 per cent in reference to Cox **& Snell R Square** and 39.9 per cent according to **Nagelkerke R Square**. According to Field (2005), a Nagelkerke R^2 of 40 per cent is considered sufficient for a model. This shows that around 40 per cent of the changes in the uptake of carbon finance can be explained by changes in the project size.

Table 6.37: Classification Table and Variables in the Equation

Classification Table[a]

	Observed		Predicted		
			Use of Carbon Finance (Projects)		Percentage Correct
			Non User	User	
Step 1	Use of Carbon Finance (Projects)	Non User	32	7	82.1
		User	15	8	34.8
	Overall Percentage				64.5

a. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	X1_1	2.476	.713	12.077	1	.001	11.898	2.944	48.085
	Constant	-9.371	2.615	12.841	1	.000	.000		

a. Variable(s) entered on step 1: X1_1.

The classification table, which is used in binomial logistic regression to show the ability of the model in prediction of attributes, shows the percentage accuracy in classification (PAC) to be 64.5 %, which is above the cut value of 50%. This shows that the probability of an attribute on size affecting the uptake of carbon finance is over 64.5 times in a hundred.

The variables in the equation table shows that the independent variable, project size is important in prediction the uptake of carbon finance, as shown by the Wald test at 12.077 and p=.001. This shows that the variable size added significantly to the overall model prediction. From the variables in the equation table, the binomial logistic regression equation for project size and carbon finance uptake;

$$\text{Logit } (p/1\text{-}p) = \beta 0 + \beta X1 + a$$

Was therefore expressed as;

$$\text{Log}(p/1\text{-}p) = -9.371 + 2.307\ X1$$

The estimates of the relationship between the independent variables and the dependent variable, with the dependent variable being on the logit scale show that the independent variable, size of the renewable energy project was significant in predicting the odds of up taking carbon finance. Odd ratio for project size indicate that for each one-point increase in the scale for project size, the odds of up taking carbon finance increase by a factor of 11.05.

The tests of the hypothesis on project size reveal that the size of the project, in terms of megawatts of electricity produced, was a determinant in the uptake of carbon finance among renewable energy developers in Kenya. Most of the project developers highly rated the attributes of project size, including transaction costs due to size, higher emission reductions from the project and higher capital requirements for the projects. Project suitability for CDM was rated a little bit higher, signifying the need for more cost effective projects, especially in meeting the CDM requirements. The ranking high of size in CDM projects is consistent with findings by Michaelowa (2014) who find that project size is important in attracting revenues from CDM, because buyers prefer a project that will fulfill their cap requirements. Other findings on size (Sjardin, 2010) show that large scale projects have lower transaction costs because of economies of scale, when it comes to compliance with the markets requirements, particularly those of the CDM. It is also consistent with Kiplagat (2011), who find that renewal energy projects tend to suffer in CDM because capacity addition tends to be small and incremental. The overall findings on size disapproves the hypothesis that the size of the project does not influence the uptake of carbon finance, showing that size matters to carbon credits buyers. While size is important in attracting higher amounts of carbon finance, due to high emission reductions, it does not however, determine whether the project will attract carbon finance in the first place.

6.9.2 Project Sector and Carbon Finance

This research also tested the hypothesis on the influence of the project sector on uptake of carbon finance. Composite scores were computed to represent the various attributes of project sector which included; the type of renewable energy project was in, problems of baseline selection in the sector, value of carbon offsets from the sector, issues of additionality in the sector and investor desirability of the carbon offsets from the sector. The hypothesis was tested by regressing size on uptake of carbon finance, guided by the equation $Y= \beta_0+\beta X_2$, where X_2 represents project sector and Y denotes uptake of carbon finance. The results were as presented below;

Table 6.38: Omnibus tests of Model Coefficients and Model Summary for Project Sector and Carbon Finance

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	3.029	1	.082
	Block	3.029	1	.082
	Model	3.029	1	.082

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	78.746[a]	.048	.065

a. Estimation terminated at iteration number 4 because parameter estimates changed by less than .001.

The Omnibus Tests of Model Coefficients shows that the sector of the project does not add any significance in the prediction model, as the chi-square is not significant (chi-square= 3.029 df = 1, p>.000). The R^2 values tell us approximately how much variation in the outcome is explained by the model. With reference to Cox & Snell R^2 , the explained variation in the dependent variable based on the model is 48 % while with Nagelkerke R^2 it is 65%. Since the chi-square is not significant, the hypothesis that project sector influences carbon finance uptake is rejected.

Table 6.39: Classification table and variables in the equation

Classification Table[a]

	Observed		Predicted		
			Use of Carbon Finance (Projects)		Percentage Correct
			Non User	User	
Step 1	Use of Carbon Finance (Projects)	Non User	33	6	84.6
		User	22	1	4.3
	Overall Percentage				54.8

a. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	X2_1	.733	.443	2.731	1	.098	2.080	.873	4.960
	Constant	-3.048	1.569	3.775	1	.052	.047		

a. Variable(s) entered on step 1: X2_1.

From the classification table, the percentage accuracy in classification is 54.8 %, a predictive power of slightly more than the probability of just tossing a coin. The variables in the equation table shows that the independent variable, project sector is not a determinant of the uptake of carbon finance (Wald test = 2.731, $p > 0.50$). The binomial logistic regression equation for project sector and carbon finance uptake was expressed as follows;

$$\textbf{Log (p/1-p) =} -3.048 + .733\ \mathbf{X_2}$$

The estimates of the relationship between the independent variables and the dependent variable, with the dependent variable being on the logit scale show that the independent variable, use of low carbon technologies was not significant in predicting the odds of up taking carbon finance. Odd ratio for project sector indicate that for each one-point increase in the scale for project size, the odds of up taking carbon finance increase by a factor of 4.96.

6.9.3 Carbon Offset Prices and Carbon Finance

The study also sought to determine the influence of the prevailing carbon offset prices on the uptake of carbon finance. Composite scores were computed to represent the various attributes of carbon offset prices including the prices of carbon offsets in the international carbon markets, supply and demand of international carbon offsets, the crediting period or period over which project will generate carbon credits and type of carbon credits generated by the project. The hypothesis was tested by regressing size on uptake of carbon finance, guided by the equation $Y= \beta_0+\beta X_3$, where X_3 represents carbon offset prices and Y denotes uptake of carbon finance. The results were as presented below;

Table 6.40: Omnibus tests of Model Coefficients and Model Summary for Carbon Offset Prices and Carbon Finance

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	1.180	1	.277
	Block	1.180	1	.277
	Model	1.180	1	.277

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	80.594[a]	.019	.026

a. Estimation terminated at iteration number 4 because parameter estimates changed by less than .001.

The Omnibus Tests of Model Coefficients shows that the carbon offset prices did not add any significance in the prediction model, as the chi-square is not significant (chi-square= 1.180 df = 1, p>.000). Based on this model, the Cox & Snell R^2 is only 19 percent while with Nagelkerke R^2 is 26 per cent, showing that the variable carbon offset prices did not provide much explanatory power for the uptake of carbon finance. This leads therefore to the rejection of the hypothesis that carbon offset prices prevailing in the international carbon markets influence the uptake of carbon finance.

Table 6.41: Classification table and variables in the equation

Classification Table[a]

	Observed		Predicted		
			Use of Carbon Finance (Projects)		Percentage Correct
			Non User	User	
Step 1	Use of Carbon Finance (Projects)	Non User	39	0	100.0
		User	23	0	.0
	Overall Percentage				62.9

a. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	X3_1	.515	.500	1.058	1	.304	1.673	.628	4.461
	Constant	-2.531	1.980	1.634	1	.201	.080		

a. Variable(s) entered on step 1: X3_1.

The classification table shows that the percentage accuracy in classification (PAC) is 62.9 per cent, which is above the cut value of 0.50, showing the strong predictive power of the model in predicting the adoption of carbon finance using the prevailing carbon offset prices.

From the variables in the equation, the probability of becoming a user of carbon finance, based on a unit change in the prevailing carbon offset prices is p=0.561, showing that the variable did not add to the predictive power of the model as it was not significant.

The binomial logistic regression equation for project sector and carbon finance uptake was expressed as follows;

Log (p/1-p) = 2.531 +.515 $\mathbf{X_3}$

The estimates of the relationship between the independent variables and the dependent variable, with the dependent variable being on the logit scale show that the independent variable, use of carbon offset prices was not significant in predicting the odds of up taking carbon finance. Odd ratio for prevailing carbon offset prices indicate that for each one-point increase in the scale for project size, the odds of up taking carbon finance increase by a factor of 4.46.

6.9.4 Low Carbon Technology and Carbon Finance

Low carbon technologies are highly rewarded in the carbon markets. For this reason, the study south to determine how technology used by renewable energy developers in Kenya influence their uptake of carbon finance. This influence was tested through research hypothesis three, which was to determine the influence of technology on the uptake of carbon finance. Composite scores were computed for the attributes of technology, which included type of renewable energy technology used in the project, applicability of the technology used in CDM procedures and cost of the applicable technology, all of which were used in the evaluation. The hypothesis was tested by regressing size on uptake of carbon finance, guided by the equation $Y= \beta_0+\beta X_4$, where X_4 represents carbon offset prices and Y denotes uptake of carbon finance.

Table 6.42: Omnibus tests of Model Coefficients and Model Summary for Low Carbon Technology and Carbon Finance

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	37.229	1	.000
	Block	37.229	1	.000
	Model	37.229	1	.000

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	44.545[a]	.451	.616

a. Estimation terminated at iteration number 6 because parameter estimates changed by less than .001.

The Omnibus test of model coefficients shows that the model was highly significant in predicting the effect of the independent variable (low carbon technologies) on the dependent variable (uptake of carbon finance), (Chi square 37.229, df=1, $p<0.050$). Thus the model is statistically significant in predicting the effect of technology on the uptake of carbon finance and leads to accepting the hypothesis that low carbon technologies influence the uptake of carbon finance.

The model summary shows that the variation between the low carbon technologies and uptake of carbon finance can be explained 45 per cent using Cox & Snell R square, while for Nagelkerke R^2 it was 61.6 per cent. A Nagelkerke value of over 60 per cent is deemed to be sufficient in explaining the variation between the dependent and the independent variable (Peng et al., 2002). As such, the variation in use of low carbon technologies is able to explain over 61.6 per cent in the variation of the uptake of carbon finance.

Table 6.43: Classification table and variables in the equation

Classification Table[a]

	Observed		Predicted		
			Use of Carbon Finance (Projects)		Percentage Correct
			Non User	User	
Step 1	Use of Carbon Finance (Projects)	Non User	35	4	89.7
		User	6	17	73.9
	Overall Percentage				83.9

a. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	X4_1	4.610	1.224	14.179	1	.000	100.490	9.120	1107.2
	Constant	-16.60	4.326	14.736	1	.000	.000		

a. Variable(s) entered on step 1: X4_1.

The classification table shows that the percentage accuracy in classification (PAC) is 83.9 per cent. This is above the cut value of 0.50, reflecting the high dependency of the model in expressing the true positives. The Wald value of 14.179 at p = 0.00 shows that the variable technology was highly significant in predicting the uptake of carbon finance. From the variable is the equation, the overall model for technology and the uptake of carbon finance, expressed in form of the binomial logistic regression equation;

$$\textbf{\textit{Logit (p/1-p)}} = \beta_0 + \beta X_4 + a$$

Where p is the probability of up taking carbon finance, is expressed in terms of variables as follows;

$$\textbf{Log (p/1-p)} = -16.605 + 4.610\mathbf{X_4}$$

From the regression equation, it shows that for every one-point increase in low carbon technologies, the odd of taking up carbon finance increase by 1107.24. This shows that technology is an important determinant of a project using carbon finance or not.

6.9.5 Market Affiliation and Carbon Finance

Hypothesis 5 of the study sought to determine the influence of the markets in which the carbon offsets are traded on the amount of carbon finance that a project is likely to accrue. The two main markets for carbon credits, the regulatory compliance market and the voluntary markets where used as the proxies for this hypothesis. The computation of composite scores for the attributes of the market affiliation also involved the length of the crediting period as well as approval process required to enable sale of credits in either the mandatory cap-and-trade or the voluntary market. The hypothesis was on whether selling carbon credits in either the CDM (regulatory compliance) or the voluntary market influenced the uptake of more carbon finance. The hypothesis was tested by regressing size on uptake of carbon finance, guided by the equation $Y= \beta_0+\beta X_5$, where X_5 represents carbon offset prices and Y denotes uptake of carbon finance.

Table 6.44: Omnibus tests of Model Coefficients and Model Summary for Market Affiliation and Carbon Finance

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	4.667	1	.031
	Block	4.667	1	.031
	Model	4.667	1	.031

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	77.108[a]	.073	.099

a. Estimation terminated at iteration number 4 because parameter estimates changed by less than .001.

The chi-square test of independence was performed to examine the relation between the carbon market in which the offsets are destined and the carbon finance uptake. The relation between these variables was significant (chi-square=4.667, df = 1, p = 0.031). This shows that the variable carbon market affiliation added significantly to the predictive power of the model. The hypothesis that carbon market affiliations influences the uptake of carbon finance is thus accepted.

From the model summary, and in reference to Cox & Snell R^2, the explained variation in the dependent variable (uptake of carbon finance) based on changes in the independent variable 9carbon market affiliation) is 52.3 per cent while with Nagelkerke R^2 it is 71.4 per cent. According to Field (2005), a Nagelkerke R^2 of over 70 per cent shows a strong explanatory power of the independent variables over the dependent variable. Thus, in this data, over 71.4 per cent variation in the uptake of carbon finance is explained by variation in the independent variables of size, sector, offset prices, technology and market affiliation.

Table 6.45: Classification table and variables in the equation

Classification Table[a]

	Observed		Predicted		
			Use of Carbon Finance (Projects)		Percentage Correct
			Non User	User	
Step 1	Use of Carbon Finance (Projects)	Non User	34	5	87.2
		User	22	1	4.3
	Overall Percentage				56.5

a. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	X5_1	.972	.485	4.011	1	.045	2.642	1.021	6.837
	Constant	-3.890	1.728	5.068	1	.024	.020		

a. Variable(s) entered on step 1: X5_1.

The classification table shows that the percentage accuracy in classification (PAC) is 56.3 per cent, which is a little more than the cut value of 0.50. This reflects the percentage of cases that can be correctly classified as users of carbon finance with the independent variables added, the market affiliation of the project and not just the overall model. The classification table also shows the sensitivity of the model by showing correctly the percentage of cases that had the observed characteristic, the uptake of carbon finance, which were correctly predicted by the model (true positives) which is 34. The Wald value of 4.011 at $p< 0.50$ shows that the market affiliation was significant in predicting the uptake of carbon finance. From the variable is the equation, the overall model for technology and the uptake of carbon finance, expressed in form of the binomial logistic regression equation;

$$\textit{Logit}\ (p/1\text{-}p) = \beta_0 + \beta X_5 + a$$

Where p is the probability of up taking carbon finance, is expressed in terms of variables translates to;

$$\textbf{Log (p/1-p)} = -3.890 + 0.972\mathbf{X_5}$$

The tests of the hypothesis and the regression equation reveal that the market in which the credits are sold is a determinant of the uptake of carbon finance. Market affiliation was divided into attributes relating to the regulatory compliance and the voluntary carbon market. The estimates of the relationship between the independent variable (market affiliation) and the dependent variable (uptake of carbon finance) with the dependent variable being on the logit scale show that market affiliation is an important determinant of the uptake of carbon finance.

6.10 Summary of the Chapter

This chapter present a quantitative and qualitative analysis of data collected in the study. A triangulation of sources and methodology is used, with data being collected from primary and secondary sources and several methods used to analyze it. A binomial logistic regression is employed to model the relationship between the uptake of carbon finance and renewable energy development by assessing the determinants of the uptake. The analysis confirms that renewable energy producers will need to increase the amount of power they produce, use more advanced low carbon technologies and sell carbon credits into the compliance markets if they want to receive more carbon revenues. The tests of hypotheses reveal three main determinants of carbon finance uptake among renewables in Kenya which developers must strive to meet for them to access more carbon revenues for their projects. To examine the challenges that hinder the development of renewable development, confirmatory factor analysis is used while content analysis is used to analyze the opinions of carbon business stakeholders on the uptake of carbon finance in the country. While the stakeholders are optimistic on the prospects of increasing carbon uptake, the changes in the global carbon finance architecture could thwart these efforts made.

CHAPTER SEVEN

DISCUSSIONS OF RESEARCH FINDINGS

7.1 Introduction

Having presented the analysis of the data and findings of the study in chapter six, this chapter highlights how the statistical findings relate to the purpose of the study. It gives an explanation of each of findings as per the objectives of the study, and interprets them in light of the Kenyan situation and prior research. Section 7.2 presents a discussion on the understanding of carbon finance in among renewable energy developers while section 7.3 presents a discussion on the uptake of carbon finance among renewable energy developers in Kenya. Section 7.4 discuses results from analysis of the determinants of carbon finance and section 7.5 the constraints of accessing carbon finance. A discussion on the challenges facing renewable energy investors is presented in section 7.6 while the opinions of carbon business stakeholders are discussed under section 7.7. Finally, section 7.8 gives a summary of all discussions presented in the various section in the chapter.

7.2 Understanding of Carbon Finance in Kenya

The study finds that renewable energy developers in Kenya have low levels of knowledge on climate finance and how greenhouses gases cause global warming. Moreover, they have little understanding of how carbon offsets are created from reducing emissions. These findings show that renewable energy developers are not inclined to aspects of carbon financing, and how reducing GHGs could bring financial benefits to their projects. The responses from the developers reveal that knowledge on the basic elements of carbon finance, such as carbon credits carbon trading in both the regulatory compliance and voluntary markets, is extremely low. Sena (2015) and Nyambura and Nhamo (2014) also report that operators of emission reducing projects in Kenya do not seem to be aware of the benefits that international carbon markets could offer them.

On the carbon standards that are used in carbon trading, the study find that the CDM Gold Standard is most popular, followed by the Verified Carbon Standard, which is used in voluntary carbon trading. However, the rating for the developers understanding of both standards remains low, and further scrutiny from developers who had accessed carbon finance reveal an equally low level of their use. Further, the developers seem not to be much aware of the various carbon finds, from which any carbon revenues are likely to flow into their projects. Of these funds, the Ci-Dev, operated by the World Bank is more popular, followed by the UN's Green Climate Fund. Carbon Africa (2015) in their analysis of the carbon market landscape in Kenya, also reveal that project developers as well as regulators do not fully understanding the function of the carbon markets, resulting to subdued usage of carbon finance by developers. Moreover, a World Bank report (2014) also attests that knowledge on carbon funds and their role in mitigating climate change is poorly understood by developers in many African countries. The implication for the low levels of understanding of these carbon standards and carbon funds are that developers aren't likely to benefit from carbon finance inflows, using these standards and from the funds, which they are barely aware.

The study also finds that many developers, while not fully understanding the elements of carbon finance, have somewhat some level of knowledge on what carbon finance entails. Majority of Kenyan developers understand carbon finance to be all finances used in the reduction of greenhouse gases, whether contributed by governments, non-governmental organizations or corporations. This understanding mirrors the definition of carbon finance as the resources provided to activities generating (or expected to generate) greenhouse gas (or carbon) emission reductions through the transaction of such emission reductions by the World Bank (2010).

A substantial percentage also understand carbon finance as the financial flows for climate change mitigation and adaptation in developing countries. The understanding in this group is that the use of carbon finance to help in mitigation was the primary reason the resources are provided in the first place, with adaptation coming in because the mitigation was not successful. However, they were not able to agree on the individual components of what constitutes carbon finance, similar to the reporting by (Stadelmann et al., 2011). Many stakeholders also suggest that an aspect of a carbon tax should be introduced in Kenya, to ensure that those who pollute the environment are punished while good environmental behaviours are rewarded. Further, others suggest that the use of a tax break could afford more opportunities for the promotion of clean energy production among renewable energy developers. Lambe (2014) also agrees that a tax break could spur renewable energy investments among Kenyan developers, given that the biggest fear among investors is to recoup back their investment capital.

7.3 Carbon Finance Uptake by Renewable Energy Developers in Kenya

According to IPCC (2015), the amount of finance devoted to tackling climate change has been increasing steadily over the last five years. The pledges made by the global north to the global south are now over USD 100 billion per year, as confirmed by the conference of Parties number 21 at Paris in 2015. However, Irvine (2014) find that most of this promises by the developed countries to poorer countries haven't been forthcoming. Current levels of carbon financing for developing countries (middle and low-income countries) fall far short of what is needed for mitigation and adaptation (Bode, 2014). The findings of this study on the uptake of carbon finance among renewables confirm these assertions.

The study finds that many project developers in Kenya do not use climate finance in their developments. Only a small fraction of around 1.6 per cent appears to have utilized in climate finance in some way. The analysis of climate finance use among the renewable energy projects studied shows that a significant percentage, around 37 per cent, had initiated the process of the accessing climate finance. However, a further scrutiny of the project status shows that carbon finance has not played any significant role in the projects lives. Some projects had only received advice from would be carbon buyers, and were way far away from even selling carbon credits. These findings confirm the assertions by Nyambura and Nhamo (2014) and Woods et al. (2016) who find that Kenyan developers struggle to meet the transaction costs and bureaucracies that come with the use of carbon finance.

The analysis of the project design documents for Kenyan projects registered with the CDM shows a huge potential to mitigate climate change by large amounts of carbon emission reductions. However, this is not in tandem with the amount of finance received by these companies. Only a few Kenyan companies, Kengen power generating Company, Mumias Sugar Company and Kenya Power and Lighting Company appears to have received substantial amounts of climate finance, through the sale of carbon offsets. The study also finds that majority of project developers in the country rely on their own equity to initiate projects since banks do not have credit lines relating to investments in renewable energy. This probably explains the low investments in renewable energy projects, in a country that is endowed with abundant renewable energy resources. These findings are similar to those by Abdullah and Jeanty (2011) who found that Kenya had not leveraged her potential in renewable energy to access the international carbon markets.

This study also finds that Kenya's access to international carbon markets, albeit low, is poised to help in the growth of renewable energy investments. This is evidenced by the number of projects that have initiated processes to access these markets. Further, there has been a proliferation of international climate finds, such as the Green Climate Fund, which is currently working with the Ministry of Finance to rope in more developers of RE projects. The treasury has, through the Climate Public Expenditure Budget Review (CPEBR), mainstreamed climate change activities in the country's budgeting process, which has resulted to approximately Kenya shillings 52.768 Billion being spent on agriculture and renewable energy sectors. The Ci-Dev has also been instrumental in supporting the small hydro projects of Kenya Tea Development Authority (KTDA) and has already done a scoping study with over 11 small hydro projects.

7.4 Determinants of Carbon Finance Uptake by Renewable Energy Developers

The determinants of the uptake of carbon finance are explored at the country level and the project level. At country level, it has shown that private mitigation finance is influenced by many factors including geopolitical, country size, economic performance and the prevailing carbon offset prices, as well as the markets the offsets are traded, whether voluntary or regulatory compliance (Halimanjaya, 2015; Dolsak & Crandall, 2013; Eyraud et al., 2011). The focus of this study was on project level determinants of the uptake, where there has been some level of disagreement among scholars as to what exactly determines how much finance flows into an emission reducing firm or project. These determinants were explored in a setting of a developing country, which had not been explored before.

From this study, it was shown that the size of the project, in terms of megawatts of electricity produced, was a major determinant of the carbon flow into the project. Most of the project developers rated highly the attributes of project size, including transaction costs due to size, higher emission reductions from the project and higher capital requirements for the projects. Project suitability for CDM was rated a little bit higher, signifying the need for more cost effective projects, especially in meeting the CDM requirements. The ranking high of size in CDM projects is consistent with findings by Michaelowa (2014) who find that project size is important in attracting revenues from CDM because buyers prefer a project that will fulfil their cap requirements. Other findings on size (Sjardin, 2010) show that large scale projects have lower transaction costs because of economies of scale, when it comes to compliance with the requirements of the market, particularly those of the CDM and thus making them attractive to carbon credits buyers. It is also consistent with Kiplagat (2011), who find that renewable energy projects tend to suffer in CDM because capacity addition tends to be small and incremental. Olsen and Fenhann (2008) find that although CDM rules do not provide a clear threshold for the size of the project that should be allowed to enter the pipeline so long as it is additional, most developers go for large size projects because of transaction costs, economies of scale and large carbon credits sales.

The overall findings on size approve the hypothesis that the size of the project influences the uptake of carbon finance, showing that size matters to carbon credits buyers. While size is important in attracting higher amounts of carbon finance, due to high emission reductions, it does not, however, determine whether the project will attract carbon finance in the first place. However, while large scale projects are more preferred by project developers and carbon buyers alike, the Marrakech Accord attempted to provide a level playing ground for small scale projects under CDM, noting that small scale projects can have also considerable sustainable development benefits.

The second determinant of the uptake that was examined was the project sector, which was shown not to be a determinant of the uptake of carbon finance. In line with Dolsak and Crandall (2013), the study shows that developers are more enthusiastic to renewable energy development, as compared to other sectors such a waste management, possibly because of the abundance of renewable energy resources in the country. However, the lack of importance of project sector as a determinant is also in line with findings by Del Rio and Linares (2014) who find that buyers who want to meet their targets in a less costly way will always seek for projects that are additional, regardless of the sector. In preference for offsets from certain sectors, and in contrast with the findings of this study, Bode (2006) find that carbon buyers wishing to meet their emissions targets are attracted in a specific sector by their specific interests. It is also apparent that of the fifteen sectors listed as applicable to CDM projects by the CDM board, renewable energy comes as the first sector, signifying its potential for carbon emissions reductions. Sena (2015) also finds that the renewable energy sector projects have been a key sector of interest for many developing countries, including Kenya. In agreement with these findings, Rajan (2009) also finds that renewable energy projects have helped developing countries improve their energy supply in a more sustainable way. This is also similar to Kollmuss et al. (2008), who find those investors' desire offsets from certain types of projects, such as renewable energy, more than others, such as those in waste management. However, the findings of this study on project sector could have been compromised by the fact that the project developers in this research were sourced from only one sector, that of renewable energy.

The study also tested the hypothesis on the influence of prevailing carbon offset prices on the uptake of carbon finance. The results do not uphold the hypothesis, with the conclusion that the prevailing carbon offset prices do not influence the uptake of carbon finance for renewable energy projects in Kenya. Individual examination of the various attributes of offset prices also reveals low ratings, including for supply and demand of international carbon offsets, the length of the crediting period and the type of carbon credits generated by the project. This probably could be for the reason that despite the decline in carbon offset prices in the international carbon markets, since the carbon market crisis of the 2010s, the development of CDM projects, as well as those in the voluntary markets has not stopped (Carraro & Favero, 2009). The findings of the study also negate the commonly held preference for carbon offsets from the mandatory market, which fetches considerably higher prices than voluntary offsets.

Sjardin (2010) notes that because different countries and regions pursue different climate policies covering different sectors, and use different allocation rules, different carbon prices may prevail in different carbon markets. This could as well explain why the prevailing prices may not be as crucial to the uptake of carbon finance. Ellis and Kamel (2007) also note that while prices for CDM and JI offsets are linked to the broader markets for EU ETS and Kyoto allowances, carbon offset prices tend to vary based on the project type, its location, the market demand and the stringency of the offset program requirements. The emergence of a vibrant voluntary carbon market in the last five years has brought with it over a dozen a dozen voluntary standards, with varying prices. This to a large extent has increased the market for many small projects, such as those in developing countries. This to a large extent has diminished the competition in the carbon markets, with the prices of offsets going tumbling.

The fourth determinant of the uptake of carbon finance that was examined was the use of low carbon technologies, as tested in research hypothesis four. The test of this hypothesis reveals that the technology used in the project determines if a project will attract carbon finance or not. Both the test of hypothesis and the regression equation reveals that the technology used in the project is a determinant of the uptake of carbon finance. The attributes of the technology including the type of renewable energy technology used, the applicability of technology used in CDM, and cost of technology were highly rated, suggesting that technology plays a major role in the uptake of carbon finance. These findings are in line with Weitzel et al. (2015) who find that that technology transfer can bring development faster to developing countries. Smith et al. (2009) also find that low carbon technologies are more highly rewarded, with the result that revenues from selling carbon credits could be used to finance more advanced technologies that would not have been otherwise viable. Geels, Berkhout and van Vuuren (2016) advance that technology transfer is a major factor in the attraction of carbon revenues to a project, identifying project size as an attribute of technology deployment. Yang et al. (2016) note price setting measures for carbon offsets must create incentives for technological progress. They argue that if the carbon price is not high enough, the pressure on technological development will not be sufficiently strong. However, Weitzel et al. (2015) and Nygaard (2015) agree that more intensive research and development is needed to produce technological options that can allow both climate stabilization and economic development, especially for developing countries.

That many African countries face technological inadequacies despite the developments of RET across the world could also be a reason why technology is lowly rated, with any technology that brings additionality benefits being rewarded. With Africa facing the problem of inadequate data, effects of climate change and a limited local capacity to manufacture most of the projects' components in RE, technology is relegated to the rear, with more efforts being spent on the search for adequate finance. These findings are also in line with Gudyanga (2011), who finds inadequate capacity in the area of science and technology in Africa extends to the poor development of RE technologies. According to Showers (2016), the growth of renewable in Africa has been attributed to the low costs of technology, making it more accessible to poorer sections of populations. The availability of technology could have made it be taken for granted, hence the low rating awarded to it by respondents.

Research hypothesis five was based on the influence of the market in which credits are sold on the uptake of carbon finance. The market affiliation was divided into attributes relating to the regulatory compliance and the voluntary carbon market. The test of the hypothesis was based on finding out the influence of trading carbon offsets in either of the two markets on climate finance.

The estimates of the relationship between the independent variable and the dependent variable, with the dependent variable being on the logit scale, show that market affiliation is an important determinant of the uptake of carbon finance. Among the attributes of market affiliation, the sale of offsets in the CDM market was highly rated, an indication that the CDM market is a more lucrative market for the sale of credits similar to the findings by Wara and Victor (2008), who find those project developers are more inclined to the regulatory markets. Peters-Stanley, Hamilton, Marcello and Sjardin (2011) also find that buyers are more inclined to the CDM market, where they see the credits being more credible and certified and contributing more to sustainability.

The sale of offsets in the voluntary markets was not highly rated; showing that sale of offsets in the voluntary market is not the main intention of developers, but rather their main aim is to sell them in the regulatory market. However, because of the rigorous CDM requirements, many project developers, though registered under CDM, sometimes do seek to sell credits in the voluntary markets. Hamilton et al. (2010b) do find that many project developers in Africa are seeking refuge in the voluntary market. The approval process by the Designated National Agencies (DNAs) also plays a role in accessing carbon finance, as shown by the high rating of the attribute. In conjunction with the time and effort used in developing CDM projects, the approval process also serves to hasten the process of access sing the finance.

7.5 Constraints of Accessing Carbon Finance in Kenya

This study confirmed that access to climate finance among Kenyan renewable energy developers is low. This is as confirmed by objective two, which assessed the level of uptake of carbon finance among RE developers. Research question three, as a follow up to this objective, sought to find out the constraints of accessing carbon finance among Kenyan renewable energy developers.

The findings of this study reveal that access to finance to develop renewable energy projects to completion is one of the main constraints to accessing carbon. For a project to generate carbon credits, it must be complete and be running (Lambe et al., 2015). According to this study, many project developers do not complete their projects because of financial constraints. Park (2016) also finds that many clean entrepreneurs in Africa have no enough funding to attain completion of their projects, with the result that many green ideas go unimplemented. This study also finds that many Kenyan banks have no green products or products tailored to renewable energy development. Of the over 40 banks in the country, only two had lines of credits open for renewable energy developers. Moreover, the study also reported that mainstream commercial banks shy away from lending to renewable energy. These findings are similar to Oji et al. (2016) and Deichmanna (2011) who find that financing renewable energy products in Africa is a challenge for developers because, for financiers, the perception of financial risks associated with financing renewable energy projects is higher than the anticipated returns. However, the problem is that carbon finance provides only a portion of the required funding, compelling developers to find other sources of funding to close the financing gap (Rajan, 2009).

The study also finds that RE developers incur high transaction costs in generating carbon credits. This constraint is brought about by the rigorous processes that are required by various carbon buyers to ensure that the credits are verified and additional. Acker et al. (2012) find that small scale renewable energy project developers find it hard to access climate funding because of huge transaction costs. Qian and Yao (2011) also find that many carbon credits developers are discouraged by transaction costs in the CDM markets, instead opting to produce credits for the less rigorous voluntary markets. The high transaction costs of meeting the generation and sale of carbon credits were shown as a major impediment to renewable energy developers in accessing carbon finance. The high rating of this constraint also confirms findings of previous studies such as Wara and Victor (2008) and Lohman (2009) who find that the transaction costs of meeting the CDM requirements do affect the time of entry of many projects into the CDM pipeline.

The initial investment costs for renewable energy projects was also shown to be an impediment for RE developers. The study finds that many developers were afraid of losing their investments, in case they did not meet the full costs of the investments. Apergisa and Payne (2012) and Kiplagat (2011) also find that the cost of renewable energy investments is higher on average than most other developing countries, partly because many of the projects part and components have to be sourced from outside the country. In agreement with Kamau et al. (2010), he also advances that land acquisition problems, because of the land tenure system, increases the costs of renewable energy projects at almost double of most these other countries.

The study also finds that many renewable energy developers either unaware of the existence of climate funding sources or they did not know that their projects would qualify for the same. Further, it was observed that many of the developers did not understand the climate finance acquiring procedures, as demonstrated by lower scores on knowledge on of the major climate agreements in the world. Despite the generation of information leading to and after the 2015 Paris Climate Conference, renewable energy developers in Kenya are not yet versed with the requirements and sources from which they can accrue carbon finance. Pfeifer and Stiles (2009) report that some of these challenges relating to levels of awareness stem from the market structures and complexity of the carbon markets. Gujba, Thorne, Mulugetta, Rai and Sokona (2012) find lack of understanding for many renewable energy developers is a major hindrance to low carbon energy in developing economies

Lack of consultants to help developers meet the requirements of the carbon markets is shown also to be a hindrance to the access of carbon finance. Many developers, though aware of the existence of carbon finance, did not know where to start the process and what was required. To meet carbon markets requirements, they had to look for consultants to help out in this processes. However, as confirmed by Carbon Africa (2016), these consultants are not available. And when they are, the cost of hiring them is prohibitive for small scale project developers. Gillenwater (2008) report that competent verifiers for CDM carbon credits are severally lacking and that the requirements of competence for verifiers need to be more refined.

This study finds that regulations on development of renewable energy technologies are well developed in Kenya, as RE developers did not find regulatory impediments in their developments. This is contrary to Sena (2015), who report that corruption and other regulatory problems make it hard for developers to acquire necessary permits to start their projects. Allam and Nwankwo (2014) report that this unpredictable investment climate in Africa includes problems relating to the taxation regimes, interest rate fluctuations and lack of support of foreign direct investments, all of which make the environment of doing business difficult. Rugabera et al. (2013) also show that these challenges, such as lack of capacity in some African public sector institutions and weak regional coordination, discourage renewable energy investment through the use of carbon finance. Other studies also show that many African countries do not have sovereign credit ratings, which are important for boosting investor confidence (Sanni et al., 2014).

7.6 Challenges of Investing in Renewable Energy in Kenya

According to IEA (2015), Kenya ranks as number 22 in Africa in terms of energy generation. However, Mohammed et al. (2013) report that many renewable energy projects in the country are never taken to completion, with the result that the country's power capacity is way below its potential. One of the objectives of this study was to find out the challenges of renewable investing in Kenya, as an explanation of why so much of the country's potential is untapped.

The findings show that the main risk faced by project developers is that of access to finance, in agreement with Fortune and Collins (2014) who report that access to finance is a major obstacle for renewable energy development in Africa. It was observed from the findings that financiers are afraid that they may not recoup their investments if the project is not successful. Collier and Venables (2012) also find that many projects are never completed for lack of finance while Devinney et al. (2016) find that banks in developing countries are unwilling to lend to clean energy ventures because of lack of collateral and cash flow uncertainty. The study also finds that many renewable energy developers are not aware of carbon revenues, and where they are, the processes of acquiring them are not clear to them. This is in line with African Progress Panel (2015) that reports that many renewable developers in Africa, especially small scale projects, have little knowledge on the availability of carbon revenue.

This study finds that project developers also encountered technical risks in their projects, especially the dependence of the project's operations on the weather. This challenge is seen for many hydro projects, which are highly vulnerable to fluctuations in water levels. Showers (2016) also reports that, in line with the study findings, most types of renewable technologies in Africa face the problem of inadequate data, effects of climate change ad a limited local capacity to manufacture most of the projects' components

Showers (2016) stresses that to electrify Africa, the dissemination of technology is a necessary condition. In most types of renewable technologies, Africa faces the problem of inadequate data, effects of climate change and a limited local capacity to manufacture most of the projects' components. The study finds that cost of renewable energy technologies, though on average have come down across the world, are still high in Kenya. It also finds that the technological capacity to develop these projects is lacking, in line with Barry et al. (2011) who report low levels of know-how and capacity to implement RE technologies in Africa.

The regulatory framework is observed to be not a strong risk in Kenya. Project developers find that the government has put in place an enabling regulatory framework to spur renewable energy investments. The FiT scheme and the Power Purchase Agreement were cited as the main examples of the enabling regulations, which allow developers to sell all the generated power to the government. This finding is against Rugabera et al. (2013), who find that most energy regulatory regimes in Africa are composed of conflicting laws and are often bureaucratic. However, the study also finds that regulations surrounding independent power producers are not well developed. The study also finds adoption of policy options to improve power production from renewable energy sources. Oji et al. (2016) also find that many African countries lack the capacity to implement many policy options for energy investments.

Kenyan project developers also face the problem of public acceptance issues against the projects. This aspect of political risk is highly pronounced for investments in renewable energy projects, such as hydro projects, that involve displacement of communities and compensation problems. Patel (2006) find that many large scale projects also face the problem of political interference such as approval licenses. Bryan et al. (2013) also find political risks increasingly being connected to the regulatory regimes, and the level of transparency in the ruling governments, which he finds to be a concern in most African countries.

7.7 Opinions of Carbon Business Stakeholders on Carbon Finance Uptake

To further comprehend the role of carbon finance in the development of renewables, the study sought the opinions of leading carbon business stakeholders in the Kenyan market. The stakeholders were picked from organizations, both governmental and non-governmental, who has a broad knowledge of the carbon sector, either as regulators, carbon buyers or supporters of low carbon activities. They agree that there is paucity in knowledge and understanding on the concepts of carbon finance, which probably has led to lower levels of uptake. The finding is consistent with findings from other developing countries, such as China (Lewis, 2010) and India (Chaurey & Kandpal, 2009). Some of the reasons they provide for such low uptake include the complexity of the process of accessing carbon finance, with its ever evolving rules and regulations, making it difficult for developers, especially for small scale energy projects, to fully comprehend the processes leading to its access. This perception is similar to Abdullaha and Jeanty (2011) who find that despite the huge renewable potential in most African countries, the use of climate finance is limited. Bowen (2011) also finds that most developers do not understand fully the functioning of CDM because of its rigorous and bureaucratic processes.

Sena (2015) also notes that many project developers in Kenya are more interested in power sales, other than access to the carbon markets. This was confirmed by the analysis of the stakeholder opinions, who believe that most project developers are interested more in selling electricity to the government, through the FiT scheme, where they are guaranteed of their returns. The accruing carbon finance from the sale of carbon credits is a coincidental benefit. The creation of awareness by the government to the carbon developers on the availability and the procedures of acquiring carbon finance are seen by the stakeholders to be another hindrance. Pfeifer and Stiles (2009) also report that many African governments do not disseminate information on these carbon markets to would be developers, and this contributes to low uptake of these finances. The tedious processes and bureaucracies of accessing climate finance are also seen as a major contributor to the low uptake. Moreover, the stakeholders also find that the capacity to meet the requirements, in terms of verifiers, in agreement with Bond et al. (2012), is severely lacking.

The carbon business stakeholders were in agreement that there are no sufficient incentives to promote carbon finance access for carbon developers in the country. Although many of them see the DNA office at NEMA as providing all the necessary support in terms of clear rules, procedures and efficiency in processes, they also find that developers do not get any financial help, to complete their projects to the point that they can access climate finance. Further, they find that help on meeting the stringent conditions for CDM is not usually forthcoming. Porras et al. (2015) finds these conditions very demanding for African countries, and suggest that countries like Kenya should demand changes to current carbon financing under the CDM if they are to benefit from any emerging scheme. The majority of the stakeholders agree that Kenya needs to do more to improve the uptake of carbon finance among developers, as the current framework isn't conducive to the growth of carbon markets. They suggest that a carbon tax and tax breaks for developers could go a long way to improve the uptake. This is backed by Lambe et al. (2015) who report that generally, there a relatively good capacity in carbon project development and transaction management in Kenya's private sector, which should be extended to the public sector as well.

The stakeholders were evenly split on their opinions on the future potential of carbon markets in Kenya. While some see the abundance of renewable energy resources as an avenue for the country's ability to succeed in the international carbon markets, others cite the lack of awareness by investors and the perennial problems in the global carbon markets to predict gloom for the country's future potential. However, like Kiplagat (2011) and Maina (2010), there is no doubt that renewable energy potential could contribute to more access. Moreover, Carbon Africa (2015) reports that project developers in Kenya are increasingly using CDM as a preferred approach especially in the distributed household energy efficiency and renewable energy sectors as evidenced by over 11 projects registered between 2011 and 2015. But Deichman et al. (2010) report that this potential is barely exploited and that it would need billions of dollars' worth of investments to tap these resources. NEMA (2015) also find that the ability to exploit these resources is affected by the lack of baking products for renewable energy and non-access to the UNFCCC (2013) loan facility for developing countries, which only 10 per cent of the projects were able to access by 2015.

7.8 Summary of the Chapter

The discussion of findings provides an interpretation of the research findings, in light of the literature reviewed on carbon finance. It also highlights the contextual problems of the understanding of carbon finance in Kenya, as shown by deficiency of knowledge on carbon finance processes. This chapter also references previous research on carbon finance, and compares the results with findings from other studies. A review of these previous studies shows a paucity of literature on carbon finance research from a Kenyan context, which makes comparison of the findings very difficult. However, studies from the rest of the world show that carbon finance has been beneficial to renewables developers, across Europe and Australasia. It follows from the results that the levels of awareness from developers on carbon finance are low, thus more awareness need to be created if the country is to gain from financial flows meant to help in emission reductions. Moreover, the framework for renewables development needs made more robust and less bureaucratic, to make it easier for developers to accrue carbon finance.

CHAPTER EIGHT

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

8.1 Introduction

The broad objective of this study was to analyze the relationship between carbon finance and the development of renewable energy projects in Kenya. This chapter presents a summary of the findings, the conclusions and recommendations of the study. The chapter is arranged as follows; first, a summary of the research approach and objectives is presented, followed by a summary of the research findings in sections 8.2, 8.3 and 8.4 respectively. Then the conclusions based on the findings for each objective are presented in section 8.5, followed by the theoretical, practical and policy implications of the research in section 8.6. Section 8.7 presents the study's contribution to knowledge while section 8.8 presents the limitations of the study. Finally, section 8.9 makes suggestions for further research, based on the findings of the study.

8.2 Summary of Research Objectives, Research Methods and Study Findings

8.2.1 Summary of Research Objectives

The broad objective of the study was to establish the relationship between carbon finance uptake and renewable energy deployment in the context of a low and middle income country, Kenya. The aim was to establish the role of international carbon finance in the financial structure of renewable energy projects in the setting of a low and middle income country. To achieve the broad objective of the research, several specific objectives were derived as listed below;

The specific objectives are as follows;

(i) To examine the understanding of carbon finance among renewable energy developers in Kenya.

(ii) To determine the level of the uptake of carbon finance among organizations producing renewable energy in Kenya

(iii) To establish the determinants of the uptake of carbon finance among renewable energy developers in Kenya

(iv) To establish the challenges of investing in renewable energy projects in Kenya.

8.2.2 Summary of the Research Approach

The study employed several methods to meet the specific objectives of the research. A population comprising of renewable energy developers and other carbon business stakeholders was sought as respondents and the following methods were used in analyzing the data obtained;

i) Quantitative analysis comprising of descriptive statistics was used to analyze the responses on the understanding of the various concepts of carbon finance among the developers in Kenya. To examine the understanding of carbon finance among renewable energy developers in Kenya.

ii) Quantitative analysis comprising of a binomial logit regression analysis and hypothesis testing was used to analyze the determinants of the uptake of carbon finance among renewable energy developers

iii) Quantitative analysis comprising of factor analysis was used to determine the main challenges affecting renewable energy developers in Kenya.

iv) Qualitative content analysis was used to analyze text data collected on the opinions of the various carbon business stakeholders on the uptake of carbon finance in renewable energy projects in Kenya.

8.3 Summary of Research Findings

The broad objective of this study was to analyze the uptake of carbon finance, and the determinants of this uptake among renewable energy developers in Kenya. This section summarizes the findings of the study as below.

8.3.1 Meaning of Carbon Finance and its Uptake by Renewable Energy Developers

The first objective of the study was to establish the understanding of carbon finance and its meaning as a concept among the renewable energy developers. The findings reveal low levels of knowledge on the elements of carbon finance, such as carbon credits, carbon trading, carbon funds and carbon offset standards. The findings further demonstrate low levels of awareness on the CDM and voluntary carbon market methodologies among the developers. These findings carry important implications for the uptake of carbon finance, and could be the cause of the low levels of carbon finance uptake that has was demonstrated by the empirical findings.

8.3.2 Carbon Finance Uptake by Renewable Energy Developers

Objective two of the study sought to address the uptake of carbon finance among renewable energy developers and the reasons for the reported uptake. The findings reveal that many renewable energy project developers had not used carbon finance in their project implementations. While a sizeable number of project developers have had access to carbon finance, the data received demonstrates these amounts to be insignificant compared to project costs. Further, the study finds that only four Kenyan projects have sold carbon credits, implying low levels of uptake of carbon finance from the compliance market. The findings also show low levels of financial support for renewable energy projects from carbon funds outside of the regulatory markets. The low levels of carbon finance uptake are explained by high cost of carbon finance acquisition procedures, which makes it prohibitive for project developers to pursue these finance. The demonstrated problem of awareness as well as lack of consultants to help meet the market requirements are also to blame.

There is consensus among developers that carbon finance is any amount of finance or financial support received from either governmental, non-governmental or corporations that are used towards promoting the reduction of greenhouse gases. However, the study finds that there is no sufficient understanding of the processes and procedures required to obtain these funding, as a result of which, the uptake is low. The demonstrated low levels of uptake are interesting, because empirical evidence suggest Kenya has huge renewable energy resources, which could translate into higher uptake if properly harnessed.

8.3.3 Determinants of Carbon Finance Uptake among Renewable Energy Developers

The third objective of the study was to establish the determinants of carbon finance uptake among renewable energy developers in Kenya. Findings reveal that the size of the renewable energy project, the level of low carbon technology deployed in a project and the carbon market inclination of a project are important considerations in access to carbon finance. The findings on size of the renewable energy project show that investors strive to implement large projects, because of their benefits such as economies of scale, the lower transaction costs and their relatively higher carbon emission reductions.

The level of low carbon technology employed is also an important consideration in that more advanced technologies have been proven to reduce more emissions, making them more attractive to developers. However, they have been shown to come at a higher cost, relative to the conventionally available technologies. For many project developers in the Kenyan market, technology is a prohibiting factor because new technologies have been shown to be more expensive. For instance, many small scale hydro power developers rely on conventionally old technology, compared to more efficient equipment that are currently available due to costs.

The carbon market in which the credits are sold is another significant determinant. The findings demonstrate higher levels of awareness on the elements of the compliance market, as opposed to other carbon funds found in the voluntary carbon market. This explains the reason as to why many projects registered for carbon credits generation and sales are in the CDM or compliance market. However, the study reveals that developers do register their projects in both the compliance and voluntary carbon markets, in an attempt to benefit from both markets. Findings also demonstrate that prevailing carbon offset prices are not a major consideration for developers, as carbon credit sales can only be done at the point the project is operational and cannot be held until market prices improve. The important implication for these findings is that developers are made aware of the important parameters they ought to input in their developments, if the need to accrue carbon finance.

The study also sought to determine the constraints that renewable energy developer's face in the quest to access carbon finance. Several factors were found to be a hindrance to carbon funding for project developers. The rigorous crediting process that offset generation goes through, higher transaction costs and low levels of awareness are some of the factors identified. The study also found that rigorous and bureaucratic CDM requirements also brings about another constraint, lack of qualified verifiers to ascertain the value of carbon credits generated, as a result of which the carbon credits do not fetch good prices in the market. For a project to sell carbon credits in the carbon market, it has to be complete and meet the additionality principle, that the carbon emissions reduced by the project are additional and not from a business as usual scenario. The study reveals lack of technical capacity in local workers to meet the requirements for accessing carbon finance such as conducting financial appraisals, determining baselines of anthropogenic emissions, and the process of validation, verification and monitoring. Further, the study finds that project developers face the constraint of financing their projects to completion, which in turn means they cannot access the carbon credits markets. The research finds that there is no existing capital market infrastructure to raise funds such a green bonds and derivative securities for green projects in the country.

8.3.4 Challenges of Renewable Energy Investing in Kenya

The fourth objective of the study was to establish the constraints of renewable energy investments in Kenya. The objective was motivated by empirical literature showing that significant renewable energy resources remain unexploited. Project developers in Kenya also face a myriad of challenges in investing in renewables. The study identified several challenges that investors face in the quest to implement their projects.

The study reveals that project capital, to implement the project to completion is lacking for renewable energy developers in Kenya. Project based financing for renewable energy development is shown to be lacking from the mainstream commercial banks in Kenya, attributed partly to the perceived investment risks, lack of collateral and reduced financial incentives in the sector. Section 6.7.2 confirms limited sources for funding, lack of bank lending and inability of the projects to raise funds from the capital markets as some of the problems developers face with financing.

Political risks were also identified as another hindrance to project development in renewable energy. These risks are manifested in form of inadequate policy frameworks, which impede the predictability of cash flows from the project, further compounding financial risks. Public participation in project design to ensure public acceptance of the project is a case in point. Other policies which discourage renewable energy investing through carbon finance such as high levels of taxation and interest rates were also revealed.

The study also reveals that institutional challenges hinder progress in renewable energy investments in Kenya. While Kenya's renewable energy policy framework is deemed to be robust, the study reveals gaps in its implementation that need to be addressed if more energy is to be harnessed from renewables. Kenya's Investment Plan (IP) for the Scaling-Up Renewable Energy Program (SREP) and the Feed-in-Tariff were revealed by respondents as important polices for the promotion of renewable energy projects. However, their implementation and the licensing regime, requiring over 22 licenses before a project could be fully operational are a major deterrent to the sector.

There is also insufficient human capital to meet project specific need in renewable energy deployment in the country. The study reveals lack of capacity in form of skills deficiency in the country in terms of major renewable energy technologies such as wind, bagasse cogeneration, and geothermal drilling. The implication is that the country has to rely on foreign consultants to implement renewable projects, making them more expensive and difficult to complete. The study also reveals that the envisaged technology transfer under CDM has not been achieved in the country, leaving the country to rely on foreigners to help meet the carbon market requirements.

8.4 Conclusions

In view of the research findings presented in the preceding chapters, the study draws several conclusions based on the research objectives and hypotheses tested as below.

8.4.1 Meaning of Carbon Finance among Carbon Business Stakeholders

Based on the first objective, which was to establish the understanding of carbon finance or climate finance among renewable energy investors, several conclusions can be drawn. First, the study concludes that there is no sufficient understanding of the processes and procedures required to obtain carbon finance among renewable developers in the country, a result of which, the uptake is low. The low levels of awareness and understanding are attributed to the complexity of carbon finance, with evolving rules and regulations, making it difficult for developers, especially for small scale energy projects, to fully comprehend the processes leading to its access. Secondly, most developers in Kenya understand carbon finance to be any amount of finance or financial support received from either governmental, non-governmental or corporations that are used towards promoting the reduction of greenhouse gases.

The deduction in the study is that carbon finance includes all funding received or paid for carbon emission reducing activities, either traded through the market, donor funding in terms of overseas development assistance (ODA), carbon taxes levied on polluters or capital allowances for environmentally conscious investments. Prior studies have documented tax rebates or holidays, fees for use of environmental assets and ethical equity or green bonds as part of carbon finance, but the study concludes that their use and awareness levels are limited. While these definitions may not encompass the whole plethora of financial flows to address climate change, it serves to help future researchers on carbon finance to get a basis upon which they premise their data collections. The study focused mainly on carbon finance derived from sale of carbon credits in the international carbon markets, with well as any other source that purely benefitted the project because of its emission reducing abilities. The ability of many businesses and developers to differentiate between the various funds used, other than those flowing directly to compensate for emission reductions, was limited.

8.4.2 Uptake of Carbon Finance

The findings presented reveal that many renewable energy project developers do not use carbon finance in their project implementations, despite the opportunities provided by the international carbon markets. Analysis of information from both renewable energy developers and other carbon business stakeholders confirm that use of carbon finance in renewable energy development is limited, as evidence finds that only four Kenyan project have sold carbon credits. The carbon business stakeholders also opine that there are no sufficient incentives offered to renewable energy developers to enable them access carbon revenues. Based on these findings, the study concludes that uptake of carbon finance in the country is low, despite the opportunities offered by international carbon markets.

While carbon finance offers additional benefits to project developers in Kenya, the findings of this study reveal that it is rarely the reason for their developments. Descriptive statistics presented confirm that renewable energy developers in Kenya are motivated more by the desire to achieve electricity sales to the government than acquisition of carbon finance. The enthusiasm gained by project developers in the first commitment period of the Kyoto Protocol seems to have dissipated because of the uncertainty following the end of the first crediting period in 2012. Therefore, despite the renewable energy potential available in the country (section 3.4), access to carbon finance remains low. Renewable energy provides the base of the country's electricity needs as it provides over 70 percent of the electricity needs in the country. The study therefore concludes that more efforts need to be expended in helping developers accrue carbon finance, by addressing the problems of awareness and access in equal measure.

8.4.3 Determinants of Carbon Finance Uptake among Renewable Developers

Regression analysis and tests of hypotheses carried out confirm that three determinants are significant for the uptake of carbon finance; the size of the renewable energy project, the use of low-carbon technologies and the carbon market affiliation. While size was important to carbon buyers working to fulfil their cap requirements, more advanced technology was seen to improve the ability of a project to reduce more carbon emissions. Carbon offsets for the compliance market are more valuable to buyers because of the validation and verification process they go through, as compared to that of the voluntary market. The sectoral scope and the prevailing carbon offset prices were not significant, hence not supported by the tested hypotheses. Although these findings are supported by some empirical studies, they seem to contradict others as shown in section 4.2.

Based on these findings, the study concludes that to accrue carbon finance, developers should invest in large scale projects producing more electricity, use advanced low carbon technology and incline their projects to the compliance market. While these factors are more important in acquiring funding for the projects, project developers should, however, not ignore the broader carbon markets, as the amount of funding that accrues to their investments will to a large extent depend on the prevailing carbon offset prices.

8.4.4 Constraints of Carbon Finance Uptake

This research identifies several constraints that hinder access to carbon finance, even for projects that have met size and technology requirements. Lack of access to finance for large initial capital outlays required to develop projects, deficiency in human skills to meet carbon market requirements for projects and inadequate institutional support were found to hinder access to carbon finance. Policy development and implementation as regards to access to carbon finance was also found to be a problem, as demonstrated by lack of an existing policy on carbon finance in the country.

From these findings, the study concludes that access to carbon finance can be increased, if these barriers are addressed and a robust policy on carbon finance put in place. The country needs to grow human and institutional capacity to help developers with the advice and support that they need to access international carbon markets. The DNA, therefore, must put in place a mechanism to have more carbon market experts, if the country has to accrue more of these carbon revenues.

As demonstrated by empirical findings, Kenya can also take advantage of UNEP initiated activities aimed at encouraging investment in African countries, including the Africa Carbon Asset Development Initiative (ACAD), the SCAF Facility (for renewables), several forums and workshops, and publications, including a guidebook on financing CDM.

8.4.5 Challenges facing Renewable Energy Developers in Kenya

Factor analysis carried to meet objective four on the challenges facing developers, confirm several challenges facing renewable energy developers, in the quest to implement their projects. The financial constraint, also confirmed by empirical evidence was seen as a major challenge, compounded by lack of bank borrowing and inability to raise funds from the capital markets. Capital markets instruments for green investing, such as green bonds and weather derivatives, which could augur well for renewable energy developments, were found to be absent from the Kenyan capital market. Project developers also face political, technical challenges and policy challenges which reduce the completion rates and time for projects, increasing the financial risk of the project.

From these findings, the study concludes that renewable energy developers in Kenya face enormous challenges, which explains the low level of exploitation of renewable resources in the country. Creation of enabling policies by the government on the demand side of electricity, through the FiT for example, has failed to improve the conditions of the supply side. In the current situation, Kenya remains a case of the greater African problem of insufficient power amidst huge untapped power generation potential. The government and developers should take advantage of the current initiatives on the promotion of renewable energy investments, such as the Global 100% Renewable Energy Platform supported by the United Nations, coupled with declining unit costs of deploying renewables and advances in technology, to increase the country’s investments in renewables.

8.5 Research Implications

The findings of the research presented in chapter six and seven have both theoretical and practical implications.

8.5.1 Theoretical Implications of the Study

By exploring the relationship between carbon finance uptake and renewable energy development, this research brings forth several theoretical implications for field of carbon finance;

i) Creates a better understanding of the uptake of carbon finance in renewable energy deployment.

   As a new and evolving area of research, carbon finance has not been fully and effectively studied in the context of low and middle income countries (Luxmore, et al., 2013). The theoretical foundation for the field is therefore shaky, and the understanding of the interrelationships between the basic variables is limited (Wood et al., 2014). This study forms a base upon which deeper interrogation of the variables of the concept can be made, together with their causal effects with those from other disciplines.

ii) Deepens knowledge on the determinants of carbon finance and its uptake in Kenya. Other studies based in Kenya and the region have focused on CDM and its contribution to sustainable development such as Nyambura and Nhamo (2014) and Lambe et al. (2014). The study comprehensively analyzes carbon finance uptake in renewable energy, contributing to the available literature and knowledge of carbon finance. The findings from this research underscore the need for more research in the area of environmental finance in Kenya and other African countries

iii) While the study did not test any pre-existing theory, it makes inter disciplinary use of four theories (the Asset Pricing Theory, Diffusion of innovation theory, the Value-Belief-Norm theory, and the technology emission means theory) to develop an interpretive understanding of a rapidly evolving area of research, carbon finance as reviewed in chapter two.

iv) By examining the constraints of using carbon finance in renewables, as well as the challenges facing renewable investors, this study helps in the understanding and resolution of the trending problem of climate change.

8.5.2 Practical and Policy Implications of the Research

The findings of the study presented in chapter six has several implications for practitioners in the field of carbon finance.

i) Educate and market the use of carbon finance among renewable energy developers in Kenya.

This research shows that levels of awareness, among renewable energy developers, on the use of carbon finance are very low. Sufficient levels of awareness are needed to improve the level of carbon finance uptake, including encouragement of policies that lead to increased use of renewable energy in the country. The country also lacks policies to educate citizens on the woes of climate change, which would likely create the need for use of carbon finance. There is a need for the country to invest in a pragmatic and practical approach to enlighten all renewable energy developers and the general public on an issue relating to carbon finance. Research and technical assistance are also needed for accurate dissemination of knowledge on carbon issues.

ii) Design policies to promote renewable energy deployment

The research identifies multiple challenges for renewable developers in the country. Prior research suggest that renewable energy projects are important candidates for generation of carbon revenues, thus investing more in renewables will help to generate more carbon finance (Kalkbrenner & Roosen, 2016; Ganda & Ngwakwe, 2014). The research also finds little support for developers on the supply side, other than on the demand side where all generated electricity is guaranteed to be sold. It also identifies gaps in policies, which hinder the successful implementation of the projects. The implication is that proper policies should be designed and implemented, which should include incentives for technology transfer for renewable energy developers.

iii) Create capacity in local banking sectors and the capital markets to enhance the potential for obtaining carbon finance.

Bank lending for renewables and capital market instruments for renewable energy producers have been shown by this research to be lacking in Kenya. To overcome this challenge, the research finds that there is need to create an enabling environment and implement policies to enable commercial lending and issuance of capital market instruments to suit the needs of developers.

iv) Strengthen the role of Designated National Authority (DNA) and build human capacity and expertise needed to support developers meet requirements of the carbon markets.

Lack of verifiers to help meet the requirements of emission baseline setting, development and validation of carbon credits produced by developers was identified as a major constraint in accessing the carbon markets. The implication here is that there is need to develop a formal pool of national CDM experts such as local consultants, academics, and engineers from the line Ministries and from appropriate government agencies such as renewable energy agencies.

v) Develop and implement a carbon finance access strategy.

This study finds no evidence of a strategy by the government to accrue carbon revenues in the country. Moreover, the existing climate change framework does not take into account the use of carbon finance but stresses on the need for emission reduction using renewable energy. Moreover, the strategy should incorporate incentives for carbon development such as tax breaks and tax holidays. Such a strategy would equip developers with the information and knowledge they need to produce more carbon revenues. The strategy would also focus on other sectors, such as forestry and agricultural sectors, which could generate more revenues from emission reductions in the country.

8.6 Contribution to Knowledge

This study makes contributions to carbon finance research in a number of ways. From a theoretical perspective, the study uses four theories drawn from different fields as a basic framework to explain the relationship between the concept of carbon finance and renewable energy deployment. Through the Asset Pricing Theory, the main theory anchoring the study, the concept of carbon finance, primarily hinged on carbon pricing is promoted by the study findings. The Diffusion of Innovations theory, which explains how new innovations, such as carbon finance instruments are adopted in a population is applied in the study. It is confirmed by the findings that renewable energy developers in Kenya have adopted use of carbon finance, albeit at the early stages. Further, the Value-Belief-Norm theory's sustainable values and pro-environmental beliefs are shown to have taken root in the country. The other carbon stakeholders confirm that, indeed, the country is on the path to sustainability, as shown by its acceptance of international climate agreements and enactment of legislation to support the same. The confirmation of low carbon technology as a determinant of carbon finance uptake is backed by the Technology-Emissions-Means theory, which postulates that technology is vital for carbon emissions reductions. Therefore, investors that are environmental friendly are willing to pay for technology that helps reduce emissions.

While the theories reviewed in this study provide a sound basis of examining the concept of carbon finance use in renewable energy, the implication drawn is that no single theory is sufficient in the explanation of these concepts. The study extends the use of a multi-theoretical approach to study the concept of carbon finance in a context of a low and middle income country. Moreover, a combination of two or more theories has also been shown to provide a firmer foundation for interrogating the variables of a study, than a single theory alone (Jaccard & Jacoby, 2010). The study also extends the theory of carbon finance research, and the broader environmental finance theory and the sustainable development concept to a setting of a low and middle income country.

The study fills a contextual literature gap, as identified in chapter three showing most literature on carbon finance is from developed countries. Review of extant literature through chapter one and three show a gap in carbon finance literature in low and middle income countries, particularly in Africa. By establishing the determinants of carbon finance uptake in the context of such a country, as well as analyzing its uptake, the study provides a contextual basis upon which other scholars can further interrogate the relationships. By filling gaps identified in extant literature, the study provides a basis for other scholars to conduct future studies in the field of carbon finance.

By addressing objective three on determinants of carbon finance in a low and middle income country, the study advances knowledge on the uptake of carbon finance in this countries. Review of literature appear to indicate inconsistent findings and lack of consensus on the determinants of carbon finance uptake even in these developing countries (Michaelowa, 2012; Halimanjaya, 2014). On investigation, the study contributes to knowledge by confirming that the size of renewable energy project, the level of low carbon technology used in a project and the carbon market inclination are important factors in accruing carbon finance in renewable energy. While the research confirms findings by Lewis (2010), it differs on context, an aspect which this research strived to achieve. The study contributes to knowledge by providing a comprehensive basis of interrogating these variables, validating and documenting the determinants of the uptake in this context. By showing little understanding of the carbon finance concepts and low uptake, the study documents pertinent information on the use of carbon finance in the context of this countries.

This study also provides a methodological contribution, again on a contextual basis. The study uses analytical methods, specifically binomial logistic regression, factor analysis and hypothesis testing to interrogate the relationship between uptake of carbon finance and renewable energy deployment in a low and middle income country. Several other studies, such as for example Michaelowa (2014) and Villarreal-Singer et al. (2013) apply analytical methods to investigate carbon finance relationships with renewable energy, but on different settings and with differing results. The study applies the use of a binomial logistic regression technique in the context of resolving climate change and in a low and middle income country. While binomial logistic regression is a widely used technique (Apergis & Payne, 2012), its application to test the relationship between uptake of carbon finance and renewables development provides a new setting. It also experiments with the use of factor analysis in scheming factors that hinder the growth in renewable energy development in the Kenyan context.

8.7 Limitations of the study

This study examined the specific determinants of carbon finance uptake in renewable energy projects in the context of a low and middle income country, Kenya. The evolving nature of carbon finance research brings some underlying limitations, as opposed to research in a more established field of study. As such, the findings of this research should be thought through and interpreted with caution, due to the following limitations;

This research covered a particular period in time (2006-2016) when, as literature review in chapter three show, a significant change in the structure of carbon finance markets was made. The passing of the Paris Climate Accord in 2015 fundamentally alters the provisions of the Kyoto Protocol. The compliance carbon markets based on the protocol are therefore expected to change, based on the new clean development mechanism, whose structure and mode of operation is yet to be agreed. This poses the interpretive and generalizable ability of this study over time.

The study did not benefit from rigorous grounding in prior literature due to lack of previous studies on carbon finance in Kenya. Therefore, discussion on findings were not as robust, as compared to other studies where plenty of literature is available. Most of the available studies focused on CDM only (Nyambura & Nhamo, 2014; Lambe et al., 2015), and they did not provide a strong foundation for the study. Use of prior research on the subject of interest forms the basis of literature review for any study which this study did not have. Therefore, it lacked a sound basis of enhancing the understanding the research problem and making comparisons on the use of carbon finance in renewable energy in Kenya.

Data for this study was collected from a single low and middle income country, Kenya. Unlike other similar developing countries, Kenya has a huge potential for renewable energy production, which can be leveraged to accrue more carbon finance. Moreover, prior research shows that Kenya has more projects registered for CDM than many other countries in Africa, coming second only to South Africa. Therefore, generalizability of the findings of the study to other countries should be taken with caution, even though triangulation of methodology was employed to complement the exploratory and descriptive designs used.

The study relied on self-reported cross sectional data from the respondents. Efforts to collect longitudinal data was hampered by paucity of data, and may not reflect the progress of carbon finance uptake over time. This lack of longitudinal data was explained by projects developed at different points in time, and the changes in technology that necessitated change of carbon emissions computation methodologies. As such, proper interrogation of the subject was hampered by, among other things, the problem of data flow over the years since the inception of the projects.

While the study focuses on effects of carbon finance in the energy sector, studies reveal that other sectors such agriculture and forestry have also benefited from carbon finance. However, as shown in section 3.6 of this study, renewable energy projects have accrued more carbon finance than other projects because of their carbon emission reduction abilities. For this reason, the study's generalizability to other sectors in the country should be treated with caution. Increasing the number of sectors studied could have enhanced the generalizability of the findings. However, the results of this study might still be widely applicable, as they will help renewable energy developers understand what they might do to access carbon finance.

The study analyzed the determinants of the uptake of carbon finance at a project level. It did not analyze what these determinants would be at a country level, which probably would have accounted for some of the determinants or constraints at the project level. Further, it did not analyze the uptake of carbon finance at the country level, given there are many carbon emission reducing projects that are not in the renewable sector. Therefore, the findings do not reflect a whole country scenario, as they would, had all the sectors been included.

8.8 Suggestions for Further Research

This study focused on carbon finance uptake in renewable energy projects in Kenya. It identifies four overarching research areas, from the evidence presented in this report that future researchers should explore to further inform ongoing efforts within the climate change debate and use of carbon finance in Kenya as below.

The study focused only on the uptake of carbon finance in the renewable energy sector in Kenya. Although there are limitations on types of projects eligible for CDM, the land use sector holds great potential for carbon finance for Kenya, because its economy is highly dependent on agriculture. Possible extensions of the study would be an evaluation of carbon finance uptake and its contribution to other sectors important to carbon emissions reductions such as land use (primarily agriculture and forestry) and municipal waste management. Further, because carbon finance uptake has been affected by factors within and outside the country over the years, a longitudinal study of how carbon finance has progressed over the years, since the ratification of the Kyoto Protocol to the current Paris Climate Accord should also be carried out. This study also focused on carbon finance determinants at project level. An analysis of the uptake and determinants at the country level, given that Kenya is a signatory to both the Kyoto Protocol and its predecessor the Paris Climate Accord, could shed more light into the carbon finance topic in the country.

The literature reviewed and the research gaps observed in this study suggest that the determinants of carbon finance flows can be assessed at two levels; the country level and project level. This study focused only on project level determinants because of time constraints and financial requirements. The study could possibly be extended to examine country level determinants to provide more insights into carbon finance flows into the country. More studies should also be done to assess the effectiveness of carbon finance, both from bilateral and multilateral institutions, for low and middle-income countries in Africa. The study also reviewed literature and focused on renewable energy projects in Kenya. A study encompassing other countries in East Africa, such as Tanzania and Uganda, could also shed more light as to the carbon finance uptake and the challenges of renewable energy investing in the region.

To understand the challenges of renewable energy investing in Kenya, the study also focused on challenges renewable energy investors face in implementing their projects. The study can possibly be extended to include the challenges of carbon emission-reducing projects in Kenya, including those in the wider energy sector, municipal waste management and climate-smart agriculture. This could possibly give a holistic picture of how the country has fared in the international carbon markets.

The use of a binomial logistic regression technique in this study was fraught with certain short comings, such as use of only a binary variable. Although the technique is widely used in analysis, its use is limited in the subject of climate change mitigation, by regressing carbon finance uptake against certain determinants, such as in this study. To gain more understanding of the complexity of the carbon finance use in renewables and other sectors, and with the multiplicity of carbon funds that are emerging today, it is necessary to consider use of other analytical techniques in further studies.

This study also sought the opinions of carbon business stakeholders on several issues relating to carbon finance uptake in Kenya. The carbon business stakeholders included the carbon buyers present in Kenya, the carbon developers, international organizations promoting low carbon business as well as regulators. Because of a fundamental shift in the world climate governance system, by the ratification of the Paris Climate Accord, further research is needed from these stakeholders as to the possible impacts the proposed new clean development mechanism might have on the flows of carbon finance.

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Appendix i

Research questionnaire for renewable energy developers

SECTION A: BACKGROUND INFORMATION

1. Name of the organization ....(Optional)
2. Principal activity of the organization…………………………………………………
3. Name of the respondent (optional)……………………………………………………
4. Job Title/ Position of the respondent…………………………………………………
5. Please indicate your academic qualification below;

a. High school and below [ ] *b. Tertiary level [ ]*

c. Graduate [ ] *d.Masters [ ]*

e.PhD degree [ ]

6. For how many years have you worked with renewable energy projects?
   a. Less than 5 Year [ ] *b. 6 to 10 Years [ ]*
   c. 11 to 20 years [ ] *d. Over 20 years [ ]*

SECTION B: PROJECT SPECIFIC INFORMATION

1. Please indicate the location of the project……………………………………………….
2. Who is/are the project owner/s………………………………………………………………..
3. What is the commercial status of the project
   a. Commercially viable [ ] *b. commercially unviable [ ]*
4. What is the estimated project life?
   a.Below 10 years [ ]
   b.10 to 20 years [ ]
   c.Over 20 years [ ]
5. Indicate among the boxes below the type of renewable energy the project generates

   a. Geothermal [ ] *b. Solar [ ]* *c. Wind [ ]*

   d. Hydro [ ] *e.Biomass [ ]* *f.Other*

6. On a scale of 1(low) to 5(high), using a tick (√), kindly indicate the extent to which the criteria listed was used as a basis of choosing the renewable energy technology applicable to the project chosen

	Criteria	*1*	*2*	*3*	*4*	*5*
1	*Adequate resource base for the renewable energy technology*					
2	*Availability of the technology*					

3	*Cost of the Renewable energy technology*					
3	*Commercial viability and financing*					
4	*Environmental impacts and benefits*					
5	*Socio-economic impacts, including job creation;*					
6	*Adequacy of potential improve energy efficiency*					

7. For how long has the project been in operation?
   a.5 years and below [ ] *b. 5 to 10 years* [ ]
   c.10 to 15 years [ ] *d. Over 15 years* [ ]

8. Please indicate among the boxes below level of power generated by the project?
   a.Below 5 MW [ ] *b.5 to 10 MW* [ ]
   c.10 to 20MW [ ] *d. Over 20 MW* [ ]
9. For how long has the project been generating the current level of power?
   a. Last 5 years [ ] *b.Last 6 to 10 years* [ ]
   c.Last 11 to 15 years [ ] *d.Last over 15 years* [ ]
10. What is the projected power capacity the project is expected to achieve in the next 5 years?
   a.Additional 5 MW [ ] *b. 6 to 10 MW* [ ]
   c.11 to 20 MW [ ] *d. Over 20 MW* [ ]
11. What is the total amount of money in shillings invested in the project up to date?
   a.Below 10 million [ ] *b.11 to 50 million* [ ]
   c.55 to 100 Million [ ] *d.100 to 500 million* [ ]
   e. Over 500 million [ ]
12. What is the main source of the project finance?
   a. Owners equity [ ] *b. Project generated funds* [ ]
   c.External sources [ ] *d.Government* [ ]
   e.Carbon finance [ ]

SECTION C: ACCESS TO CLIMATE FINANCE

1. Which Greenhouse gases does the project reduce?

   a. Carbon dioxide (CO_2) [ ] *b. Methane (CH4)* [ ]
   c. Nitrous oxide (N_2O) [ ] *d. Ozone (O_3)* [ ]
   e. Chlorofluorocarbons (CFCs) [ ]

2. Kindly indicate the estimated emission reductions per annum Metric Tonnes of CO_2-equivalent over the life the project in the spaces below;

Year	Metric Tonnes of CO_2-e
2015	
2014	
2013	
2012	

2011	
2010	
2009	
2008	
2007	
2006	

3. What are the estimated potential CO_2 reductions that the project can achieve____
4. What is the project's baseline year?_____________________
5. Kindly indicate which of the following parameters was used in establishing the project's baseline.
   a.*Technology* [ ]
   b.Common practice within the sector [ ]
   c.Market share of the product [ ]
6. From which of the following sources did the finance to undertake the project come from?
   a. Owners equity [ ] *b. Project generated funds* [ ]
   c.External sources [ ] *d.Government* [ ]
   e.Carbon revenues [ ]
7. If the project used carbon revenues, from which carbon market are the carbon credits from the project sold?
   a. Compliance (CDM) market [ ]
   b. Voluntary Market [ ]
8. Which type of carbon credits does the project use?
   a. CDM Gold Standard [ ]
   b. VER Gold Standard [ ]
   c.Voluntary Carbon Standard [ ]
   d.Climate, Community and Biodervisty Standard [ ]

9. Which units of carbon market are applicable to your project?

a. Allocated Allowance Unit (AAU) [ ] *b. Emissions Reduction Unit (ERU)* [ ]

c.Certified Emission Reduction (CER) [ ] *d. Verified Emissions Reduction (VER)* [ ]

10. Were carbon revenues used upfront in the implementation of the project?
    a.Yes [ ]
    b. No [ ]
11. If yes, please indicate how much of the following upfront costs were incurred to start the project and how much was from carbon revenues

	Cost	**Kshs/USD**	**Carbon revenuesKshs/ USD**
1	*Development of project documentation*		
2	*Contract negotiation and writing*		
3	*Registration fees*		
4	*Internal monitoring costs*		
5	*Professional fees for all the mandatory checks(Design, validation and verification)*		
6	*Taxes and government approval*		

12. How much carbon revenue has the project generated over the years? Use the table below to fill the amount of carbon revenue received for the project;

Year	*Amount in USD*	*Source*
2015		
2014		
2013		
2012		
2011		
2010		
2009		
2008		
2007		
2006		
Total		

13. To what extent did the following project characteristics affect the carbon financing possibilities of the project? Use a scale of 1(low) to 5(High).

	Project characteristic	***1***	***2***	***3***	***4***	***5***
1	*Time taken to meet the requirements of the market and sell credits*					

2	*Technological requirements*					
3	*Size of the project*					
4	*Expected revenues from the carbon credits*					
5	*Approval process by the DNA*					
6	*Transaction costs*					
7	*Crediting period*					
8	*Lack of flexibility*					

14. In a likert scale of between 1(low) and 5(high), using a tick (√), kindly indicate the extent do the following factors affect the implementation of the project in the absence of carbon financing?

	Factors	*1*	*2*	*3*	*4*	*5*
1	*Costs of resource assessments*					
2	*Exposure to regulatory changes risks*					
3	*Cost competitiveness*					
4	*Financial cost relative to other technologies*					
5	*Operational risk compared to conventional technologies*					
6	*Uncertainties over RE resource adequacy*					
7	*Uncertainties over Carbon Financing*					
8	*High Transaction Costs*					
9	*High discount rates*					
10	*High payback period of the project*					
11	*High cost of capital affecting economic viability of the project*					
12	*Lack of access to capital*					
13	*Lack of access to credit*					
14	*High up-front capital costs*					
15	*Lack of financial institutions to support RETs,*					

16	*Highly controlled energy sector*					
19	*Restricted access to technology*					
20	*High investment requirements*					
21	*Lack of skilled personnel/training*					
22	*Missing market infrastructure*					
23	*Lack of entrepreneurs in renewable energy technologies*					
24	*Product not reliable - Market size may get affected.*					
25	*System constraints-Market cannot be realized by producers.*					
26	*Lack of standard and codes and Product quality and product certification acceptability is affected*					

15. Explain briefly how use carbon revenues changes the implementation conditions ofthe project____

16. Using a tick, (√), kindly respond to the following statements using the scale given below on the risks affecting the renewable energy project development

SA = Strongly Agree, A = Agree, NS = Not Sure, D = Disagree, SD = Strongly Disagree

	Risk	***SA***	***A***	***NS***	***D***	***SD***
1	***Regulatory risk***					
a	*Regulations surrounding independent power producers hinder project development*					
b	*Implementation of new energy efficiency regulations likely to affect project development*					
c	*Implementation of new energy efficiency regulations likely to affect project revenues*					
d	*Regulations of renewable energy and energy efficiency not well developed*					
e	*Insecure legislation in the renewable energy sector*					
2	***Technical risk***					
a	*Renewable energy technologies not developed in the new location*					
b	*Renewable energy technologies not mature for the location*					
c	*RET so much dependent on weather*					
d	*RET no reliable for integration in the national grid*					
e	*RET requires large land take*					
f	*Insufficient data for prudent analysis*					

3	***Financial risks***					
a	*Lack of financial instruments in local financial institutions to stimulate renewable energy projects*					
b	*Lack of sector know how and unwillingness to invest in renewable energy*					
c	*Lack of sufficient information for prudent financial analysis*					
d	*Fear of the financier getting their investment back should any aspect of the project fail or underperform*					
e	*Lack of funds / improper financial conditions for renewable energy such as collateral*					
f	*Lack of collateral to support start ups in renewable energy*					
g	*Difficulties in guaranteeing sufficient cash flows from the project*					
4	***Political /country risk***					
a	*Local government intervention in the Project or appropriation of profits or assets*					
b	*Government role in the process*					
c	*Public acceptance issues against the project*					
d	*Political instability and long term restrictions*					

Appendix ii

Research questionnaire for carbon business stakeholders

SECTION A: BACKGROUND INFORMATION

7. Name of the organization ....(Optional)
8. Principal activity of the organization…………………………………………………
9. Name of the respondent (optional)……………………………………………………
10. Job Title/ Position of the respondent…………………………………………………
11. Please indicate your academic qualification below;

    a. Tertiary level and below [ ]

    b. Graduate [ ]

    c. Post Graduate [ ]

12. For how many years have you been involved in carbon business in Kenya?

    a. Less than 5 Year [ ] *b. 6 to 10 Years* [ ]

    d. 11 to 20 years [ ] *d. Over 20 years* [ ]

SECTION B: CARBON FINANCE OR CLIMATE FINANCE AND RENEWABLE ENERGY

1. How is your organization involved in the carbon business in Kenya? Kindly select the most suitable way you engage in carbon business below.

	Criteria	
1	*Carbon credits buyer*	
2	*Regulator(Designated National Agency)*	
3	*Carbon credits developer*	
4	*Carbon business adviser*	

2. Among the criteria listed below, kindly highlight the one(s) that best describes your understanding of carbon finance or climate finance

	criteria	
1	*Financing channeled by national, regional and international entities for climate change mitigation and adaptation projects and programs*	
2	*Financial flows for climate change mitigation and adaptation in developing countries.*	
3	*All finances used in the reduction of green house gases*	
4	*Compensation paid by green house producers to those who clean the environment*	

3. In your opinion, do you think there is sufficient understanding of carbon finance or climate finance among Kenyan companies producing renewable energy?..

Kindly explain your answer briefly
………………………………………………………………………………………

4. Does your organization support renewable energy projects as carbon emission reduction candidates?

Yes [ ]

No [ ]

5. Using a tick (√**)**, kindly highlight way or ways in which your organization supports the initiation of renewable energy projects as candidates for carbon emission reduction.

	Criteria	
1	*Feasibility study support for renewable energy projects*	
2	*Professional advice on the requirements of CDM and other climate finance actors*	
3	*Help in project documentation, contract negotiation and writing*	
4	*Initial financial support to start the project*	
5	*Financial support during the project life*	
6	*Technological support for RE projects*	
7	*Taxes and government approval*	
8	*Carbon market support by identification of buyers*	

6. Using a tick (√), in a likert scale of between 1(low) and 5(high), kindly rate the extent to which the reasons highlighted below have contributed to **NON** use of climate finance or carbon finance by renewable energy developers in Kenya.

	Reason	***1***	***2***	***3***	***4***	***5***
1	*Lack of awareness on carbon finance availability*					
2	*Lack of information on climate finance acquiring procedures from the government*					
3	*Higher project development costs*					
4	*High transaction costs to meet carbon credits generation*					
5	*Size of project not attractive to carbon credits buyers*					
6	*Lack of sufficient finance to develop the project to required size*					
7	*Lack of financial instruments in local financial institutions to stimulate renewable energy projects*					

8	*Lack of knowledge on climate finance products from local banks*					
9	*Insufficient knowledge on project proposal development*					
10	*Private investors consider the risk for investments in renewable energies still high compared to alternative investments*					
11	*Unpredictable policies and regulatory uncertainty on renewable energy production*					
12	*Lack of consultants to help in meeting the CDM requirements*					
13	*Lack of technology to develop renewable energy projects to standard required by investors*					

7. Using a tick, (√), in likert scale of between 1(low) and 5(high), kindly rate the following statements on the risks affecting the renewable energy project development as major candidates for carbon emission reduction in Kenya.

	Risk	***1***	***2***	***3***	***4***	***5***
1	***Regulatory risk***					
a	*Regulations surrounding independent power producers hinder RE project development*					
b	*Implementation of energy efficiency regulations likely to affect project development and project revenues*					
c	*Regulations of renewable energy not well developed*					
d	*Insecure legislation in the renewable energy sector*					
2	***Technical risk***					
a	*Renewable energy technologies not developed in the project location*					
b	*Renewable energy technologies not mature for the location*					
c	*RET so much dependent on weather*					
d	*RET no reliable for integration in the national grid*					
3	***Financial risks***					
a	*Lack of financial instruments in local financial institutions to stimulate renewable energy projects*					
b	*Lack of sector know how and unwillingness to invest in renewable energy*					
c	*Fear of the financier getting their investment back should any aspect of the project fail or underperform*					
d	*Lack of collateral to support start ups in renewable energy*					
e	*Difficulties in guaranteeing sufficient cash flows from the project*					
4	***Political /country risk***					

a	*Undefined government role in the process*					
b	*Public acceptance issues against the project*					
c	*Political instability and long term restrictions*					

8. In your opinion, are there sufficient incentives form the government for carbon developers in Kenya? …………………………………………………...

Kindly give a brief explanation...

9. Kindly suggest what do you think should be done to improve the investment climate for investors in green houses gas reducing activities in Kenya…………………………………………………………………………………

10. In your own opinion, do you think there is more potential for carbon markets growth in Kenya, than has been realized?

Kindly explain your answer briefly………

Appendix iii

Renewable Energy Projects

	PROJECT	MW	PPA STATUS	PROJECT STATUS
	HYDRO POWER PROJECTS			
1.	Sondo Miriu HPP	60MW	PPA signed	Complete
2.	Sang'oro HPP	20MW	PPA signed	Complete
3.	Tana New Hydro Project 20 MW	20MW	PPA signed	Complete
4.	Imenti Hydro project	1MW	PPA signed	Complete
5.	Gikira	1MW	PPA signed	Complete
6	Unilever Tea Hydro project, Kericho,	3MW	PPA negotiations on going	Complete
7	Chania/Mataara Hydro Project	1MW	PPA signed	construction on-going
8	Gura Hydro Project, Gura Nyeri	6MW	PPA signed	construction on-going
9	North Mathi-oya- Metumi, Muranga	6MW	PPA signed	construction on-going
10	Iraru Hydro Project, Iraru	2MW	PPA signed	construction on-going
11	South Maara Hydro Project, Mara	2MW	PPA signed	construction on-going
12	Nyambunde Hydro Project	2MW	PPA signed	Under construction
13	Lower Nyamindi Hydro Project	2MW	PPA signed,	Under construction
14	Kipsonoi-Settet Hydro Project	3.6MW	PPA signed	Complete
15	Gucha Hydro Project	3.6 MW	PPA negotiations on going	Under construction
16	Chemosit/Kiptiget Hydro Project	2.4MW	PPA negotiations on going	Under construction
17	Itare river Hydro project, Kabianga	2MW	PPA signed	Under construction
18	Yurith/Chemosit Cheptuyet Hydro	3MW	PPA signed	Under construction
19	GenPro-Teremi Falls, Mt. Elgon	3MW	PPA signed	complete
20	Yala hydro project	1.5MW	PPA signed	complete
21	Rupingazi Hydro Project, Embu	5.6MW	PPA signed	Under construction
22	Mt Kenya CBO Hydro project	1.0MW	PPA signed	complete
23	Webuye Hydro Project, Webuye Falls	10MW	PPA finalized	Complete
24	Othaya Hydro project	1 MW	PPA signed	complete
	WIND POWER PROJECTS			
25	Ngong 1 - Phase III	51	PPA signed	Complete
26	Kinangop Wind Project,	30 MW	PPA finalized,	under construction
27	Kipeto Wind Farm	50 MW	PPA finalized,	Phase I complete
28	Lake Turkana Wind Project	310MW	PPA signed	Phase 1 complete

29	Corner Baridi Windfarm	51 MW	PPA finalized	Complete
30	Ol- Danyat Wind Project, Kajiado	10MW	PPA finalized,	under construction
31	Limuru Wind Power project	50	PPA negotiations on going	Under construction
32	Kajiado Wind Farm	50 MW	PPA finalized	Under construction
33	Meru Wind Power project	50MW	PPA finalized	Under construction
34	Esilanke Wind Farm, Kesirian	100MW	PPA finalized	Under construction
35	Kinangop Wind Project	30 MW	PPA finalized,	under construction
36	Kipeto Wind Farm	50 MW	PPA finalized,	under Phase I
	GEOTHERMAL POWER PLANTS			
37	Olkaria 1 – Unit 4-5	140MW	PPA signed	Complete
38	Olkaria 2	105 MW	PPA signed	Complete
39	Olkaria 3- Unit7-9	62 MW	PPA signed	Complete
40	Olkaria 4	24MW	PPA signed	Complete
41	OrPower Wellhead 4	24MW	PPA signed	Complete
42	Olkaria Wellheads (OW37, OW43, OW914-915)	55.6MW	PPA signed	Complete
43	Eburru Hill	2.5MW	PPA signed	Complete
44	Olkaria Wellheads	20MW	PPA finalized	Under construction
45	Menengai 1 – Stage 1	103MW	PPA finalized	Under construction
46	Olkaria 5	140MW	PPA negotiations on-going	Under construction
47	Olkaria 6	140MW	PPA negotiations on-going	Under construction
48	Suswa geothermal plant	150MW	PPA negotiations on-going	Under construction
49	Baringo Silali	200MW	PPA negotiations on-going	Under construction
50	Bogoria-Silali	200MW	PPA negotiations on-going	Under construction
	SOLAR POWER PROJECTS			
52	Kopere Solar Park, Kisumu	15MW	PPA signed	complete
52	Witu Solar Project, Malindi	40 MW	PPA finalized	Complete
53	Kesses Solar PV Plant in, Uasin Gishu	40 MW	PPA finalized	Under construction
54	Garissa solar park	50MW	PPA signed	Complete
55	Chemelil Solar Project, Chemelil	15MW	PPA negotiations on-going	Under construction

56	Rumuruti Solar Project	40 MW	PPA finalized	Under construction
57	Makueni Solar Project	30MW	PPA finalized	Under construction
58	Samburu PV solar power project,	40 MW	PPA finalized	Under construction
59	Kieni Solar PV project, Kieni	1.5 MW	PPA negotiations on-going	Under construction
60	Strathmore University Solar PV project, Nairobi	1MW	PPA negotiations finalized	Complete
61	George Solar Farm, Naivasha	10MW	PPA signed	Under construction
62	Cedata Solar farm, Eldoret	40MW	PPA signed	Under construction
63	UNEP Nairobi solar project	1MW,	PPA signed	Complete
	BIOMASS COGENERATION PROJECTS			
64	George farm Biogas Plant	2 MW	PPA signed	Complete
65	Rea Vipingo Biomass Plant, Kibwezi ,	1.44MW	PPA Signed	Complete
66	Mumias Bargasse Cogeneration	35 MW	PPA signed	Complete
67	Cummings Biomass, Marigat Baringo	10 MW	PPA signed	Complete
68	Ramisi BiomassCogeneration, Kwale	18 MW	PPA Signed	Complete
69	Naiorbi River Biogas Project	1		complete

Appendix iv

Carbon Business Stakeholders

	STAKEHOLDER	PRINCIPAL ACTIVITY
1	Ministry of Energy & Petroleum	Energy Regulator
2	National Environmental Management Authority	Designated National Authority
3	Hivos/SNV	Carbon developer/Advisor
4	Camco Kenya	Carbon Advisor/ clean energy advisory
5	Viability Africa	Carbon Advisor
6	ClimateCare	Carbon developer
7	Carbon Africa	Carbon developer/Carbon advisor
8	Low Carbon Development	Carbon developer/Carbon advisor
9	KfW Bank	Carbon buyer
10	Clean Air Action Corporation	Carbon buyer/Advisor
11	BEA International Developer	Carbon developers
12	Promethium Carbon Developer	Carbon developers
13	Ministry of Finance	Financial regulator
14	Ministry of Environment & Natural Resources	Environmental regulator
15	United Nations Environmental Project	Low carbon development advisor
16	African Development Bank	Clean energy advisory/development
17	World Bank	Carbon buyer/Developer
18	Kenya Climate Innovation Centre	Low carbon development advisor
19	Climate Pal	Carbon advisor
20	The Paradigm project	Carbon buyer
21	USAID Kenya	Low carbon development advisor
22	Independent Consultant	Carbon consultant
23	Kenya Association of Manufacturers	Clean energy advisory

Appendix v

Renewable energy CDM projects in Kenya

	Project	Type	Powe rMW	Date of PDD	Crediti ng period	Annual Estimated GHG reduction tCO2e	Total estimated GHG reduction tCO2e
1	Olkaria I Units 4&5 Geothermal Project	Geother mal	140	7/11/201 2	7	635,049	**4,445,343**
2	Olkaria II Geothermal Expansion Project	Geother mal	115	14/10/20 14	7	140,682	**984,772**
3	Olkaria III Phase 2	Geother mal	100	30/09/20 13	7	250,970	**1,756,789**
4	Olkaria IV Geothermal Project	Geother mal	140	7/11/201 2	7	651,349	4,559,443
5	Optimisation of Kiambere Hydro Power Project	Hydro	165	14/9/201 2	10	41,204	412,040
6	Corner Baridi Wind Farm	Wind	50	05/12/20 12	7	111,224	**778,567**
7	Kinangop Wind Park Project	Wind	60	11/01/20 12	7	121,036	847,252
8	Likoni Improved Cook Stove Project.	Biomass	6.2	23/12/20 10	7	4,924	34,470
9	"35 MW Bagasse Based Cogeneration Project	Biomass	35	13/11/ 2006	10	95,521.57	**955,215.68**
10	Kipeto Wind Energy Project	Wind	50	12/12/20 12	7	254,125	1,778,876
11	Lake Turkana Wind Power Project	Wind	310	7 /1/ 2011	7	736,615	5,156,304
12	Olkaria IV Geothermal Project	Geother mal	140	7/11/201 2	7	651,349	**4,559,443**
13	Karan Biofuel CDM project	Biomass	24	20/09/20 12	10	43,699	436,990
14	Redevelopment of Tana Hydro Power Station Project	Hydro	20	17/04/20 14	10	28,505	**285,050**

15	Nairobi River Basin Biogas Project	Biomass	33	11/06/2012	10	35,949	359,486
16	Wind Electricity Generation at Ngong Hills, Kenya.	Wind	5.1	05/05/2014	10	9,941.11	99,411.10
	Total		1392				27,449,451