DOCTOR OF PHILOSOPHY

A Choice Experiment Study of Household Investor Preferences for Renewable Energy Investments in Sub-Saharan Africa
A Case Study of Ghana

Menyeh, Bridget Okyerebea

Award date:
2020

Awarding institution:
University of Dundee

A CHOICE EXPERIMENT STUDY OF HOUSEHOLD INVESTOR PREFERENCES FOR RENEWABLE ENERGY INVESTMENTS IN SUB- SAHARAN AFRICA: A CASE STUDY OF GHANA

By

Bridget Okyerebea Menyeh

BSc Biochemistry (University of Ghana, Legon)
MSc Energy and the Environment (Lancaster University, United Kingdom)

A thesis submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy at the University of Dundee, Scotland, United Kingdom.

June 2020

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS

DCE Discrete Choice Experiment

SSA Sub-Saharan Africa

CE Citizen Energy

CRE Community Renewable Energy

IEA International Energy Agency

RE Renewable Energy

RES Renewable Energy Systems

RETs Renewable Energy Technologies

PV Photovoltaics

FIT Feed-in -tariffs

IPPs Independent Power Producers

WTP Willingness to Pay

MWTP Marginal Willingness to Pay

ASC Alternative Specific Constant

GDP Gross Domestic Profit

RPL Random Parameter Logit

MXL Mixed Logit

LCM Latent Class Model

SRI Socially Responsible Investments

ACKNOWLEDGEMENTS

This PhD journey has not been easy and I am grateful to have come this far. Foremost thanks go to the Almighty God who consistently provided for me throughout my PhD. Indeed, His strength was made perfect in my times of weakness.

Special mention goes to my enthusiastic supervisor, Dr Ariel Bergmann. My PhD has been a great experience not just for the academic support but the many lively discussions that accompanied them. Also, I appreciate the support of my second supervisor Dr David Rodley. Additionally, special thanks to Stephen Dow, who stepped in toward the end of my thesis. My profound gratitude also goes to Professor Nick Hanley for his very useful comments on my thesis.

Finally, I would like to thank my family, especially my dear husband, Dr Theophilus Acheampong, who believed and spurred me on. I appreciate my mum, Ms Joyce Nyame, for her prayers and encouragement. My special gratitude to my sweet daughter Kathryn, whose smiles and eyes made me want to finish my PhD so we could spend quality time together. Also, to my extended family, your encouragement is forever appreciated.

DECLARATION

I, Bridget Okyerebea Menyeh, the Candidate, declare that I am the sole author of this thesis, that all references cited have been consulted by me; that the work in this thesis was done by myself and that this work has not been previously accepted for a higher degree.

……………………

Bridget Okyerebea Menyeh

ABSTRACT

Inadequate access to electricity remains one of the pressing challenges in Sub-Saharan Africa. Ensuring universal access by 2030 will require additional sources of finance as current investment volumes are inadequate. Increasingly, the integral role that household investors can play is being realised and understanding the preferences of such household investors is crucial to raising the necessary investments to bridge the gap.

Using a discrete choice survey administered to Ghanaian households considered at least middle class in terms of income, this thesis sought to investigate household investor willingness to pay for the attributes associated with renewable energy investments and assess if and where preference heterogeneity exists for the attributes. A second study on financial literacy was also undertaken to guage household investor understanding of basic financial literacy concepts considering that crowdfunding for renewable energy requires investors to make their own financial investment decisions often without expert advice.

The findings show that the track record of the developer is the most valued attribute associated with the highest marginal willingness to pay for RE projects. This was followed by the project viability attribute that represents the availability of support systems deemed necessary to enhance the viability of RE projects. Interestingly, the rate of return, although valued, was not the most important in the decision-making to invest. Additionally, the findings establish the presence of heterogeneity between respondents for investment attributes. On demographics, young people (18 to 34 years) were found more likely than other counterparts to invest in renewable energy. Also, an investigation of the choice of technology showed that solar PV was the most preferred technology while wind energy is the least preferred.

Regarding the financial literacy study, the findings show that financial literacy is not lacking among the middle-class. Among the three concepts tested, it was found that risk diversification is the least understood concept, while compound interest was the easiest to score. Secondly, a gender gap in financial literacy is not found as heavily documented in the financial literacy literature.

Overall, this thesis highlights the importance of non-financial factors in the renewable energy investment decision making of household investors aside the rate of return. It also contributes to the scanty literature on financial literacy among the middle class, especially in a developing country context.

Keywords: *Financial Literacy; Renewable Energy; Middle Class; Discrete Choice; Citizen Investment; Crowdfunding*

CHAPTER 1 INTRODUCTION

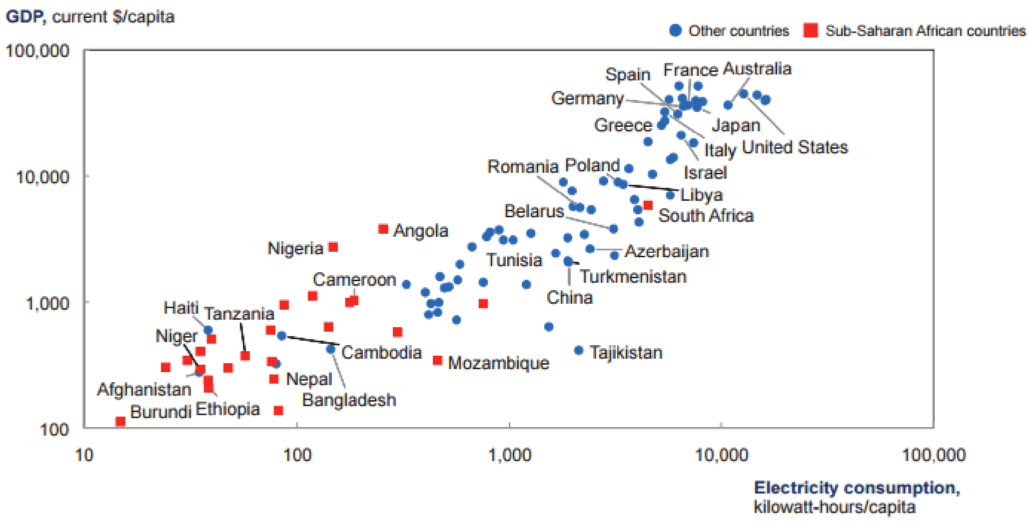
This introductory chapter sheds light on the rationale and motivation for undertaking this dissertation by providing a detailed background and statement of the problem. It proceeds to outline the research aim and specific research questions targeted at addressing existing gaps. It further describes the methodology and the contributions (that is, academic and global contributions to sustainable development goals) made by this thesis. It concludes by laying out the structure of the entire thesis.

1.1 Research Background

Adequate access to electricity is a crucial requirement for the development of any nation. There is evidence from many studies that a strong link exists between electricity consumption and development (wealth creation/GDP) (Ferguson *et al.*, 2000; Yoo, 2005; Castellano *et al.*, 2015). This is depicted in Figure 1.1, which shows a causality running from electricity consumption to economic development for some developing countries at the bottom and more prosperous developed nations at the top. Though some studies show mixed results suggesting that the nexus is sensitive to regional differences (Karanfil and Li, 2015), studies on causality in selected African countries like Ghana, Kenya, Angola, Senegal and the Gambia by Akinlo (2008), Chontanawat *et al.* (2008) and Wolde-Rufael (2009) support the energy to GDP nexus. In other words, economic growth will be impeded in the absence of the required power for growth.

The importance of a secure supply of electricity is, however, not only necessary for the economic development of people (that is, reducing poverty) but also for other areas such as education and health. The interconnectedness between these areas is embedded in the UN Sustainable Development Goals (SDGs), which recognise that strategies to reduce poverty go together with strategies to improve health, education, inequality, among others.

Figure 1.1 Relationship between Electricity Consumption and GDP



Source: Castellano *et al.* (2015, pg. 6)

As such, access and security of electricity supply is high up the agenda of many nations. The World Energy Outlook report by the International Energy Agency (2018) estimates that more than 600 million people lack access to electricity in Sub-Saharan Africa (SSA): an access rate of 43%. The report also states that many of those without access are projected to remain without electricity in 2040, alluding to the slow progress in reaching the goal of universal access. In recent years, however, an additional challenge and responsibility has arisen - the problem of climate change which has introduced environmental concerns in mainstream energy policy, necessitating a restructuring of the current energy systems (Rydin *et al.*, 2012).

1.2 Renewable Energy and Power in SSA

Renewable energy offers the opportunity to pursue future energy needs sustainably using local energy renewable energy resources. Sub-Saharan Africa has massive untapped potential of renewable energy resources that could be exploited for an affordable and secure supply of energy (Barasa *et al.*, 2018). This includes vast hydro, solar, biomass, wind and geothermal energy resources. For example, estimates seen in IRENA (2015) suggest that SSA has 1,525,977 GWh/yr of technically feasible hydro power potential.

For countries in Sub-Saharan Africa, renewable energy presents the opportunity to enhance electricity access, energy security and contribute to climate change mitigation efforts. The opportunity that this presents for the power sector has been discussed on several global and regional platforms and made its way into various national targets for countries in SSA. Many countries have expressed their commitment to exploit their renewable energy resources through their national energy plans with many setting targets to achieve the vision.[1] According to IRENA (2015), 41 out of 54 countries had introduced renewable energy targets for at least one type of renewable energy with others taking a more sector-wide approach in the crafting of targets. Often, the targets are non-binding aspirational goals to guide policy.

1.3 Statement of the Problem

Bazilian *et al.* (2011) suggest that if Africa is to achieve Universal Access by 2030, electricity generation capacity will need to grow at 13% per year. Over the last two decades, however, only a 2% annual growth is evident across the sub-region (Eberhard *et al.*, 2012). Inadequate investment or financing has been one of the major factors cited for the poor performance of the sector. Meeting these renewable targets requires an assessment of the financing need for achieving access broadly and how much is required for renewable energy expansion.

A few studies have sought to estimate the financing need for energy infrastructure in Africa. One study by Briceño-Garmendia *et al.* (2008) estimates that Africa requires financing of about US$43 billion per year. What part of this is conventional fuels or renewable energy (RE) was not precisely mentioned, and this US$43 billion includes investments in North Africa where access rates are already commendable. Similarly, Eberhard *et al.* (2011) estimate some US$40.8 billion a year for the power sector. Similar

[1] For many countries, national energy plans tie into their nationally determined targets(NDCs) towards addressing climate change at the global level.

numbers by Duarte *et al.* (2010) is also reported in an AfDB policy brief. Additionally, a report by the African Progress Panel (2015) estimates an investment need of about US$55 billion annually. More recently, IRENA (2015) estimates a cumulative investment need of US$681 billion (US$45.4 billion per year) for Africa between 2015 and 2030, which is shown in Figure 1.2.

Figure 1.2 The Cumulative Investment Need for Africa (2015 to 2030)

Region	Investment billion USD (2015 - 2030)			
	All generation	Large hydro	Other renewables	T&D
N North Africa	342	2	218	186
W West Africa	89	36	31	52
C Central Africa	32	13	17	14
E East Africa	72	36	21	49
S Southern Africa	145	18	94	74
Total	**681**	**106**	**381**	**375**

Source: IRENA (2015, pg. 40)

Specifically, several works have sought to estimate the financing gap[2] to better understand the scale of the challenge. A study by Foster and Briceno-Garmendia (2010) estimates a financing gap for the electricity sector of around US$23 billion annually. An IEA (2014) study arrives at an annual average investment need of US$22 billion for Sub-Saharan Africa, outside operational and maintenance costs. Out of the US$22 billion, they argue that about US$7.5 billion is required for oil, gas and coal investments.

Studies that estimate renewable energy investment gaps are, however, limited. One of the few is the IEA (2012) study that estimates the RE need for Africa (included in the region "The Middle East and Africa) between 2010 and 2020 at US$450 billion (US$45 billion

[2] The financing gap is defined as the financing required for adequate power that contributes to socio-economic development that is not currently being provided due to several financing constraints.

per year). This estimate is supported by an Organisation for Economic Co-operation and Development (OECD) publication by Kaminker and Stewart (2012). All these studies highlight the challenge of inadequate financing to address “electricity access” (that is, lack of grid access and reliability issues due to supply shortages) problems in many countries in Sub-Saharan Africa.

In summary, many countries in SSA have electricity access challenges that will need large investments to fix; currently, there is overwhelming evidence that financing volumes are way below what is required. If this continues, it will be hard for the region to achieve Universal access towards 2030.

Increasingly, the role of citizen/household investors in financing renewable energy projects is being realised and two issues become important in light of the evidence of inadequate financing as discussed above. These are issues around household investor (citizen investor) preferences for renewable energy investments and the financial literacy of household investors. Studying these twin issues helps to understand the preferences of household investors and what renewable energy investments they are most likely to fund as well as gauge their financial knowledge regarding basic financial literacy concepts as they may have to take these investment decisions often without expert advice.

1.4 Citizen/Household Investment in the Power Sector

The current financing sources for power sector investment as outlined by Kouassi and Pineau (2011) are

- national and regional public financing which includes governments, state-owned enterprises and regional development banks
- international donors mainly bilateral and multilateral donor organisations
- the private sector (local and international banks and other private players

These financing sources reflect the players in the century-long established traditional finance system (that is, banks, venture capital, private equity firms and family offices). The inability of these financing sources to effectively handle the financial needs of the power sector in SSA suggests the need to look at other possible innovative financing sources to complement current efforts.[3]

Citizens as financial actors in the electricity supply chain, particularly in power generation are less talked about in the low carbon transition discussion in Sub-Saharan Africa. Outside the financial benefit of citizen investment in local renewable energy sources, Curtin *et al.* (2017) assert that this is also a way to garner societal support for the energy transition.

One conjecture as to why citizens are given little prominence as financial participants may relate to poverty and saving rates across the sub-region relative to some places in the world. The different levels of electricity market reform across the region also hint at the difficulty in conceiving the possible roles of citizen investment in electricity provision. However, economic progress made in certain countries across the continent[4] and the increasing realisation of developing one's local energy resources makes it timely to consider citizen investment. More than any place in the world, the "all-hands-on-deck" approach to providing sustainable, reliable power is required.

What is Citizen Investment?

Citizen investment borrows from the concept of "energy citizenship". Energy citizenship involves the conscious effort of citizens to participate in all levels of engagement

---

[3] The inadequate financing for infrastructure projects including power projects has been well discussed in many policy documents. The dominant theme is that there are structural issues that limit project finance in Africa. For example, the African Economic Outlook by the African Development Bank(AfDB,2018) cites issues related to in-country capacity, governance, country and sector risk, procurement, counterparty risks among others.

[4] Many reports detail the rise of the middle class in Africa. See https://www.mckinsey.com/industries/retail/our-insights/the-rise-of-the-african-consumer

regarding ones' energy issues. Roberts *et al.* (2014) explain that this concept hinges on the idea that a wider consciousness among citizens can contribute toward the transition to a low carbon future. This consciousness encompasses citizen participation in the production and management of the energy they use sometimes termed "prosumer" or "community energy". This could go further into citizens' participation in the owning and management of distribution grids as well as energy service companies (dependent on the degree to which the regulation within countries permit).

The existence of citizen power plants is traced to the 1990s, witnessing more significant growth over the last decade due to increased environmental attention and climate change globally. The most significant growth of the citizen power movement has been in Europe (Bauwens *et al.*, 2016; Magnani and Osti, 2016; Van Der Schoor *et al.*, 2016) with notable examples being Germany and Austria. According to Enzenberger *et al.* (2003), citizen investment in clean energy often manifests in three (3) distinct ways: private individual investors, as part of a community-owned project or as investors in a local project headed by a professional developer. Community-owned projects are by far the most dominant spurred on by many support systems nationally and in some cases, regionally.

Community-owned projects (also community energy) encompass energy production, joint procurement, distribution; some instances, conservation initiatives are incorporated (Seyfang *et al.*, 2013; Boon and Dieperink, 2014). According to Van der Schoor and Scoltens (2015), community energy projects "provide the opportunity for citizens to actively engage in the community and the local energy system". Here, household investors[5] through third-parties purchase shares in a local or nationwide renewable energy project (Walker and Devine-Wright, 2008; Aitken, 2010; Walker *et al.*, 2010; Yildiz, 2014).

[5] Household investors, retail investors and individual investors are used interchangeably in this thesis.

The scale of projects is often small scale (less than 50MW) (Yildiz, 2014). Community energy often assumes different forms depending on the governance structure, ownership, participation, local consumption and technology. Primarily, stakeholders in community energy assume the role of investors or contributors depending on the objectives of the group (Hoffman and High-Pippert, 2010; Huijben and Verbong, 2013).

Citizens, as active financial participants in the energy transition, have given a tremendous boost to climate actions efforts in many countries and come with a suite of other benefits. These include the promotion of behavioural changes in energy conservation (Hondo and Baba, 2004, 2010), directly reducing emissions and minimising the feeling of helplessness experienced by individuals or citizens (Heiskanen *et al.,* 2010). Simply, it offers an opportunity to be “energy responsible” and fosters the power to shape a critical aspect of the economy and the ecosystem.

Other benefits include stimulating the local economy due to local generation of income, contributing to a better understanding of climate and energy issues and creating niches that can be leveraged for future projects in other areas (Bergman and Eyre, 2011; Bolton and Foxon, 2015; Devine-Wright, 2014). Also, according to Schreuer (2016), citizen power plants are a tool for empowerment, giving the power to bottom-up organisations and initiatives as opposed to international corporations. At the regional level, governmental support can lay the foundation towards a local and regional market for green energy.

To access the financial benefits of citizen or household investors, understanding the projects there are most likely to fund is crucial. This will involve investigating the attributes that feed into their investor decision-making and quantifying these attributes in order to determine where the willingness to pay lies. Also, as socio-economic variables have been increasingly shown in the literature to affect the willingness to pay, investigating the influence of these variables on willingness to pay is equally important.

1.5 The Case for Financial Literacy in Investment Decision-making

Over the past few years and especially after the 2008 global financial crises, online alternative financing methods like crowdfunding has grown from what was thought of as a small niche market to almost becoming mainstream especially in Europe, Asia and the United States. Crowdfunding represents a concept where numerous people contribute money via an online internet platform to support a project. Through these little contributions, often loans, substantial funding can be obtained to finance projects. In all, consumers through the internet can apply digital technology to enhance their personal finance.

The renewable energy sector has benefitted immensely from the use of crowdfunding as a tool to enhance access to finance. Many citizen energy or community energy projects have been financed using crowdfunding. For example, the Middelgrunden Wind Turbine in Denmark utilised crowdfunding through a cooperative model to finance 50% of the project estimated at €23 million.[6] Platforms such as Mosaic and Abundance in the US and UK respectively have sourced financing for many renewable energy projects via this model.

Though crowdfunding allows investors to invest and show support to projects they care about, crowdfunding like other digital financial products[7] or services carries new risks for consumers. According to the OECD (2018), these risks can be:

---

[6] From https://www.greeneconomycoalition.org/news-analysis/people-power-denmarks-energy-cooperatives

[7] According to the G20/ INFE (2017) report, digital financial services can be defined as "financial operations using digital technology, including electronic money, mobile financial services, online financial services, i-teller and branchless banking, whether through bank or non-bank institutions".

(1) market-driven (including misuse of unfamiliar financial products to uninformed consumers, new types of fraud)

(2) regulation/supervision driven (uneven levels of protection including lack of cooperation across agencies)

(3) consumer-driven (a mismatch between increasing digitalisation in daily consumer life and financial literacy levels) and

(4) technology-driven (use of algorithms to deny access to certain services or generate inaccurate information).

Exposure to any of these risks could result in distrust for digital financial services, the exclusion for certain groups of consumers, over-indebtedness and consumer vulnerability. Further compounding this challenge is the complexity with understanding some features or risks associated with renewable energy projects (these include technology risk, development risk and pricing risk)[8] which may be absent in other conventional investments. Due to this, investors may participate in investments whose risks they do not fully understand leaving them vulnerable.

In reducing the risks mentioned above and ensuring that digital financial services like crowdfunding result in increased financial inclusion, efforts to assess and enhance digital financial literacy is underway in several countries, including the G-20.[9] Financial literacy is considered a great tool to ensure that people that have access to digital financial services are well-informed and benefit from the opportunities that exist in the digital finance space (OECD/INFE 2015).

[8] Risks include failure of technology, development risks such as issues with siting and permitting processes which can cause project delays as a well as price uncertainty with sale of electricity.

[9] The G-20 in recognition of the opportunities and challenges presented by the digital financial economy has put together a series of initiatives to enhance financial inclusion through financial education. In June 2010, at the Toronto Summit, it developed a set of nine principles to guide governments in their quest for greater financial inclusion. Amongst these is the Empowerment Principle which seeks to develop financial literacy and financial capability.

In line with promoting household investment in renewable energy, understanding the financial literacy level of target groups could help identify key core competencies that need to be developed to ensure the safe use of such services and promote inclusion. It is generally agreed that effective customer protection occurs before the investor takes the investment decision. Thus, assessing financial literacy to develop necessary measures to optimise investor behaviour and decision-making are useful additions to regulatory measures.

Additionally, knowledge of financial literacy for groups within the population ensures that consumer protection issues can be separated from knowledge and skills issues such that policy and initiatives can be useful in dealing with challenges (OECD, 2018). At the minimum, many crowdfunding platforms in certain jurisdictions are required to test investor knowledge on basic finance principles like compound interest, risk diversification and inflation.

1.6 Existing Literature and Research Gap

Investors have received considerable attention in academic literature due to their importance in driving the global low carbon transition. For large renewable energy projects, considerable attention is given to utilities and institutional investors. For example, Kaminker and Stewart (2012) examine the limited role of institutional investors in clean energy, looking at the problems and risks they face. Also, Bürer and Wüstenhagen (2009) examine renewable energy policies that mainly venture capitalists find more favourable for investment in Europe. Helms *et al.* (2015) examine the differences in preferences by utilities and institutional investors in making renewable energy investments under the feed-in tariff scheme in Germany. In all, evidence shows that the research stream is highly skewed toward policy support measures that support investments by utilities and institutional investors in Europe.

Literature about individual (household or retail) investors is sparse, and the very few available concentrate on definitions and descriptions of how retail investors organise themselves including the contribution of such groups to overall renewable energy investment (see Walker and Devine-Wright, 2008; Yildiz, 2014). In looking at organisations, community energy and energy cooperatives remain favourites with a particular focus on their governance, size, return on investment and technology preferences (see Schreuer & Weismeier-Sammer, 2010; Yildiz, 2014; Yildiz *et al.*, 2015 and DGRV, 2016).

Some other studies have delved into the motivations as well as barriers to community energy projects (Rogers *et al.*, 2008; Walker, 2008; Bomberg and McEwen, 2012; Bauwens, 2016; Kalkbrenner and Roosen, 2016). A more recent study by Salm *et al.* (2016) takes it a step further to assess retail investor risk and return preferences to unearth expectations towards renewable energy investments in Germany. More needs to be done in bridging the knowledge gap regarding retail investors as this contributes to the entire understanding of investors within the renewable energy investment landscape. In agreement with Bergek *et al.* (2013), doing this will increasingly shed light on the heterogeneity of RE investors and aid policymakers design more segmented policies that support the goals of each investor class.

Another point to note is that most studies on retail investors have been conducted in European countries exposing the significant gap in the research literature about potential RE retail investors in developing countries in Sub-Saharan Africa. Justifiably, research is often stimulated by what happens in a country/region; with most European countries supporting such initiatives (that is, retail investors) by clear policy and legal frameworks; often revealed preference data is often present to conduct studies. Indeed, some studies even combine revealed and stated preferences in understanding investment choices.

Considering all that is currently being done and what more there is to learn especially in developing country contexts in Sub-Saharan Africa, this thesis thus seeks to explore the decision-making of household investors in a market where investing in renewable energy “collectively” is possible (hypothetical market) but currently limited or absent. Currently, electricity market reform in Sub-Saharan Africa that enables different levels of private financial participation and policy frameworks for promoting any form of citizen investment is limited at best. The thesis attempts to get ahead of policy and explore the feasibility and preferences of citizens investing in renewable energy power projects in a developing middle-income country context, which is Ghana.

Also, with the burgeoning nature of the use of internet for financing renewable energy, there is a knowledge gap on the financial literacy of household investors; even more so, for those in developing countries. Exploring financial literacy in this setting provides insight into the role and responsibilities of all stakeholders in reducing the risks that investors face.

1.6.1 The Ghana Case

Ghana, over the last few years, has had several power outages stemming from mainly the lack of adequate energy supply to meet energy demand for economic growth. This problem is recurrent despite the abundant renewable energy potential available for use in generating electricity. This is further complicated by the estimated 10% year-on-year demand growth brought on by rapid urbanisation and energy demand from an expanding industrial base (Acheampong and Ankrah, 2014). According to Obeng-Darko (2019), installed generation capacity for grid power stood at 4,310 MW as at the end of 2017. The capacity increases to 4,398 MW if the two national solar plants are included. Excluding hydropower, the renewable energy component of the power mix stands at about 0.2%. [10]

Efforts by successive governments to develop the country's renewable energy resources can be seen in two key energy policy documents: The Strategic National Energy Plan (SNEP) 2006–2020 (Energy Commission, 2006) and the National Energy Policy (NEP) 2010 (Ministry of Energy, 2010). The former is the first policy document that details the plans of the Ghana government to exploit and utilise renewable energy for electricity production. The general idea behind the development of this policy, according to the Ghana Energy Commission (2006) is to utilise all the energy resources available to the country efficiently. Among the renewable energy sources, the commission names solar as one of the abundant energy resources worth exploring. It is in this policy document that the target for renewable energy is loosely articulated. More precisely, it states:

"*…accelerate the development and utilisation of renewable energy and energy efficiency technologies to achieve 10% penetration of national electricity by 2020" (*Energy Commission, 2006, p. 31).

The National Energy Policy (NEP, 2010) came to reaffirm the intention of the government to utilise renewable energy resources to ensure efficient use of the available resources and combat climate change.

In 2011, the Renewable Energy Act (Act 832) was enacted. This provided both the legal and regulatory framework within which the renewable energy policy goals could be achieved. Administration of the Act was primarily laid at the door of the Ghana Energy Commission. Under the Act is the Feed-in-Tariff support scheme created to guarantee

[10] Though hydro is regarded as renewable energy, the country has long had hydropower plants e.g. Akosombo hydropower. Hence, a commitment to increase renewable energy is fraught with some accounting issues. That is whether to consider the decades old hydropower plants in the commitment or target.

the sale of electricity produced from renewable energy sources (RES). The Act also details the role of transmission operators in connecting RE producers to the grid.

Currently, the 10% renewable energy target by 2020 has been moved to 2030[11] due to the very little progress made in exploiting RE resources as evidenced in the policy documents discussed. Sakah *et al.* (2017), Pueyo (2018), Obeng Darko (2019) cite several factors for the slow progress including the lack of finance or financial support from the state, unclear policy priorities of the Energy ministry, regulatory non-performance and overlaps, confusion over whether to list hydro in the target and the lack of regulatory assessment.

Towards 2030, a penetration of 9.5% renewable electricity into the generation mix is required if this target is to be met. Critical to this is the attraction of investment into the sector and the role of private investors. Though no formal framework or policy document exists for actively involving citizen groups in the power generation, the potential of citizen financing to enhance the financing of renewable energy power projects cannot be discounted. This is because countries like Ghana have a segment of population (middle class and above) who have more disposable income for investment.

Amongst the recommendations for a thorough look at the entire renewable energy landscape, a look at promoting citizen involvement in renewable energy is an option worth exploring both in Ghana and across the Sub-Saharan Africa region. Central to this, is understanding the preferences of individual investors for investing in renewable energy.

1.7 Research Aim

This thesis aims at investigating the factors (financial and non-financial) that influence household investors preferences in renewable energy power projects in Ghana. Overall,

[11] See https://www.ghanaweb.com/GhanaHomePage/business/Government-shifts-renewable-energy-target-10-percent-target-shifted-to-2030-544475 and http://ghananewsonline.com.gh/ghana-increase-renewable-energy-10-2030/

it seeks to advance the understanding of household investor preferences for renewable energy projects in a developing country context.

1.8 Research Objectives

In achieving the above-stated aim, the thesis will seek to achieve the following objectives:

1. To assess which attributes are relevant to household investor preference for renewable energy investments.
2. To determine the marginal willingness to pay of household investors in Ghana for renewable energy investment attributes.
3. To determine where heterogeneity exists, if any, in preferences for the renewable energy investment attributes.
4. To investigate the effect of demographic variables like age, education and income on the likelihood of investing in RE projects.
5. To assess the basic financial literacy of the middle class on the concepts of compound interest, risk diversification and inflation.
6. To investigate how demographic variables like gender, age, education and income affect the knowledge of these financial literacy concepts.

1.9 Research Methodology

This thesis applies both qualitative and quantitative approaches to attain its objectives. A detailed qualitative method using focus groups and expert opinion was undertaken to refine attributes necessary for understanding renewable investment decision-making in the chosen research context. More specifically, to investigate household investor preferences for renewable energy projects, a discrete choice experiment (DCE) was performed with Ghanaian urban middle-class households.

In a discrete choice experiment, respondents are asked hypothetical but realistic choice situations to ascertain their preferences or utility. The minimum criteria for inclusion were individuals deemed at least middle class by income measures to obtain responses from individuals who are likely to have more disposable income for savings and investment. Ghana, being a middle-income country (lower), has a segment of the population that falls under the poverty line and obtaining results from such people, may not be relevant for the study.

Several reasons inform the decision to utilise a discrete choice study for this thesis. Firstly, stated preference studies allow for valuation in circumstances where analysis of revealed preference is complicated due to immature markets for the good or service under study. Secondly, DCEs makes it possible to disentangle various policy framework choices and use them as attributes to gauge respondent preferences. This ensures that attributes that are relevant for informing policy are considered in strategies to address resource problems. Thirdly, DCE's provides insight into the key factors affecting the decision-making process and thus useful in forecasting demand. The suitability of DCE's in eliciting preference data in the renewable energy literature is seen in Bergmann *et al.* (2008), Ku and Yoo (2010), Scarpa and Willis (2010), Noblet *et al.* (2015), Salm (2018) among many others.

1.10 Originality and Contribution to Knowledge

Originality

To the best of my knowledge, this study will be the first of its kind to look at household investor preferences for renewable energy investments in Sub-Saharan Africa and Ghana, the case study country. The literature on investment for power projects is skewed towards foreign investments from multilateral, bilateral and private banks as domestic resource mobilisation is considered too low due to low saving rates. However, this work proceeds on the premise that middle-income countries have a segment of the population who have financial resources that can be leveraged to bridge the investment gap for renewable energy power investments.

Contribution to Knowledge

This thesis makes several contributions to knowledge. First, it fills the gap in the academic literature concerning the preferences of household investors for renewable energy investments in a developing country context. Secondly, it provides insight into possible target groups and their trade-offs regarding such investments. Thirdly, it bridges the research gap about financial literacy amongst the middle class; which is a group least studied in household literacy and finance literature. Overall, the thesis provides holistic insights for policymakers to design policies that seek to engage citizens, looking at both financial and non-financial considerations to attract the necessary investments for renewable energy.

Synergies with the Sustainable Development Goals (SDGs)

This thesis contributes to bridging the financing gap for renewable energy projects and has strong synergy effects on the SDGs on three fronts. Firstly, enhancing access to electricity or energy spurs economic growth and thus contributes to the reduction of poverty (GOAL 1). The focus on renewable energy as a source of power promotes climate mitigation efforts (Climate action) and contributes to the production of clean and affordable energy (GOAL 13 and 7). Targets in GOAL 13 includes “Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning” and engaging citizens on this front promotes climate awareness and can foster pro-environmental behaviour.

1.11 Thesis Outline

The remainder of the thesis is structured as follows: The following chapter shortly reviews the relevant literature on citizen investment in renewable energy looking at the motivations and frameworks under which they have been studied. and benefits. Chapter 3 describes the applied experimental design, including methods, attributes and levels, and the design of the choice questionnaire.

Chapter 4 describes the results of the survey and choice experiment, including utility estimates, willingness to pay measures and other findings on investor classes, technology choice, investor style, and attribute rankings. Chapter 5 discusses the nexus between financial literacy and investment decision-making and presents the results of the survey on financial literacy. Chapter 6 summarises the thesis by providing conclusions about the key research findings and limitations.

CHAPTER 2 CITIZEN RENEWABLE ENERGY INVESTMENTS LITERATURE

2.1 Introduction

This chapter aims to provide a detailed literature review on citizen investment in renewable energy. It achieves this by discussing the key themes, conceptual frameworks and trends on citizen investment in renewable energy. To properly situate the thesis, it begins with a brief discussion of the general principles that underlie the investment in renewable energy and how this varies across countries. It goes on to look at the current trends in renewable energy investments and how households contribute to such investments. It then delves into the citizen investment literature looking at the motivations, behavioural finance theories and conceptual frameworks in the academic literature used to analyse such investments.

2.2 Renewable Energy Investment: The Underlying Principles

In recent times, it is almost impossible for any nation to discuss energy without the mention of renewable energy. Renewable energy that is, “energy obtained from natural and persistent flows of energy occurring in the immediate environment” (Twidell and Weir, 2015) is considered one of the important ways to achieve the world’s energy needs sustainably with minimal damage to the environment.[12] The case for investing in renewable energy has been driven by three main principles which are briefly discussed below.

Resource Scarcity

In the last few decades, the concept of peak oil was a principal factor for the search for alternative energy sources and hence renewable energy. According to Dr Colin Campbell

[12] Renewables are more environmentally friendly but are not devoid of negative externalities.

(Association of the Study of Peak Oil), peak oil refers to the “maximum rate of production of oil in any area under consideration, recognising that it is a finite natural resource, subject to depletion” (Bradshaw, 2013). In other words, oil as a finite natural resource could be depleted and leave the various sectors that depend on it debilitated. Thus, the recommendation for mitigating peak oil was to use alternative sources of energy. The theory of peak oil has been subject to much debate splitting oil experts and researchers into two major groups: the believers and the critics. Though this principle has helped bring on and finance alternative sources of energy like renewables, it is often considered a weak principle due to improved, innovative technology ensuring that more oil is recovered; hence altering the resource situation (Donovan, 2015).

Security of Supply

Ensuring energy supply security is a significant challenge for both developed and developing countries as prolonged disruptions have massive economic implications. For the most part, extreme volatility in oil and gas markets has been the major security risk oil-importing countries must contend with. To reduce supply disruptions, one of the known avenues is to diversify the supply source or technology and increase domestic supply from local energy sources to meet future demand growth.[13] Investing in renewable energy technology (RETs) is considered a sustainable way to diversify and make the energy system less vulnerable to oil price shocks – thereby reducing energy prices.

Environmental Considerations and Climate Change

In the advocacy for greater use of renewable energy, environmental concerns, especially the adverse effects of global climate change, remain central in discussions. Climate change mitigation is a major policy goal for many nations around the world, and

[13] Increases in renewable energy must be accompanied by careful power system planning in order to deliver variable renewable energy to the grid. Grid integration of renewable energy must be done so as to not compromise system stability and reliability.

renewable energy deployment represents one of the trusted avenues to achieve targets of the Kyoto Protocol and the Paris Agreement[14]. Outside climate change or global warming, environmental concerns such as air pollution, ozone depletion, acid precipitation, emission of radioactive substances associated with energy use are well detailed in the literature.

To minimise damage to the environment and ensure “sustainable development”[15], investing in renewable energy is promoted (Dincer, 2000). By deploying renewable sources of energy, the dimensions underpinning sustainable development (derived from the Brundtland report) such as safeguarding ecological sustainability, meeting basic needs and ensuring intragenerational and intergenerational equity can be achieved (Holden *et al.*,2014). In many cases, the role of renewable energy in achieving the Sustainable Development Goals (SDGs) has been studied, for example, in Schwerhoff and Sy (2017).

In general, the World Commission on Environment and Development (WCED) definition, as seen in the Brundtland report recognises that sustainability must encompass social, environmental and economic dimensions, and this is operationalised through the triple bottom line concept by Elkington (1998). The triple bottom line is a framework that suggests that return on investment and shareholder value (economic concerns) can be pursued in the presence of environmental and social goals and is a central principle behind socially responsible investments.

[14] The Paris Agreement aims to tackle global climate change by keeping a global temperature rise in the present century to well below 2 degrees Celsius above pre-industrial levels – a limit of 1.5 degrees Celsius is most desired.

[15] Though several definitions for sustainable development exists, one of the well-known definitions is found in the 1987 Brundtland Report which defines it as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs”.

The Application of the Principles across Countries

The three principles driving renewable energy investment, as discussed above, have, however been pursued to different degrees across countries. With issues of electricity access and supply unreliability, renewable energy investment and deployment in most African countries is to help improve energy access and energy security as many countries have had to depend on expensive fossil fuel options (IRENA, 2019). For instance, the Kenyan National Energy Policy (2014:42) states that renewable energy has the potential to enhance energy security as well as "…reduce dependence on imported fuels and its attendant price volatility".

In some SSA countries, leveraging renewable energy to meet the demands of many rural communities without electricity has been another attraction for governments. This is evident in many national renewable energy policies across the Sub-Saharan African region. For example, the National Renewable Energy and Energy Efficiency Policy (NREEEP, 2015) for Nigeria emphasizes the role of renewable energy in enhancing access and improving energy security. Specifically, it underscores the opportunity that renewable energy provides in reaching "areas far-flung from the national grid".

Lastly, renewable energy investment on the environmental / climate change grounds is a principle featuring in many policy documents but arguably not a primary focus. This is explained by the fact that the Africa contributes little to global greenhouse gas emissions compared to Asia, Europe and North America (Ritchie and Roser, 2017). In spite of that, research suggests that Africa will not be spared the negative consequences and global climate change necessitating the partnership with developed countries to reduce emissions and limit global warming well below 2°C or 1.5°C.

Under the Paris Agreement, countries are required to communicate their plans for post-2020 climate actions considering their domestic circumstances and capabilities. These plans, termed Nationally determined contributions (NDCs), spell out the mitigation actions of which renewable energy deployment is a constant feature. As at April 2020, about 44 countries in Sub-Saharan Africa were listed as having submitted their NDCs excluding Angola, South Sudan, Senegal and Republic of Congo.[16]

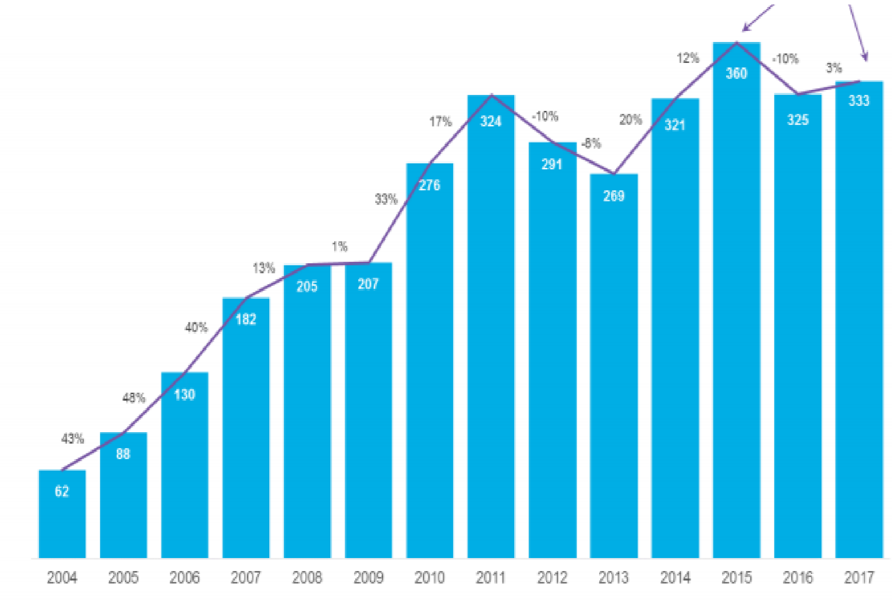
These NDCs spell out the various initiatives to reduce emissions and increase utilise renewable energy resources domestically with many detailed national renewable energy targets. Some examples include Liberia which seeks to "raise share of renewable energy to at least 30% of electricity production and 10% of overall energy consumption by 2030", Ghana which seeks to **"**scale up renewable energy penetration by 10% by 2030" and Kenya that seeks to "expand geothermal, solar and wind energy production, other renewables and clean energy options" as part of its climate mitigation efforts.

2.3 Global Investment Trends in Renewable Energy

Global investment in renewable power has been on the ascendancy though levels remain less than desired. According to Bloomberg New Energy Finance (BNEF) (2018), global annual renewable energy investment rose from 2013 reaching its peak in 2015; after a decline in 2016, a 3% increase recorded in 2017 (see Figure 2.1) bringing investments to US$333.5 billion. The decline in investment for 2016 is attributed to the lower cost of wind and solar (PV and thermal) power over the period, that is, average dollar capital expenditure per MW down and the slowdown in financing notably in China, Japan and some emerging markets (UNEP-BNEF, 2017). In terms of technology, solar and wind dominate renewable energy investments globally. Geothermal power investment has remained stable from 2013 to 2016 while biomass-fired power declined alongside large-scale hydro towards 2016.

[16] See NDC Registry at https://www4.unfccc.int/sites/NDCStaging/Pages/Home.aspx

Figure 2.1 Global clean energy investment trends



Source: Bloomberg New Energy Finance (2018, pg.4)

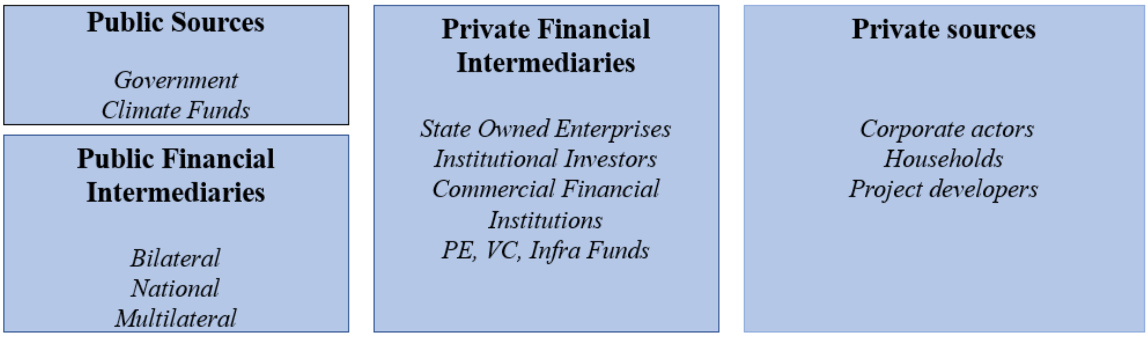
Growth in annual investments in 2017 is, however, skewed in favour of a few countries: China and the United States of America. China alone accounted for about 40% of clean energy investments in 2017 approximately US$132.6 billion, followed by the USA at US$56.9 billion. The region with the slowest growth in renewable energy investment continues to be the Middle East and Africa. For two years covering 2015 and 2016, renewable energy investment in Sub-Saharan Africa was averaged at US$4.6 billion compared with US$106.9, US$81 and US$60.6 billion for East Asia and Pacific, OECD and Western Europe. A report from the UNEP, BNEF (2017) puts investment in the region at US$7.7 billion; the lowest since 2011 and a 32% decline from 2015 levels.

What these trends indicate is that the picture is bleak, and the existing system is not working in line with the goals of achieving universal access. Hence, more will have to be done to ensure that about 600 million people without access have access by 2030. This will involve a re-examination or reinforcement of current methods as well as a careful consideration of other financing channels as has been explored in this thesis.

2.4 Renewable Energy Financing Landscape

IRENA, CPI (2018) identifies four main investor sources for the financing of renewable energy projects globally, as depicted in Figure 2.2. Contrasting public and private sources, private sources are the highest with the majority of investment remaining domestic (more than 90%). Of the three actors depicted in the private sources' category, project developers contribute the most to the category.

Figure 2.2 Investor types for renewable energy financing globally



Adapted from IRENA, CPI (2018, pg. 15)

For Africa, two primary sources have been observed over the years: Development Finance Institutions and Climate Funds and they are discussed below.

2.4.1 Development Finance Institutions (DFIs)

The World Bank and the African Development Bank are the two major DFIs in the RE financing space in Africa. Primarily, the World Bank lends directly to climate mitigation using funds such as the Climate Investment Funds (CIF) and the Strategic Climate Fund (SCF). More recently, the Carbon Partnership Facility (CPF) has come aboard. According to the World Bank, climate investments for the 2014 fiscal year increased to almost US$11.3 billion representing 220 climate projects in 60 countries. [17]

[17] See http://www.worldbank.org/en/news/feature/2014/09/09/world-bank-group-climate-lending-grows-11-billion-fy14

Secondly, on a more continental level, is the African Development Bank (AfDB) which provides an avenue for African investors to finance RE projects. Through its annual energy portfolio, it offers concessional funds and debt/equity to government and private players, respectively. The AfDB contributes to the Climate Investment Fund yearly. It also established the Sustainable Energy Fund for Africa (SEFA) – a multi-donor trust facility financed by Danish and US government. The contribution of the Danish and US governments is estimated at around US$60 million annually. The AfDB facilitates access to RE financing through the Global Environment Fund (GEF) and Green Facility for Africa (GFA) to regional countries under its coverage. It is also known to provide risk guarantee products to the private sector for renewable energy projects in Africa.

2.4.2 Bilateral and Multilateral Funds

With increased momentum to address climate change across the world, new streams of financing have emerged solely dedicated to the promotion of low carbon energy access in the sub-region. This is heavily skewed towards multilateral and bilateral funds. Multilateral financing has mainly consisted of many initiatives under the Global Environment Fund (GEF) and Climate Investment Funds (CIF) (Gujba *et al.*, 2012). The GEF uses grant financing to promote renewable energy projects that reduce greenhouse gas emissions at a small-scale. Other development agencies like the United Nations Development Project (UNDP) have been providing similar financing and are involved with about 45 African countries with GEF financing to implement projects across Africa; about 22 countries are working on access to clean and affordable energy (Arguelles *et al.*, 2018).

The GEF also manages the Least Developed Countries Fund (LDCF) and the Special Climate Change Fund (SCCF) of the United Nations Framework Convention on Climate Change (UNFCCC). Others include the Climate Investment Fund (CIF), Adaptation Fund

(AF), Seed Capital Assistance Facility (SCAF) and Global Energy Efficiency and Renewable Energy Fund (GEEREF) with the CIF administered through the World Bank and AfDB (Gujba *et al.,* 2012). Additionally, carbons markets, including CDM and the various voluntary carbon market standards, have provided financing to support mitigation and adaption measures in developing countries (World Bank, 2011).

2.5 Household Investors in Renewable Energy Financing

The increasing acceptance and deployment of renewable energies for power generation have brought a diversity of actors into the investment space (Bergek *et al.,* 2013). From Figure 2.2, IRENA-CPI (2018) identifies them as corporate actors, households and project developers (under the private sources category). Compared to studies on utilities and institutional investment, research on household investors in the renewable energy financing space has been fragmented and limited.

Majority of studies in the renewable energy investment space have been dedicated to the assessment of different financing concepts (Mills and Taylor, 1994; Derrick, 1998), financial and policy barriers to renewable energy (Painuly, 2001; Beck and Martinot, 2004; De Jager *et al.,* 2008), institutional investor characteristics and decision-making process (Moore and Wustenhagen, 2004; Wustenhagen and Teppo, 2006; Burer and Wustenhagen, 2009; Wustenhagen and Menichetti, 2012). It is not surprising to see a dearth of literature dedicated to household investors in the renewable energy financing space, considering they remain the smallest contributor relative to others.

2.6 Business Models for Citizen Participation in RE-Financing

Citizen participation in the “new energy system” can be understood broadly and more narrowly. In a broader sense, the term energy citizenship is used. Energy citizenship involves the conscious effort of citizens to participate in all levels of engagement regarding one’s energy issues. Roberts *et al.* (2014) explain that this concept hinges on the idea that a wider consciousness among citizens can contribute toward the transition of moving towards a low carbon future. This consciousness encompasses citizen participation in the production and management of the energy they use, sometimes termed “prosumer” or “community energy”. This could go further into citizens’ participation in the owning and management of distribution grids as well as energy service companies (dependent on the degree to which the regulation within countries permit).

Within the narrower sense, Yildiz (2014) explains it as a group of actors who individually or jointly invest in renewable energy projects. He further states that such actors can be private individuals, individual agricultural or legal entities excluding large corporations. Participation is mainly through equity to ensure voting or control rights. Often, about 50% of voting rights is held by citizens, and involved citizens often come from a geographically defined area.

Yildiz (2014) explains that in Germany, institutional and strategic investors are often the contributing partners to such ownership models, while local and national energy suppliers have marginal stakes. Approaches to citizen energy or community energy projects have involved two approaches: top-down and bottom-up. The former allows renewable energy projects to be co-owned by citizens, especially in large-scale projects. An example is the Middelgrunden Wind Turbine in Denmark, where citizens through a cooperative model are reported to own 50% of the project. The bottom-up approach, on the other hand, involves citizens establishing and owning renewable energy power projects. Wholly owned citizen projects are often on a smaller scale compared to the top-down approach.

Fundamentally, citizens who want to participate financially in renewable energy projects have various avenues available to them. This spans the traditional channel, where citizens maintain some ownership through equity finance and different structures involving debt and mezzanine[18] finance. Lately, the criteria of a defined geographic area, as explained by Yildiz (2014) is becoming redundant as investors in one area can invest in projects in other areas.

Thus, to crowdfund a project, the investor or citizen does not need to be in the same jurisdiction as the crowdfunding platform. However, the home bias of investors, as well as the regulatory barriers and approaches, limits crowdfunding often to a national level (Zetzsche and Preiner, 2018). With equity finance, energy cooperatives and closed-end funding models can be discussed.

2.6.1 Energy Cooperatives

The cooperative model allows for citizens to own and participate in renewable energy projects jointly. Different names exist for energy cooperatives in different jurisdictions and include renewable energy communities (Dóci *et al.*, 2015) or community solar or solar shares in the United States (Asmus, 2008). As of 2016, about 3000 renewable energy cooperatives could be identified in Europe (Huybrechts and Mertens, 2014; Capellán-Pérez *et al.*, 2018). According to the European Federation of renewable energy cooperatives (REScoop, 2018), cooperatives are often guided by the following principles: "voluntary and open membership; democratic member control; economic participation through direct ownership; autonomy and independence; education, training and information; cooperation among cooperatives and community; and concern for community".

The financing vehicle for cooperatives remains a vital part of its attractiveness as participation amounts are quite low. In Germany, for instance, the participation amount ranges from 50 to 5000 Euros per cooperative share depending on the total investment

[18] This is a hybrid of debt and equity financing. For lenders, it affords the right to convert to an equity interest in case of default or after a set timeframe elapse.

required (Yildiz, 2014) with multiples shares for smaller amounts possible. The trigger or catalyst for the development of RES Cooperatives differ across countries and range from historical effects (e.g. anti-nuclear movements), oil price shocks in the 1970s, policy responses, municipal utilities and socio-political context (Huybrechts and Mertens, 2014). Functions also tend to differ and usually centred around generation, distribution and retailing of electricity.

The opportunity for RE cooperatives also depends on the degree of electricity market reform, that is, what actors can be involved in the various stages of the electricity production chain.[19] As Capellán-Pérez *et al.* (2018) explain, ownership structure can influence the degree to which RES cooperatives can distribute electricity. In other words, RES cooperatives have been seen to thrive in environments where the electric network is publicly owned. Works by Julian (2014) and Wagner and Berlo (2015) discuss this further with the management of local distribution networks in Germany.[20]

[19] RES Cooperatives can be involved either in the purchasing, generation, distribution, retail or hybrid RE Co-ops.

[20] Germany is a useful comparator in the discussion of RES cooperatives due to its immense success in supporting the growth of cooperatives.

Figure 2.3 Electricity Structures in SSA

Source: Eberhard *et al.* (2016, pg. 33)[21]

In SSA, as of 2014, Eberhard *et al.* (2016) state that 21 out of the 48 countries were still state-owned with vertically integrated utilities. The second group of countries (also state-owned and vertically integrated) had introduced some IPPs, predominantly in generation (see Figure 2.3). The last group of countries (small section) had unbundled power generation from transmission and distribution and also incorporated IPPs. A clear example is Ghana. The second and last groups due to liberalisation in some stages in the electricity production chain may be more compatible with the institution of RES cooperatives. It is important, however, to note that opening the sector to cooperatives requires a commitment to support their establishment and operation. This includes providing grant funding, advice and a suitable policy environment (Heras-Saizarbitoria *et al.*, 2018).

[21] Note: Includes vertically integrated companies, variations of unbundling at generation, transmission and distribution as well as the presence of IPPs. G, T and D represent Generation, Transmission and Distribution. Dn represents two or more distributors.

2.6.2 Closed-end funds

Like cooperatives, closed-end funds raise equity capital from a “crowd”. Closed-end funds are mainly made up of two stakeholder groups: limited partners and a limited liability company. Limited partners are only liable to the tune of what is invested. The company, on the other hand, takes charge of the management of the business (Yildiz, 2014). Yildiz (2014) further explains that the limited company is often the project initiator and could be project developers, energy suppliers, plant producers, among others. Aside from the crowd, banks and other financial service companies can participate in RE projects via closed-end funds. The choice of investing in closed-end funds include the preference for non-participation in issues regarding management of such RE assets to the absence of full liability in case of project failure.

2.6.3 Debt Finance

Debt finance involves instruments like bonds with guaranteed returns for the investor. Providers of such schemes are local savings banks working with local energy suppliers or private banks with interest. The motivation for investing via debt finance is the saver's desire to invest in renewable energy with guaranteed returns. Sometimes, which project the fund is invested in, is unknown to the investor.

2.7 Motivations for Citizen Investment in Renewable Energy

Relevant to the discussion on citizen participation is the question of why individual citizens choose to get involved and the characteristics of these types of investors. Unsurprisingly, a few researchers have looked at these motivations especially around community renewable energy (CRE) initiatives (see Bomberg and McEwen, 2012; Bamberg *et al.*, 2015; Dóci and Vasileiadou, 2015; Kalkbrenner and Roosen, 2016; Bauwens, 2016).

Bauwens (2016) looks at these motivations in two-dimensions: the decision to join a Community Renewable Energy (CRE) initiative and the level of engagement. He argues that both types of decisions are motivated by “self-regarding motives”, the influence of society, that is, moral norms or both. Self- regarding motives support the well-known standard economic theory that individuals will only invest resources into initiatives that benefit them. In order words, they are concerned with the material pay-off.

In Sauter and Watson (2007) and Bergman and Eyre (2011), households will only look past upfront costs to renewable energy systems or microgeneration technologies if the benefits (that is, reduced electricity bills and electricity imports) outweigh the former. In many cases, efficiency gains affecting the payback period is not incentive enough to motivate investment. This informs the increasing realisation that if renewable energy projects are to compete favourably with traditional financial investments, they need to tick the profitability box in addition to their green credentials.

The second motivation being the influence of society or moral norms is increasingly supported by the literature. Findings include peer influence and the need for acceptance (Mignon and Bergek, 2016) as well as community identity and trust (Kalkbrenner and Roosen, 2016). The role of such social and peer influence for photovoltaics can be found in Bollinger and Gillingham (2012) and Noll *et al.* (2014). Thus, one can participate in community energy projects either for economic gain and social reasons (Aitken, 2010; Walker and Devine-Wright, 2008; Walker *et al.,* 2010; Yildiz, 2014). More generally and in support of the above-mentioned motivations, Lindenberg and Steg (2007) studied environmental behaviour and motivations and situated them within three-goal frames: the hedonic goal “to feel better, feel comfortable”, the gain goal “to guard and improve one’s resources”, and the normative goal “to act appropriately”. All the motivations, as mentioned above, fall under one or more of these goal frames.

Ensuring that investors in renewable energy technologies (CRE or otherwise) obtain the desired economic gain requires creating a level playing field for all power-generating technologies. The recommendation is to reduce the market distortion created by direct subsidies, tax concessions and indirect energy subsidies for fossil fuels as well as addressing negative externalities (Owen, 2006). To this end, several measures have been introduced in the policy and regulatory space to enhance the deployment of renewable energy technologies through increased investment. The next section briefly discusses these support measures.

2.8 Support Measures for Renewable Energy Deployment

Despite renewable energy's many advantages, putting up renewable energy power plants like other power plants is fraught with many risks. These risks that are, resource quality, availability and cost risks, technology risks, construction risks, planning and approval risks, environmental risks, interest rate risks, currency exchange risks, institutional and regulatory risks have been well highlighted in power plant investment literature and generally advises project developers to carefully scrutinize for these risks (Bond and Carter, 1995; Hines, 1997; Ingersoll *et al.*, 1998; Dinica, 2006; Bhattacharya & Kojima, 2012; Arnold & Yildiz, 2015).

For renewable energy-specific risks, IRENA, IEA and REN21(2018) pinpoint barriers such as cost and financing, infrastructure, market, regulatory and policy barriers, institutional as well as awareness, public acceptance and environmental barriers. As a result, many policies and mechanisms have been put in place both at the global and country levels, to mitigate these risks, especially for project developers or power generators. The support systems afforded to project developers/power generators flow to funders when the support offered positively affects the profitability of projects.

Community or citizen energy groups, in addition to having a wide range of motivations for investing (earlier captured in this chapter) also often lack business experience; in other words, they learn as they go (Dóci and Gotchev, 2016). In addition to this, they are usually more risk-averse (Enzenberger *et al.,* 2003), require more support and have lower profit expectations (Dinica,2006; Couture and Gagnon, 2010). This makes them unique as their needs are generally not fully satisfied by the general policy support instruments. Simply put, citizen energy groups may require some bespoke support systems, and often jurisdictions that seek to advance investments from these groups provide them.

2.8.1 General Renewable Energy Support Measures

Governments at the national and sub-national levels are the central players in the design and establishment of renewable energy support policies and targets. According to IRENA (2016), cities and local governments involvement continue to grow with the realisation that cities are a part of the problem and hence also its solution[22]. Utilities represent a mixed bag as some embrace the transition and many others feel threatened. Studies like Unruh (2002), Stenzel and Frenzel (2008), Collins *et al.* (2010) document the fundamental challenges utilities feel confronted with due to the current energy disruption.

Nonetheless, they remain key players, as they liaise with renewable energy providers through power purchase agreements as well as manage many distributed energy sources in the era of individual power producers or prosumers (IRENA, 2017b). The importance placed on local approaches has ushered in communities and individuals, and they continue to influence and shape policy at various levels. Finally, regulatory bodies play a key role through their ability to affect energy market reforms and exercise control on the extent of renewable energy penetration through the type of energy producers they allow

[22] Globally, cities account for about 65% of global energy and demand and hence major contributors to carbon emissions

in. Examples include the UK Office of Gas and Electricity Markets (OFGEM) decision to allow the claim of Renewable Obligation Certificates (ROCs) for all renewable energy generation (OFGEM, 2017).

Generally, a national target for renewable energy is often the primary signal to various actors and acts as the foundation upon which other policies and measures are enacted. According to the Renewable Energy Policy Framework for the 21st Century (REN21, 2017), by 2017, 150 countries had adopted renewable electricity generation targets; 126 had implemented dedicated policies and regulations. Ghana, the country of study in this thesis, has a national target of 10% renewable energy by 2030.

Initially, investments in solar PV and onshore wind were primarily driven by regulatory and pricing policies such as fixed feed-in tariffs (FITs), offered along with guaranteed access to grids and priority dispatch. As renewable technologies have matured, and their costs have fallen, large-scale power projects have been increasingly supported by auctions, which can be designed to fulfil multiple policy objectives. A summary of regulatory and non-regulatory policies to support renewable energy and enhance electricity access is given in Fig 2.4 below.

Figure 2.4 Policy Instruments to support electricity access

Technology	Regulatory and pricing policies			Non-regulatory policies	
	Legal basis	**Price/tariff regulation**	**Main-grid arrival policies**	**Financial instruments**	**Non-financial instruments**
Mini-grids	Licensing, permitting procedures	Uniform or individual	Information on time frame for grid arrival and regulations for when the grid arrives	Grants/subsidies Tax reduction Guarantees Attractive financing	Quality/technical standards Technical assistance Capacity building Market information Energy efficiency
Stand-alone	Unrestricted	Unrestricted			

Source: IRENA, IEA and REN21(2018, pg.66)

2.8.1.1 Feed-In -Tariffs/Premiums

Feed-in tariffs are policy mechanisms designed to stimulate the rapid deployment of renewable energy sources (Couture and Gagnon, 2010). Undoubtedly, feed-in tariffs (FITs) and feed-in premiums (FIPs) have played a crucial role in encouraging the deployment of renewable energy projects worldwide. They have achieved this by increasing the bankability of projects, thereby securing the income of generators. More important than having a feed-in-tariff is the need to get a price that works for the market it is designed for – often this has proven to be a challenge. If the price is set too low, there often is a strain of government budget due to the need to subsidise; setting it too high has implications for consumer tariffs. According to IRENA, IEA and REN21(2018), the challenge of getting the right price is complicated by information asymmetry where regulators and policymakers are required to make decisions with incomplete knowledge about developments in the renewable energy industry. Hence, adjustment of tariffs in light of new information (including market developments and technological advancements) is appropriate to create the right environment for all players (National Renewable Energy Laboratory, 2016a). The reasons for the effectiveness or success of feed-in-tariffs for increasing the share of renewables has been explored in numerous policy works (see Dong 2012; Jenner et al., 2013; Hoppmann et al. 2014)

One of the essential findings from such works is the perception investors have for feed-in-tariffs, that is, investors believe it to provide a lower risk compared to other support mechanisms (Menanteau *et al.*,2003; Luthi, 2010). A large section of renewable energy investment literature demonstrates how feed-in-tariffs as part of policy attributes encourage renewable energy investment. Wustenhagen and Menichetti (2012) detail the importance of the policy variable in renewable energy investment. Gamel et al.(2016) also make reference to the effectiveness of feed-in-tariffs in stimulating renewable energy investment in Germany and how its decrease resulted in decreases in RE investment.

2.8.1.2 Auctions

The potential of auctions to discover real prices has been a significant motivation for their adoption worldwide. With the increasing cost-competitiveness of renewables, mainly solar PV and onshore wind, and the need for more sophisticated deployment policies that can contribute to other objectives, countries have increasingly moved to auctions. More than 70 countries had adopted auctions by the end of 2016, and of these, 34 countries had held auctions in the year 2016 itself, more than double the previous year (REN21, 2017). Auctions have gained popularity in different contexts in recent years, owing to their flexibility of design – which means they can be tailored to the country-specific context and objectives. Moreover, in the presence of a suitable legal framework, auctions can ensure transparency and commitment.

Auctions have often been implemented in parallel with other support instruments, such as those that aim to facilitate access to finance or maximise socio-economic benefits. In Argentina and Zambia, for example, auctions have been coupled with financial guarantees backing contracts, to increase investor confidence. In South Africa, auctions have been coupled with local content requirements to support the development of the local industry. In Mexico, auctions were coupled with electricity quotas and tradeable certificate schemes, which require a stable regulatory framework and relatively advanced market. Most importantly, auctions have been increasingly adopted given their potential for real price discovery. In China, solar and wind auctions conducted in 2011 served as price-discovery mechanisms used to set the FIT in various provinces (IRENA, 2013).

It is essential to highlight, however, that auctions reflect only the degree of competition that already exists in a market — they must be designed appropriately to do even this. Moreover, they can lead to underbidding or limit the entry of small/new players in the market (IRENA and CEM, 2015). While many countries have moved from feed-in-tariff policies with administratively set support towards competitively set tariffs through auctions, some countries have chosen to implement both.

2.8.1.3 Net Metering/Net Billing

Net metering and net billing are measures employed mainly to help or compensate distributed generation (DG) owners and by so doing improve local consumption. As a self-consumption scheme, DG owners who generate electricity can use the electricity at any time instead of when it is produced. In net metering, DG owners accrue credits which can be used to offset consumption within the current (a month) or future billing cycles. Credits here are non-monetary but in kilowatt-hours (energetic terms). Net billing, on the other hand, employs a monetary credit system (IEA-PVPS, 2016). According to the Zinaman *et al.* (2017), banking of kilowatt-hours to offset future consumption is not allowed, but rather net energy exports are metered and credited using a predetermined selling rate at the time they enter the grid.

2.8.1.4 Financial and Fiscal Incentives

Financial and fiscal incentives are also used (often in parallel with regulatory and pricing policies) to improve access to capital, lower financing costs, reduce the burden of high upfront costs or the production costs of large-scale renewable energy projects, and address split incentives associated with energy-efficient technologies. They can be introduced in the form of tax incentives, rebates, grants, performance-based incentives, concessional loans and guarantees (National Renewable Energy Laboratory, 2016b).

Tax incentives

Tax incentives are typically offered in the form of reductions in sales, energy or other taxes in the form of investment tax credits, production tax credits or accelerated depreciation. The aim of tax incentives is often to ensure that profitability of renewable energy generators or developers is not eroded by taxes such as corporate income tax, VAT and custom duties (especially from the importation of certain renewable energy equipment). For funders or retail investors, these tax incentives boost the profitability of the projects and enhance the potential for the developer to pay the returns agreed. As of 2013, 31 countries, including Ghana, Cameroon, Cote d'Ivoire and Egypt, had tax incentives for renewable energy in place (KPMG, 2013).

Capital subsidies and grants

Capital subsidies can be used to help create a level playing field with conventional energy technologies and reduce upfront capital costs. They can also be used to target particular technologies, such as solar PV installations, as well as specific segments of the population.

Attractive loans

Attractive financing is crucial to attracting investments in renewable energy. Small and medium energy developers operating in the distributed energy sector, like most developing businesses, need different types of funding at different stages of the business cycle. For these developers, capital is critical to fund operations and scale up to profitability. Even where capital is generally available, it may be inaccessible to small companies in an unproven sector. Examples of government support to improve access to capital could include grants or subsidies to reduce capital costs or provide equity; grants for start-up costs such as business plans, training and market development; direct financing through concessionary loans or lines of credit for capital purchases, working capital requirements, or consumer on-lending. They can also be guarantees to encourage financial institutions to finance small and medium enterprises in the sector.

For instance, the governments of Indonesia and Mexico have created facilities and programmes to encourage the development of geothermal energy projects. The Indonesian government established the Geothermal Fund Facility in 2011 to provide financing for government projects or public-private partnerships that engage in geothermal drilling and exploration. The facility provides favourable project loans and takes an equity stake in projects selected through a bidding process (Asian Development Bank and World Bank, 2015). A summary of support policies in selected countries in Africa as of 2015 is seen in Figure. 2.5 below.

Figure 2.5 **Renewable Energy Targets and Policies for Renewable Energy in SSA Countries**

Country	Renewable energy targets	Renewable energy in INDC or NDC	Regulatory Policies							Fiscal Incentives and Public Financing				
			Feed-in tariff/premium payment	Electric utility quota obligation/RPS	Net metering/ billing	Biofuel blend obligation/mandate	Renewable heat obligation/mandate	Tradable REC	Tendering	Tax incentives	Investment or production tax credits	Reductions in sales, energy, CO2, VAT or other taxes	Energy production payment	Public investment, loans, grants, capital subsidies or rebates
Angola	E	✓				✓								✓
Botswana									✓	✓		✓		✓
Cameroon	P	✓								✓		✓		
Congo (Democratic Republic)	P													
Côte d'Ivoire	E, P	✓							✓	✓		✓		
Ethiopia	P					✓			✓					
Ghana	E, P	✓	✓	✓	✓	✓		✓		✓		✓		✓
Guinea	E, P	✓								✓		✓		
Kenya	P, HC	✓	✓		✓				✓	✓		✓	✓	✓
Lesotho	P	✓			✓				✓	✓	✓		✓	✓
Liberia	E, P, T	✓				✓				✓		✓		
Madagascar	E, P	✓							✓*	✓		✓		
Mauritius	P	✓			✓				✓	✓		✓		✓
Mozambique	P, HC	✓				✓				✓		✓		✓
Nigeria	P	✓	✓	✓					✓	✓		✓		✓
Rwanda		✓	✓						✓	✓	✓	✓		✓
Senegal	P	✓	✓	✓	✓				✓*	✓		✓		✓
South Africa	P	✓		✓		✓	✓		✓*	✓		✓		✓
Tanzania	E, P	✓	✓		✓				✓*	✓		✓	✓	✓
Zambia		✓	✓						✓*	✓		✓		✓

Notes: E - Energy (final or primary); P - Power; HC - Heating or cooling; T – Transport | ✓* Countries which held national tenders in 2018

Source: Adapted from REN 21 (2019, pgs. 66-69)

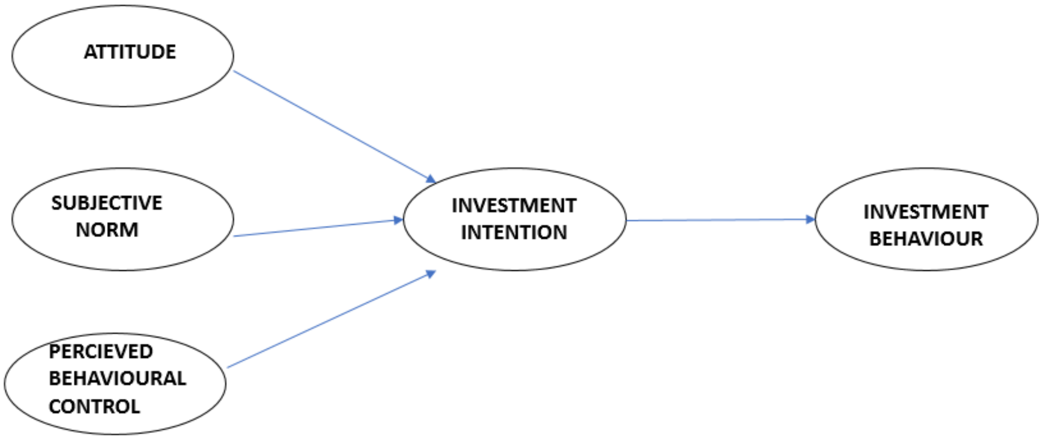
2.9 Behavioural Dimensions of Renewable Energy Investment Decision-making

Over the past decades, it has become increasingly evident that variables outside economics may drive individual investment decisions including in renewable energy. In fact, numerous studies in the field of behavioural economics and finance have done justice in establishing this link, that is, attitude and behaviour as predictors of financial decisions like investments (see Shiller, 1999; Hirshleifer, 2001; Daniel *et al.*, 2002; Barberis and Thaler, 2003; Campbell, 2006; Benartzi and Thaler, 2007; Altman, 2012).

Shefrin (2002) and Shleifer (2000) suggest that financial and investment decisions are affected by internal and external behavioural factors and contribute to the inefficiencies observed in financial markets. In other words, the decision-making behaviour of individual investors should be conceptualised as being influenced by both rational and irrational behaviour. The behaviour of individual investors has been explored by researchers, including Odean (1998, 1999), Barber and Odean (2001; 2013) amongst others.

Several theoretical frameworks have been espoused to explain the decision-making process of the investor with the two most acclaimed being the Theory of Reasoned Action (TRA) (Fishbein and Ajzen, 1975) and Theory of Planned Behaviour (TPB) (Ajzen, 1985; 1991). The TRA shows that behavioural intention is made up of the attitude which is 'an individual's positive or negative feelings about performing the target behaviour' and subjective norm which refers to 'the person's perception that most people who are important to him think he should not perform the behaviour in question'. Earlier on, the role of peer pressure and societal norms in the joining of community renewable energy initiatives is mentioned.

Figure 2.6 Theory of Planned Behaviour

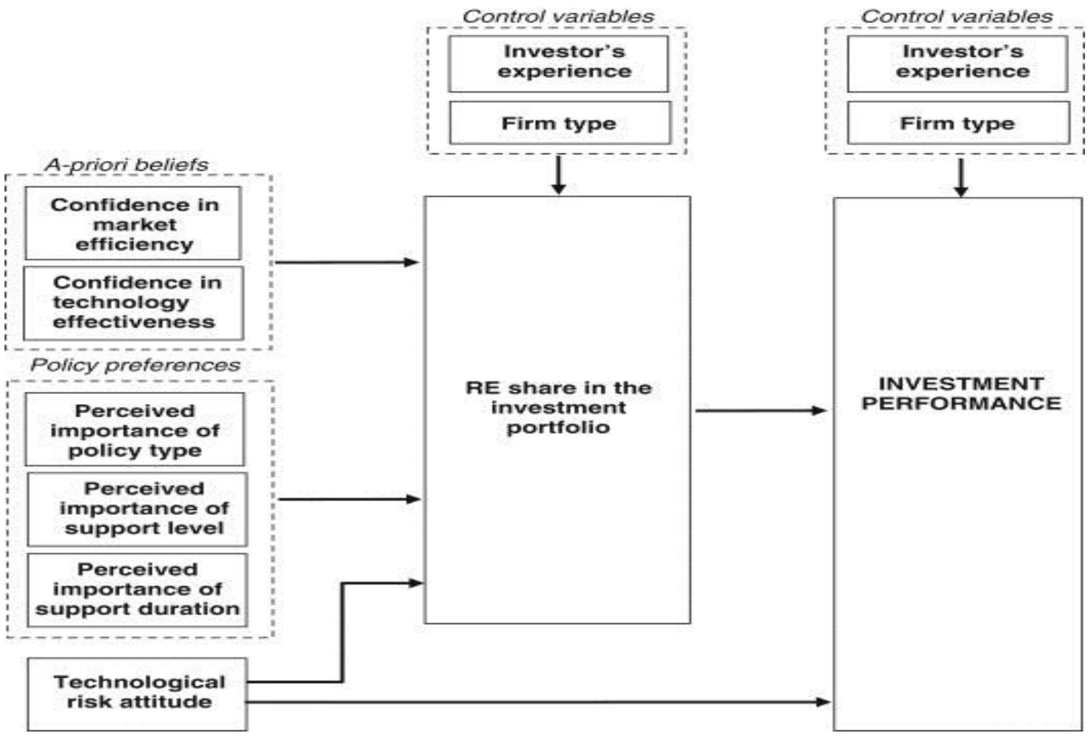


Source: Adapted from Ajzen (1991, pg.182)

Considered an extension to the TRA, the TPB (see Figure 2.6) enhances the predictive power of the TRA model by including incomplete volitional control or perceived behavioural control which is known to include past experience (Ajzen, 1991). Many studies seeking to understand environmental attitudes, for example, Gadenne *et al.* (2011) have built on these models to understand the influence of consumer beliefs on energy-saving behaviour. Others include Bang *et al.* (2000) and Read *et al.* (2013) whose work involves understanding consumer attitudes to renewable energy and predicting public opposition to wind farm developments, respectively. The theory has also been used to understand investment decisions of investors (see East, 1993; Alleyne, 2011).

Other works have sought to build on other behavioural theories to develop a conceptual model for understanding the behavioural factors that affect renewable energy investments. The conceptual model in Figure 2.7 by Masini and Menichetti (2012) employs a two-stage process in examining whether behavioural factors influence the decision to invest in renewable energy project and how the share of renewable energy in the portfolio attributable to those decisions affect portfolio performance. The conceptual model was developed through documentary analysis and expert interviews, a web-based survey questionnaire administered to European investors, followed by conjoint analysis. Here, *a priori* beliefs such as personal history, past experience in renewable energy investments and educational background are argued to influence the investment decision.

Figure 2.7 Conceptual model by Masini and Menichetti



Source: Masini and Menichetti (2012, pg.31)

Also crucial is the investor's trust in the technology considered for investment. Three policy attributes: the type of support scheme, the level of support, the duration of the support was considered most relevant after conjoint analysis. Short term policies with higher financial incentives for a limited time was strongly preferred over long-term policies with moderate levels of support though the authors admit that this could be as a result of the relatively larger representation of venture capitalists and private equity funds in the sample. Strong preference for more established technologies was also found. This is consistent with the preference of investors for technologies that are technologically developed (Murphy and Edwards, 2003; Grubb, 2004).

Another study by Wustenhagen and Menichetti (2012) also establishes a conceptual framework for the strategic choices of renewable energy investments. They outline some points that influence investor preferences for renewable energy investment, and they are as follows:

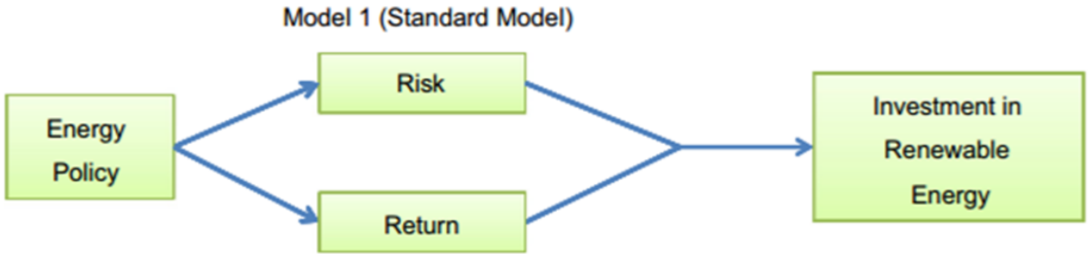
Renewable energy investment as a function of risk, return and policy

Financial theory literature has long established that sound investment decisions are influenced by the perceived risk and expected return (shown in Model 1, which is the standard model). In other words, investors will generally weigh the risks with the returns and opt for the opportunities that provide the best return for the risk they are willing to undertake. The energy policy variable is vital in renewable energy investment due to the ability of unpriced negative externalities to distort the playing field between renewables and other conventional sources.[23]

However, policies differ in their effectiveness and investors with different risk appetites or propensities will choose to invest or otherwise based on the risk they attach to policy preferences (Couture and Gagnon, 2010). This is shown in the extended model in Figure 2.9. Barradale (2010) argues that risk propensities for different investors have often influenced what ownership models are considered. Among renewable energy policies, feed-in tariffs, are considered most effective in minimising risk and enhancing return. The relationship between risk, return, and policy is shown in the basic model in Figure 2.8 below.

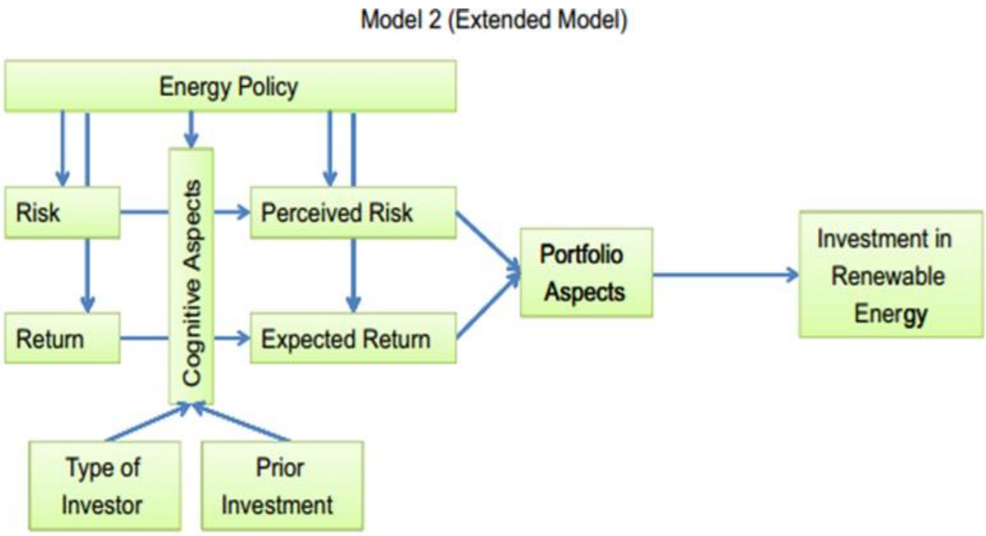
[23] Burning of conventional energy sources like fossils for energy are associated with the release of harmful gases and pollutants that affect individuals and society as a whole. These hidden costs are often not reflected in the market price despite the negative impacts to health and the environment. If these costs were priced for fossils, renewable energy will be able to compete favourably. As this is often not the case, policy is required to level the playing field between the two energy sources.

Figure 2.8 Standard conceptual model for understanding investment in renewable energy



Source: Wustenhagen and Menichetti (2012, pg. 4)

Figure 2.9 An extended model for understanding investment in renewable energy



Source: Wustenhagen and Menichetti (2012, pg. 6)

In the extended model, variables such as portfolio and cognitive aspects are introduced into the basic model. Portfolio diversification (see Markowitz, 1952) is introduced as a concept to minimise the risk associated with renewable energy projects either by incorporating renewable energy assets into other conventional portfolios or generating a portfolio of different renewable energy technologies. A portfolio optimisation study by Bhattacharya and Kojima (2012) underscores how an increase in renewable energy in Japan's electricity mix can reduce total input costs such as external volatilities of fossil fuel prices, capital costs, operating and maintenance costs and the carbon cost associated with conventional power plants.

In reality, not all individuals will have all the information regarding risks and returns as human beings act under bounded rationality (Simon, 1955) and depend on cognitive biases, e.g. such as anchoring, status-quo biases and loss aversion. These have all been shown to affect how situations are seen, perceived and processed (see Tversky and Kahneman, 1974; Kahneman, 2003), causing a deviation from what classical economic models anticipate.

The realisation that humans and specifically investors operate under bounded rationality has implications for renewable energy investment decision-making; more importantly, for policymakers. Uncertainties about policies, prices and regulations raise the risk associated with RE investment (Finon and Perez, 2007; Söderholm *et al.*, 2007). Thus, managing the expectations of investors by creating a stable policy environment is essential for continuous investment. For example, the feed-in-tariff policy in Germany and Spain saw increases in solar power investments in both countries. However, the retroactive policy action in Spain in an attempt to address higher consumer prices put a massive dent in investor confidence, and this is capable of negatively altering perceptions about renewable energy investment in the future (that is, experience regarding prior investment).

The type of investor also affects investment in renewable energy. As mentioned briefly in the first conceptual model by Masini and Menichetti (2012), different investors have a different appetite for risk and return. Over the last few years, research looking at investor heterogeneity in renewable energy have been undertaken, for example, Bergek *et al.* (2013) and Mignon and Bergek (2016). Mignon and Bergek (2016) differentiate between different RE investors: utility types, publicly owned non-energy companies, independent power producers (IPP's), Farmers, diversified companies, power project developers, sole traders and associations. They explain that the investors differ in their energy market experience, size and financial strength and internal and external investment contexts. Delmas and Montes-Sancho (2011) argue that differences in technological capabilities and profit-seeking for utilities influence the extent to which they invest in renewable energy.

Similarly, Mignon and Bergek (2016) find that different investors have different institutional demands (formal and informal). Informal demands like social interactions and expectations have resulted in solar photovoltaic adoption in several countries. On another hand, Aguilar and Cai (2010), Bollinger and Gillingham (2012), Drury *et al.* (2012) cite access to finance as well as demographic characteristics like age, gender and risk propensity as factors that influence willingness to invest.

2.9.1 Renewable Energy Investment and Demographics

The connection between renewable energy investment and investor demographics has been the subject of several studies. The literature details varying effects of demographic variables on investment attitude and behaviour with emphasis often on gender, age, education and income. Essentially, such studies aim to provide insights on the groups or persons most likely to invest in renewable energy or exhibit some kind of pro-environmental behaviour.

In the US, Aguilar and Cai (2010) document the impact of gender and age on the likelihood of investing in renewable energy. They find that females on average would invest about US$197.60 more than males in renewable energy. They also find that the most likely group to invest in renewable energies are investors between 26 and 35 years of age. Gamel et *al*. (2016) on a study of German individual investors also show that age affects preferences for wind energy investment. Specifically, they find that as age increases, the utilities for wind energy investments decrease with a large investment amount.

The wider socially responsible investment (SRI) literature also sheds light on the influence of demographics on SRI investing which includes green investing. According to Nilsson (2007), women and better-educated investors were more likely to invest a greater proportion of their investment portfolio in SRI. Again, Junckus and Berry (2010) find that the typical socially responsible investor is female, younger, wealthy and better educated.

The renewable energy literature on consumers also provides insightful connections between demographics and supporting or adopting renewable energy technologies. On education, studies mostly establish that higher levels of education correlate with the willingness to pay for RE. These studies include Zarnikau (2003), Ek (2005), Sardinou and Genoudi (2013) and Tabi *et al.* (2014).

With regards to age, Zarnikou (2003) find that younger respondents are more interested in paying a premium for renewable energy resources than older respondents. Also, studies like Mahaptra and Gustavvson (2008), Mills and Schleich (2012), Michelsen and Madlener (2012) report a reduction in the inclination to adopt renewable energy/energy-saving technologies as age increases. Sardinou and Genoudi (2013), on the other hand, suggest that middle-aged people are probably more willing to adopt renewable energy sources in their home. Similarly, Kostakis and Sardianou (2012) also find that middle-aged people are more likely to adopt renewable energy or pay for renewable energy services than younger counterparts.

On income, Zarnikou (2003) finds that as salary increases, willingness to pay a premium for renewable energy resources increases. Other studies such Mills and Schleich (2010) and Sardianou and Genoudi (2013) also find a positive correlation between income and the likelihood of investing in renewable energy technologies.

On gender, Sardinou and Genoudi (2013) found that gender is not a statistically significant factor in the willingness to adopt renewable energies. More broadly, on the issue of energy policy, Noblet *et al*. (2015) find that females are more likely to support policies that are environmentally friendly. Manley *et al.* (2013) also find that females prioritise the environment over economic and security goals in energy policy planning and formulation.

In summary, the diversities of backgrounds accompanied by motives suggest the heterogeneity of RE investors and the crucial need for policy segmentation to accommodate them. In the next section, a brief look at the literature on how individual investors behave is discussed to shed light on some of the behavioural themes that accompany investment.

2.10 Studies of Renewable Energy Investment Preferences and Decisions

A large section of literature is devoted to renewable energy investment attitudes and preferences and include works in and out of the stated preference literature. Here, an investment can be defined as the utilisation of funds with the primary aim of earning income or appreciating capital (Pandian, 2001). The important works outside the stated preferences literature are discussed first, followed by those within the stated preference literature.

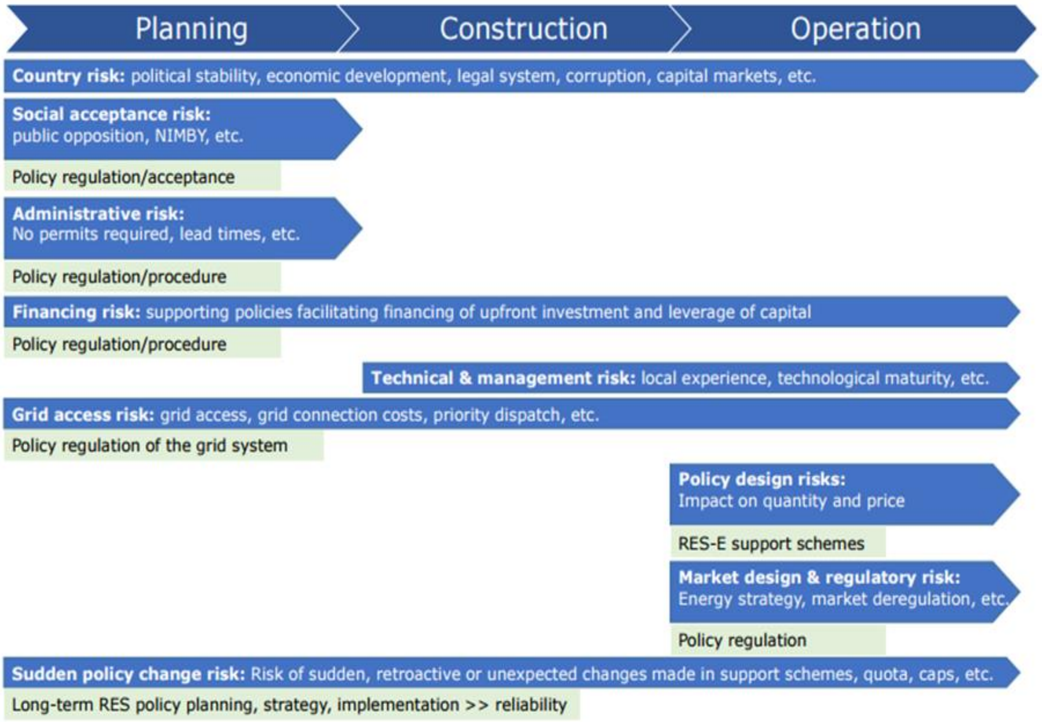
The motivations for investment are numerous and often complex, and these studies have sought to understand and predict the behaviour of the investor. These studies often combine knowledge from psychology and investment at the micro-level (that is, individuals and households) and macro levels (that is, financial markets). Again, the decision-making process for investors are both quantitative (objective) and qualitative (subjective) based on the attributes of the investment product or financial service.

Studies have also established that preference for renewable energy investment differs by investment model. This is highlighted by Yildiz (2014), who mentions equity (e.g. cooperatives and closed-end funds), and debt and mezzanine financing for renewable energy projects. Individuals who invest via any of these methods have different motivations and appetite for risk.

Preferences for investment is also known to be influenced by the phase of projects seeking funding due to various risks at different stages of the project (Breitschopf and Pudlik, 2013). Figure 2.10 below by Noothout *et al.* (2016) outline the potential risks associated with RE projects at every phase. Project Duration is also documented to influence investor decisions and hence, renewable energy investment decisions. Samuelson (1989, 1994), McNulty *et al.* (2002) and Enzenberger *et al.* (2003), present strong theoretical, empirical and practical evidence that investors who opt for longer-time horizons for investments have a higher risk appetite. The reverse is also true for risk-averse investors. Thus, the type of investors (risk-tolerant or averse) will determine their preferences for projects with different durations. Age may play a factor here as younger people with longer investment horizons may opt for projects with a longer duration than older people.

Again, developer reputation is established as influencing investor decisions. Nagy and Obenberger (1994), in a survey, investigated the weight given by shareholders to 34 investment variables. They found that after wealth maximising factors like earnings and diversification needs, and condition of financial statements, feelings of a firm’s product, firm status and reputation is what investors factored into their decision making.

Figure 2.10 Risks associated with RES projects at various project phases



Source: Noothout *et al.* (2016, pg. 18)

Lastly, studies like Borchers *et al.* (2007) and Noblet *et al.* (2015) have revealed that preferences for renewable energy investments differ by type of renewable energy technology. The latter also finds that personal characteristics such as whether the decision-maker is prevention-focused (precautionary and concerned about protection) or promotion-focused (open to change due to regard for growth and advancement) plays a crucial role. This, they believe, serves as a heuristic in their preference and allocation of funds for renewable energy investment.

Moving on to works in the stated preference literature, studies that estimate preferences do so from "people as consumers/citizens/taxpayers" and from "people as investors in renewable energy". Studies in the first category are numerous and are often to investigate what policies and programs citizens are most likely to accept, pay for or invest in, in line with government aim to increase the share of renewable energy (including energy efficiency). Such studies include Bergmann *et al.* (2006) who value the attributes of renewable energy investments (hydro, wind and biomass) in Scotland.

Their work hinges on the notion that renewable energy investments have external costs and benefits which must be valued to ensure projects are not only economically optimal but also socially optimal as much as possible. Using a choice experiment approach, they find a high sensitivity to projects with a high impact on the landscape. They also find that the implicit prices respondents are willing to pay to have ‘no impact on wildlife’ is 75% of what households would pay to reduce landscape impacts from high to zero. Their work underscores how perceived impacts, factor into renewable energy choice and decision making.

Also, Ek (2005) investigated public and private attitudes towards ‘‘green’’ electricity within the context of Swedish wind power. Results indicated that the public is generally positive towards wind power, and the probability of finding an average individual in support of wind power decreases with age and income. As expected, people with interest in environmental issues were more likely to view wind power more positively with no support for the NIMBY-hypothesis. She also found that willingness-to-pay (WTP) increased with age, income and environmental awareness.

Similarly, Dimitropoulos and Kontoleon (2009) perform a discrete choice experiment in Greece to assess the determinants of local acceptability of a wind-farm investment. They find that the acceptability of wind farms was most influenced by the conservation status of the area where the wind farm is installed as well as the governance characteristics of the planning procedure. They also find that the physical attributes of the wind farms were of less relative importance to the local community.

Ku and Yoo (2010) also examine the willingness to pay for renewable energy investment in Korea using a choice experiment study and find a positive monthly willingness to pay for wildlife protection, reduced air pollution and increased employment opportunities. Another renewable energy WTP study conducted by Lee and Heo (2016) on Korean consumers found WTP of USD 3.10 for renewable energy electricity when accounting for individual preferences.

Gracia *et al.* (2012) investigate the willingness of consumers to pay for renewable energy sources in the power mix through electricity price increases in Spain. They find that most consumers were unwilling to pay a premium for increases in the renewable energy share in the power mix. They however find a positive wtp for increases in the share of solar power and locally generated power.

Murakami *et al.* (2015) in a comparative analysis between Japan and the USA evaluate consumer willingness to pay for renewable energy and nuclear power using a discrete choice experiment. They find that the average consumer in both countries shows a negative preference for increases in nuclear power in the energy mix. For wtp measures for a 1% decrease in greenhouse gas emissions, they find that US consumers are willing to pay $0.31 per month while Japanese consumers are willing to pay $0.26 per month.

Vecchiato and Tempesta (2015) analyse people's preferences for electricity contracts including renewable energy in Italy. In general, they find that people are willing to pay more for green energy contracts. Similar to many other studies, they find willingness to pay differed by energy sources with solar photovoltaic most preferred.

Using German electricity consumers, Rommel *et al.* (2016) investigate how the willingness-to-pay for renewable energy by differentiated by the type of supplier. They find that consumers were willing to pay more for electricity supplied by cooperatives or municipally owned electricity utilities compared to investor-owned firms.

Su *et al.* (2018) value different renewable microgeneration technologies in Lithuanian households. Specifically, WTP for different RE technologies is assessed. They find that owners of detached houses in Lithuania households are ready to pay for solar energy-based technologies (some 3300 EUR and 1363 EUR per solar panel and solar thermal installations, respectively). Biomass boiler and micro wind technologies were found less desirable.

In stated preference RE investment literature for investors, Bürer and Wüstenhagen (2009) found that among 60 investment professionals from European and North American venture capital and private funds, feed-in-tariffs were perceived as more effective in stimulating investment. Preference for FiTs was more pronounced however among European investors than North American counterparts. Their study underscores the importance of policy support systems for investment decision-making.

Aguilar and Cai (2010) examine the opportunities for private investments in renewable energy and find that certainty of financial return was the most important investment attribute. This was followed by high return, diversified portfolio and estimated time for return. The study highlights the need for renewable energy investments to offer high returns, which are deemed certain by the investor. The importance of certainty of financial return suggests that risks that undermine the certainty of such returns need to be addressed.

On investor preferences for renewable energy projects, Salm *et al.* (2016) identify two target segments for investors in Germany: “local patriots” and “yield investors”. “Local patriots” are those willing to forgo return on investment in local projects. On risk, a subsequent study by Salm (2018) using a discrete choice experiment reveal that low-risk projects equally attract incumbent utilities and institutional investors. However, in higher-risk situations, institutional investors often shy away and demand a higher risk premium than incumbent utilities. These studies speak to the diversity of RE investors and the importance of an equally diverse approach to engaging and attracting their investment.

Gamel *et al.* (2016) using a choice experiment investigated the preferences of German respondents who intend to invest in wind energy in the future. The study finds that investment (the minimum amount to enter), the term (the duration of the investment) and return on investment were the most important to respondents.

Curtin *et al.* (2019) investigate citizen investment preferences in Ireland and find that citizens are motivated by financial attributes like rate of return and minimum investment holding. They also find most citizens to be risk-averse.

Generally, many studies, e.g. Borchers *et al.* (2007), Aguilar and Cai (2010), Salm *et al.* (2016) find that renewable energy technology preference was significant in many participation and investment decisions. Borchers *et al.* (2007) report solar as the most preferred technology. Salm *et al.* (2016) also report a higher preference for solar among respondents. Aguilar and Cai (2010) find that solar and wind energy investments were ranked higher than grass and wood-based technologies.

Overall, a clear conclusion to be drawn from the plethora of studies in the renewable energy investment space is that multiple variables feed into the decision making of investors. As such, any research or study will need to carefully specify its objectives and identify the key variables (economic and non-economic) that are most important for achieving the research aim or policy objective or goal.

2.11 Summary

This chapter has reviewed the relevant literature in citizen investment in renewable energy. It briefly discusses the principles that underlie investment in renewable energy and follows it with global investment trends in renewable energy with the key message being that the picture is bleak with regards to current investment towards universal electricity access for Sub-Saharan Africa. It then looks at the renewable energy financing landscape, that is the key actors before focussing on the contribution of household/retail investors.

Following, it looks at the business models and motivations for citizen investment concluding that though citizen investors have other motives like acting appropriately (pro-environmental behaviour) and feeling better or accepted as part of a group, the material payoff or profitability of the investment is still crucial. In light of this, a discussion of the literature on renewable energy support measures is explored as these have often being designed to safeguard the profitability of RE investments. The behavioural dimension of investments in renewable energy is then looked at. Finally, the literature on the studies on renewable energy investments, risks and preferences are discussed. In all, the chapter highlights the multiplicity of factors that feature in renewable energy investment decision-making by household investors.

CHAPTER 3 METHODOLOGY

3.1 Introduction

The central thesis for this dissertation is to quantify the attributes that enhance the likelihood of household investors investing in renewable energy power projects. The values attached to attributes can vary depending on culture, individual's tastes, education, class amongst many others. For people in the public policy space, knowing where some of these issues converge or diverge is critical for the acceptance and the development of policy. Quantifying the value consumers place on certain goods and services can help forecast the demand for such goods/services and feed into the design of policy.

This chapter attempts to give a theoretical rationale for the empirical research employed in this dissertation. It discusses how work was carried out to elicit household investor preferences for renewable energy power projects. It begins by giving a brief history of non-market valuation and an overview of the methods used to measure use and non-use values of non-market goods. It proceeds to give a detailed background of discrete choice experiments and the theoretical foundations underpinning its use. Further, it provides a description of the econometric models used in the dissertation as well as issues of experimental design for the choice experiment.

3.2 Resource Allocation and Market Failure

Some goods are not traded in the market, and hence obtaining an economic value for such is difficult. Other goods do not exist, and hence, markets fail to exist for them as well. However, these goods (mainly environmental goods and services such as clean air and water, healthy ecosystems) have economic value and broad implications for resource allocation. Hence, finding a way to capture this value is what non-market valuation entails.

According to Bateman *et al.* (2002), non – market valuation can be defined as the process of estimating the value of goods and services that have no market or an incomplete/limited market. Market failure is considered a critical source of economic inefficiency (see Arrow 1969) due to society's inability to allocate resources efficiently. According to Schogren and Taylor (2008), environmental market failure can be grouped into a taxonomy of externalities, nonrival goods, nonexcludable benefits and costs, nonconvexities, and asymmetric information. The lack/absence of markets for environmental goods and services can be due to it being a public good[24] or issues to do with information asymmetries, ill-defined property rights and the inability to identify or monitor tradable components (Segerson, 2017).

Markets often do not capture the value of environmental and natural resources due to two common market failures: the characteristics of public goods to allow free riders and external costs created by the production or consumption of market goods since market prices of those goods fail to reflect these costs. Hence, the value of environmental goods and services goes largely unmeasured because markets do not provide these goods and market prices do not reflect their full value to society. Understanding the full economic value of such resources can help inform decisions regarding trade-offs that society must make.

3.3 Evolution of Non–Market Valuation

This section briefly describes the history of non-market valuation to give insight into how the valuation of non-market environmental goods and services came to be as well as developments that have shaped the stated preference methodology to date.

[24] Public goods can goods that satisfy the condition of non-excludability and non-rivalry. Non-excludability means non-payers cannot be excluded from enjoying the good, a phenomenon referred to as "free-rider problem". The condition of non-rivalry means quantity of the good does not diminish with consumption.

The development of non-market valuation can be traced to the United States and often attributed to the work of Bowen (1943) and Ciriacy-Wantrup (1947) (Hoyos and Mariel, 2010; Carson and Czajkowski, 2014). Both are credited with the use of public opinion surveys in the study of public goods by drawing on how voting was conducted at the time as they believed it was a good proxy for consumer choice. Ciriacy-Wantrup in 1952 released what is considered the first book in environmental and resource economics titled “Resource Conservation: Economics and Policy” detailing the use of such surveys.

Subsequently, two federal laws were approved in support of the methodology as an economic valuation tool. These were the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) and its regulatory development of 1986. The former was to identify sites that posed a danger to humans and the environment and to find ways to make entities responsible for the hazard, that is, pay for the clean-up. The latter was for funding the recovery of lost passive use values[25] (Portney, 1994). This thus became an endorsement of the Contingent Valuation Method (CVM).

The Exxon Valdez oil spill of 1989 is deemed one of the key events that sparked interest in contingent valuation with the State of Alaska suing Exxon for loss of passive use value. Carson *et al.* (1992) provide details of the contingent valuation study citing the willingness to pay to avoid a spill like the Exxon Valdez spill at US$3 billion dollars. Carson *et al.* (2003) in their words explain that “the Exxon Valdez incident represented the quintessential case in which, to ignore passive use values, was to effectively say that resources that the public had chosen to set aside and not develop could be harmed at little or no cost to the responsible party”. In the end Exxon paid the government US$1billion in resource damages and spent US$2 billion on restoration measures (Carson, 2011). With such liability facing industries, industries disputed the reliability of CVM estimates and

[25] Passive use values are values held by individuals for a good, not for the use they derive from it but for the value derived from its existence

supported the proliferation of evidence against it - Exxon supported the publication of a book that critiqued the fundamental premises of the CVM (Boyle, 2017).

Later that year, the National Oceanic and Atmospheric Administration (NOAA) Blue Ribbon Panel after analysing all the theoretical and empirical works on CVM concluded that: “Contingent valuation studies can produce estimates reliable enough to be the starting point for a judicial or administrative determination of natural resource damages including lost passive-use value”. Also, the Panel established guidelines on how reliable and valid CV studies must be carried out. This became a catalyst for a flurry of methodological research from 1993 when the NOAA report was published till now.

Davis (1963) is recorded as being the first economist to apply the CV survey to outdoor recreation during his Harvard dissertation (Segerson, 2017). In the following years, studies by Ridker (1967) on air pollution, Brown and Hammack (1972) and Hammack and Brown (1974) on willingness to pay and willingness to accept the hunting of the waterfowl, Cicchetti and Smith (1976) on willingness to pay to reduce congestion for hikers were all conducted (Segerson, 2017). Notable in that period was Darling (1973) who employed personal interviews to assess willingness to pay for amenities in parks in California (Mitchell and Carson, 1989).

The CVM is not without criticism with notable critiques like Hausman (2012) criticising it on the basis of hypothetical bias, the disparity between willingness to pay and willingness to accept as well as issues of scope. According to Carson (2011), critiques also mention the opportunity for people to act strategically and not reveal true preferences as well as issues over elicitation format.

Till date, there are a plethora of methodological studies on CVM in the literature with many applications worldwide (see Adamowicz, 2004; Boyle, 2017). Recently, a study by Johnston *et al.* (2017) provides contemporary guidance for methods like the CVM. In environmental valuation, the demand for its use comes from policy makers and public agencies.

Over the years, the research on non-market valuation has evolved into two main branches: revealed preference method and stated preference method with refinements year-on-year. Due to the complexity of natural resources and environmental goods, one method alone is incapable of capturing all the value components. The next section will discuss these branches and the various sub-branches associated with them, dwelling predominantly on stated preference methods as this is most closely aligned with this thesis.

3.4 Revealed Preference Methods

Revealed preference method as the name suggests is used to value non-market goods by observing behaviour (revealed) to generate a value of non- market outcome that reflects that of market goods. People's behaviour in markets may help us understand the value of associated non-market goods. There are two methods employed under revealed preference: the travel cost method and the hedonic pricing method.

3.4.1 Travel Cost Method

The travel cost method is a well-known method for non-market valuation often used by those that study recreational sites such as beaches, parks heritage sites and tourist attractions. The travel cost method assesses value using consumption behaviour in closely related markets and hence often viewed as an indirect method (Weiqi *et al.*, 2004). That is, it uses the information on travel expenses and trip frequency to estimate a trip demand function. Often measured using a survey, questions include individual visitation frequency data, travel costs and other expenditures, environmental quality measures and some demographic information. Works on travel cost are seen in Hanley (1989), Willis and Garroud (1991), Fleming and Cook (2008), Zhang *et al.* (2015) and Bertram and Larondelle (2017).

3.4.2 Hedonic Price Method

The central idea behind the hedonic price method is to adequately capture the demand for environmental attributes that feed into house prices. Thus, the method estimates a function that describes how house market prices are related to environmental attributes, that is, house price is regressed against variables that describe the house, neighbourhood and other variables that capture the environment. Studies employing the hedonic price method include Morales (1980), Garrod and Willis (1992), Luttik (2000), Mansfield *et al.* (2005), Lee *et al.* (2008), Abidoye and Chan (2017) and Soler *et al.* (2019).

3.5 Stated Preference Methods

Stated preference methods are employed to estimate economic values by asking individuals survey questions to elicit their preferences (Johnston *et al.*, 2017) These set of methods are in contrast to revealed preference methods that estimate value by observing behaviour (Adamowicz *et al.*, 1998; Adamowicz and DeShazo, 2006; Johnston *et al.*, 2017). Hence, stated preference studies provide data that can be used to infer preferences (Carson and Louviere, 2011). As stated by Johnston *et al.* (2017), multiple variants of these methods exist with the common approaches being the contingent valuation method and the discrete choice method. These two approaches (which are discussed next) have gained recognition and use as they are the known methods for estimate value for public goods as well as other outcomes that cannot be measured by observing behaviour.

3.5.1 Contingent Valuation (CV)

A prominent method, the contingent valuation method estimates the willingness to pay (WTP) or accept (WTA) to changes (hypothetical increases or decreases) in the quality of goods and services through participant responses to survey questions (Mitchell and Carson, 1989; Hanley *et al.,* 1998; Oerlemans *et al.,* 2016). Contingent valuation conveys three main elements: (1) information related to preferences is obtained using a stated preference survey, (2) the study's purpose is placing an economic value on one or more goods, and (3) the good(s) being valued are public ones (pure public or quasi-public) (Carson and Louviere, 2011).

The method has been applied in several areas including environmental cost-benefit analysis and impact assessment (Venkatachalam, 2004), health economics (see Johannesson and Jonsson, 1991 and Johannesson *et al.,* 1996), transport safety (see Jones-Lee *et al.,* 1995; Rizzi and Ortúza, 2003; Haddak *et al.,* 2016) as well as combined with other stated preference methods such as choice experiments (see Louviere and Woodworth, 1983 and Louviere *et al.,* 2000). Also, Whittington (1998) and Merrett (2002) have used it to model preferences for infrastructural projects in developing countries.

Despite the strengths of the CV method , it has not been devoid of heavy criticism on grounds of validity and reliability (Kahneman and Knetsch, 1992; Diamond and Hausman, 1994; Hausman, 2012) due to the potential for a series of biases: information bias, design bias, hypothetical bias, yea-saying bias, strategic bias (free-riding), substitute sites and embedding effects (Birol *et al.,* 2006).

This survey method usually consists of three steps:

1. Description of the contingent market and what change will occur in the commodity in such a market by contrasting the status quo with the target state.

2. The respondent is then asked about their maximum offer/ money and what they are willing to pay to see this improvement or change through the administering of a questionnaire.

3. Here the administrator collects socio-demographic data by the asking of questions. The answers provide better insight on the respondent and help give meaning to the WTP or WTA value quoted by the respondent. This is usually followed by questions by respondents to interviewers to ensure that the survey was well understood.

The most common elicitation approach is the two-alternative (referendum) contingent valuation method (CVM) (Bennet and Blamey, 2001; Carson and Louviere, 2011). The CV method has a lower cognitive burden, incentive compatibility and closeness with market behaviour of people (Hoyos and Mariel, 2010). According to Carson et al.(2001), the CV method is flexible and useful for assessing the total value of non-market goods,

Considering that the objective of this thesis, is to estimate the marginal value of changing attributes rather than the total value of the good, the CV method was deemed unsuitable for attaining that objective. More importantly, the study is interested in evaluating a range of different attribute changes and a choice experiment is more applicable in reaching those objectives.

3.5.2 Choice Modelling

Unlike the CV method, choice modelling allows for the valuing of multiple attributes simultaneously (Hensher *et al.*, 2005) and handy for situations where the CV method is limiting. It is thus more suited for complex models of valuation, for example, consumer decision-making where more than one input or attribute is under consideration.

Preferences of individuals under choice modelling have been obtained by asking participants to either rank, score or choose a preferred alternative. According to Hanley *et al.* (2001), four modelling approaches have emerged which they summarise below along with how consistent each approach is with welfare estimates (see Table 3.1). Choice experiments have also been proven through practice to generate consistent welfare estimates and allow incorporation of status quo alternative ensuring its practicality with real-world situations.

Table 3.1 Choice Modelling Approaches.

Approach	Tasks	Welfare Consistent Estimates?
Choice Experiments	Choose between two or more alternatives (where one of the alternatives is the status quo)	Yes
Contingent Ranking	Rank a series of alternatives	Depends
Contingent Rating	Score alternative Scenarios on a scale of 1 - 10	Doubtful
Paired Comparisons	Score pairs of scenarios on similar scale	Doubtful

Source: Hanley *et al.* (2001, p.438)

3.5.2.1 The Discrete Choice Experiment Method[26]

This method is a quantitative survey technique for eliciting individual preferences for a commodity by an individual stating their choice over different hypothetical alternatives. All the alternatives are variants of an attribute of the commodity been surveyed. The alternatives are generated from a set of attributes with one or more levels. A respondent's choice among alternatives implies trade-offs between levels of attributes presented in alternatives for that choice set (Hoyos, 2010). According to Hanley *et al.* (1998), it is a highly structured method of data generation that elicits the factors that influence one's

[26] Also referred to by others as choice experiment, attribute-based methods", "attribute-based stated choice methods," "choice-based conjoint analyses" by other authors. Here we use discrete choice experiment to denote a multi-alternative choice design and excludes binary choice options as seen in Carson and Louviere (2011). It thereby goes with the original definition by Adamowicz et al. (1998) i.e. a series of multinomial choice questions.

choice. The method is appropriate not only for estimating the value of an environmental resource as the whole but also the individual attributes (Johnston *et al.,* 2017).

The objective of most DCEs is estimating the economic value of the different characteristics of a good or service. This often includes a price vector as an attribute to indirectly capture the marginal willingness to pay for other attributes in the study (Bergmann *et al.*, 2008) or make it amenable for use in cost-benefit analysis (Holmes *et al.,* 2017). One major strength of choice experiments is the richness of the information produced on respondents and their preferences. DCEs have various advantages over several elicitation techniques in that the presentation format is straightforward and mimics real-life choice situations, can assess trade-offs in behavioural settings, supported by experimental design theory thereby ensuring the use of smaller sample sizes (Holmes *et al.,* 2017). All these considered, this study opted to use a DCE because it is compatible with the study objective of valuing a range of different attribute changes.

Though some authors raise several issues like a high cognitive burden, increasing experimental design and econometric model complexity, the latest software packages are now available to reduce this complexity. Like contingent valuation, concerns about hypothetical bias and strategic behaviour is often raised.

3.6 Conceptual Framework for Discrete Choice Experiments

McFadden (1974) in developing the discrete choice theory for predicting consumer behaviour found that the conceptual underpinning for his analysis was vested in Thurstone's(1927) concept of random utility which notes that individuals will always seek to maximise their utility. However, because not all the predictors of an individual's value for non-market goods can be seen, there is a need for an indirect determination of preferences. Interestingly, most microeconomic models on consumer behaviour have a central foundation of utility maximisation under budget constraint (Hoyos, 2010).

Bergmann *et al.* (2006) explain that the discrete choice method draws on two fundamental blocks: Lancaster's characteristics theory of value and random utility. Lancaster's theory states that consumers do not derive satisfaction (utility) from the good itself but the characteristics of the good. Thus Lancaster (1966) asserts that the value of a good is the sum total of its individual characteristics. The random utility theory, on the other hand, states that not all the determinants of utility can be observed or derived from the respondent's choice necessitating an indirect estimation of preferences.

3.6.1 The Random Utility Model

Economists have however, found ways to measure these indirect preferences (McFadden, 1974; Manski, 1977; Bergmann *et al.*, 2006). Within the framework of random utility, an individual's indirect utility consists of the observable component of the utility and the stochastic element. Bennett and Blamey (2001) represent this using the function below:

$$U_{iq} = X_{iq} + e_{iq} \qquad \textbf{3.1}$$

where U_{iq} is the latent unobservable indirect utility of consumer q for choice alternative i, X_{iq} is the observable component for consumer q for choice alternative i, ε_{iq} is the random or unexplainable component of the utility that consumer q has for choice alternative i. The random or unexplainable component of the utility restricts the ability of the researcher to fully predict preferences. This generates a situation where the probability of choice is the most natural and logical avenue and hence becomes:

$$P\left({}^{i}/{}_{C_q}\right) = P[(X_{iq} + \varepsilon_{iq}) > (X_{jq} + \varepsilon_{jq})] \quad \forall\, i \neq j \qquad \textbf{3.2}$$

This is for all j options in choice set C_q with i and q as earlier described. To estimate the observable component of Equation 3.2, some assumptions need to be made regarding the nature of the distribution of the random or stochastic component. The general assumption is that the stochastic component is independently and identically distributed (IID) with a Gumbel or Weibull distribution. This results in the use of a multinomial logit model to determine the probabilities of choosing *i* over *j* options (Bergmann et al., 2006) which is shown in Equation 3.6 under multinomial logit models.

Specifying the Utility Function

Analysis of DCE data requires that some assumption is made about the utility function, which most often is specified to be a linear function of the attributes (see Hauber *et al.*, 2016). Thus, the utility function can be specified as:

$$U_{qi}=\beta X_i + \varepsilon_{qi} \qquad \textbf{3.3}$$

where U_{qi} is the unobservable utility of individual q for the *i*th alternative, X_i is the vector of attributes associated with the *i*th alternative, β is the vector of preference parameters for attributes and ε_{qi} is a random error term. For an experiment with six attributes, the utility function with a linear function can be written as:

$$U_{qi}=\beta_1 X_{i1} + \beta_2 X_{i2} + \beta_3 X_{i3} + \beta_4 X_{i4} + \beta_5 X_{i5} + \beta_6 X_{i6} + \varepsilon_{qi} \qquad \textbf{3.4}$$

When alternative specific constants are factored into the experimental design, they can be incorporated into the utility function. Thus, the utility function when an individual q, chooses Alternative i with the inclusion of three ASCs can be written as:

$$U_{qi} = \beta_A ASC_{A,q} + \beta_B ASC_{B,q} + \beta_C ASC_{C,q} + \beta_1 X_{i1} + \beta_2 X_{i2} + \beta_3 X_{i3} + \beta_4 X_{i4} + \beta_5 X_{i5} + \beta_6 X_{i6} + \varepsilon_{qi} \qquad \textbf{3.5}$$

It must be stated, however, that though the function remains linear in parameters, it is not a linear function of the attributes. This is a critical property of discrete choice models, in that only differences in utility between alternatives affect the choice probabilities—not the absolute levels of utility. This property also affects the inclusion of alternative specific constants. Since alternative specific constants capture the average effect of utility factors not explicitly included as attributes, only the differences in alternative specific constants are of importance. To do this, one of the constants must be normalised to zero, so the others can be interpreted using the normalised constant as the reference. To capture taste variation, which is made possible by the inclusion of socioeconomic characteristics, these socioeconomic characteristics must interact with alternative specific constants. In some instances, characteristics can also interact with the attributes of the alternatives.

3.7 Multinomial Logit (MNL)/Conditional Logit Model (CLM)

One key consideration in the estimation of an MNL model is the assumption of the nature of the random error term. Generally, the assumption is that the errors are independently and identically distributed following a Type 1 extreme value (Gumbel) distribution.[27] Following from that, Hanley *et al.* (2001) suggest that by using a multinomial logit model the probability for choosing *i* over *j* can be represented as:

$$P\left(U_{iq} > U_{jq}\right) = \frac{\exp(\mu X_i)}{\sum_j \exp\left(\mu X_j\right)} \quad \forall \neq j \qquad \mathbf{3.6}$$

where they define μ as a scale parameter that is inversely related to the standard deviation of the error term and not separately identifiable in a single data set.

[27] Ben Akiva and Lerman,1985 explain that the Gumbel distribution is characterised by the scale parameter and location factor. The scale factor cannot be easily identified due to confounding with the vector of utility parameters. Hence, the scale factor is often set to one. This has implications for the interpretation of estimates in the MNL model in that the estimated parameters cannot be their contribution to utility.

In discussing the multinomial logit model, a critical property though limiting is the well-known Independence of Irrelevant Alternatives (IIA) property which means that the ratio of probabilities of choosing any two alternatives is unaffected by presence of a third or additional alternatives (Hausman and McFadden, 1981; Louviere *et al.*, 2000; Cheng and Long, 2007; Matějka and McKay, 2015; Holmes *et al.* 2017). Secondly, heterogeneity is believed to be absent, indicating that all members of the population are regarded as having the same preference. In other words, the estimated β's is the same for all.

In several cases in the literature, the multinomial logit model is used interchangeably with the conditional logit model; however, there is some nuance that must be explained. In analysing the choice of an individual for a set of J alternatives, the multinomial model utilises the individual characteristics as a predictor or explanatory variable while the conditional logit focuses on the alternatives of the individual and uses the characteristics of the alternatives as explanatory variables (Hoffmann and Duncan, 1988; Hauber *et al.*,2016). The conditional logit model, as developed by McFadden (1974), was proven to be consistent with economic theory and random utility theory as he applied it to choice behaviour. Hence, this thesis will use the term "conditional logit" because the objective of the discrete choice experiment is to relate choice to attribute levels.

3.7.1 Interaction effects in Conditional Logit Models

In cases where researchers want to examine the effect of the socioeconomic variables, these variables can enter a random utility model. However, this is can only be done indirectly as these variables do not vary across alternatives. Capturing the effect of socio-economic variables like age and income can be done using multiplicative interactions with alternative specific constants or alternative specific attributes. The use of interaction effects can be seen in Chapter 4, where it is used in the less restrictive conditional logit model (Model II) to provide insight into possible sources of heterogeneity in respondents.

3.7.2 Testing for Violation of IIA

The plausibility of the IIA assumption in the use of the conditional logit model has been a subject of much interest to researchers. McFadden (1974) is noted to have raised his concerns of the assumption using the example of the choice of a different mode of transport by a commuter – the red bus, blue bus example[28].

According to Cheng and Long (2007), two classes of tests exist for testing violation of the IIA, that is, the choice set partitioning test and model-based test. The former they explain involves the comparison of a full MNL model to a restricted MNL model. The IIA assumption is satisfied if the estimated coefficient of the full model is statistically similar to the restricted one. The IIA assumption is rejected if a statistically significant test statistic is obtained - the full model is then considered inappropriate.

Model-based tests, on the other hand, compute a model that inherently does not impose the IIA assumption. These include the random parameter or mixed logit, which is discussed next. A brief description of other alternatives is also given.

3.8 Mixed Logit Model /Random Parameter Logit

In the analysis of applied discrete choice analysis, the mixed (McFadden and Train, 2000; Hensher and Greene, 2003) or random parameter logit model is popular. Like already mentioned, it overcomes the MNL model's inherent assumption of IIA and is considered

[28] Here McFadden in Cheng and Long (2007). "Suppose that a person can travel to work either by car or by a red bus. Assume that the probability of each mode of travel is 1/ 2, so that the odds of taking a car rather than a red bus are 1/ 2=1/2 = 1. IIA requires that if a new alternative becomes available, the probabilities for the prior choices must adjust in precisely the amount necessary to retain the original odds. Now, suppose that the alternatives are expanded to include travel on a blue bus, where this bus is identical to the red bus except for colour. We would expect that the probability of taking a red bus would equal that of taking a blue bus. In such a case, the only way to maintain the original odds of taking a car versus a red bus would be if a car is chosen with a probability 1/ 3, a red bus 1/ 3, and a blue bus 1 /3. By this logic, we could effectively eliminate the use of cars by increasing the number of colours used by bus companies. Obviously, it is more likely that the original bus riders would divide evenly between taking red and blue buses. But this more realistic scenario violates the IIA assumption since the odds of a car versus a red bus would become ½ divided by ¼ ≠ 1".

flexible. Following Hensher and Greene (2003) and still under a random utility model framework, an individual q faced with I alternatives in T choice occasions is deemed to maximise his utility under each choice occasion t, the utility associated with each alternative i is represented in a discrete choice model by:

$$U_{itq}=\beta_q' X_{itq} + \varepsilon_{itq} \qquad \textbf{3.7}$$

where is X_{itq} represents the vector of explanatory variables observed by the researcher including the attributes of the alternatives as well as socio-economic variables associated with the respondent. It also includes descriptors of the decision context and choice task in a choice situation t. The components β_q' and ε_{itq} represent the stochastic component and hence not observed by the researcher.

Assuming ε_{itq} to be independent and identically distributed (IID) extreme value type 1 and allowing for correlation across alternatives[29], the stochastic component is partitioned into two parts (ignoring t at the moment) to give:

$$U_{itq}=\beta_q' X_{iq} + [\,\eta_{iq} \; + \varepsilon_{iq}] \qquad \textbf{3.8}$$

where η_{iq} is a random term with zero mean and depends on underlying parameters and observed data, ε_{iq} is a random with zero mean that is IID over all alternatives and does not depend on underlying parameters. For mixed logit models, η_{iq} exhibit an IID extreme value type 1 distribution as well as a general distribution and can take several distributional forms like normal, log normal or triangular. Representing the density of η_{iq} by $f\ (\eta_{iq}|\,\Omega)$ where Ω are fixed parameters. Hence for any given value of η_{iq}, the conditional probability for choice i is given by:

[29] The IID assumption is restrictive in that it does not allow for the error components of different alternatives to be correlated.

$$L_{iq}(\beta_{iq}|\eta_{iq}) = \frac{\exp\left(\beta'_{q}X_{iq} + \eta_{iq}\right)}{\sum_j \exp\left(\beta'_{q}X_{jq} + \eta_{jq}\right)} \qquad \textbf{3.9}$$

The unconditional choice probability is thus the integral of the logit formula over all values of η_{iq} weighted by the density of η_{iq} and is given as:

$$P_{iq}(\beta_q|\Omega) = \int_{\eta_{iq}} L_{iq}(\beta_q|\eta_{iq})\, f(\,\eta_{iq}|\,\Omega)\eta_{iq} \qquad \textbf{3.10}$$

Its name the mixed logit is derived from the fact that, it is a mixture of logits with mixing distribution *f*. The common specification for *f* is the random parameter specification where the associated attribute of an alternative has both a mean and standard deviation. The standard deviation denotes the degree of preference heterogeneity in the sample population. As is well known, the normal distribution is the most commonly used distribution due to relatively simple estimation and interpretation (Rommel *et al.*, 2016). However, in a few cases, other distributions like log-normal may be deemed necessary for a particular context or set of assumptions. Here, we assume a normal distribution for all attributes. Also, the price attribute is often fixed to allow for WTP calculations.

An important thing worth noting is that RPL models as maximum simulated likelihood estimations use a simulation technique that can produce different answers if the parameters of the simulations are not set to be the same across regressions. Hence without setting parameters like the simulation random seed, the number of draws, and the type of draws, model outputs are likely to be different due to multiple starting points with each model run. Thus, it is advised to set these parameters and estimate the model with multiple starting points to ensure that the model converges to a stable solution.

3.9 The Latent Class Model (LCM)

The LCM is a semi-parametric model (Greene and Hensher, 2003) which is increasingly growing in its use to study preference heterogeneity among discrete choice researchers. The LC model assumes that individuals base their decision making on a set of observable attributes and a set of latent factors invisible to the analyst (Greene, 2001). It also assumes that attributes of the alternatives can be heterogeneous across groups and homogenous within groups allowing for the categorisation of the sampled population in segments. Heterogeneity is accounted for by assuming that classes within a population have preference weights identical within the class and different outside the class (Hauber *et al.,* 2016). The advantage of the LCM is that it does not require the analyst to make an assumption about the distribution of parameters though it is less flexible than the mixed logit model (Greene and Hensher, 2003). Despite this, Louviere (2006) makes a case for these models as he argues they do equally well as random parameter models in terms of estimation and interpretation. In many studies, the LC model is estimated as a complementary model to the mixed logit. This thesis takes a similar approach.

According to Wen and Lai (2010), if there are S segments in a population with each segment having a different preference structure, the utility of an individual *i* belonging to a segment *s* for an alternative *j* can be expressed as:

$$U_{qi|s} = \alpha_s + \beta_s X_{qi} + \varepsilon_{qi|s} \qquad \textbf{3.11}$$

where α_s is a vector of unknown parameters for segment s; X_{qi} is a vector of attributes that are varied between the alternatives; β_s is a vector of segment-specific parameters to be estimated; $\varepsilon_{qi|s}$ represents the random error term of the utility function. For a latent class model, the probability of an alternative *i* being chosen by individual *q* is given by:

$$P_q(i) = \sum_{s}^{S} P_q(i|s).M_q(s) \quad \textbf{3.12}$$

where

$$P_q(i|s) = \frac{exp(\alpha_s + \beta_s' X_{qi})}{\sum_{i' \epsilon c_q} \exp{(\alpha_s + \beta_s' X_{qi'})}} \quad \textbf{3.13}$$

$$M_q(s) = \frac{exp(\gamma_s' X_q)}{\sum_s^S \exp{(\gamma_s' X_q)}} \quad \textbf{3.14}$$

where X_q is a vector of segmentation variables consisting of individual/socioeconomic characteristics; γ_s is a vector of parameters for segment *s* *(s = 1, 2, …, S)*.

Wen and Lai (2010) further explain that the choice probability for alternative *i* consist of two terms: choice probability within the segment $P_q(i|s)$ is the multinomial logit model, and the choice set C_q contains a set of alternatives including alternative *i*. Also, the probability of an individual *q* belonging to a segment *s* is $M_q(s)$ which is determined by using a standard logit formulation as functions of individuals characteristics. To facilitate identification, the membership coefficient for one of the segments is normalised to zero.

3.10 Alternative Model-Based Methods

The two commonly used alternative methods for analysis using models that relax the IIA are nested logit models and most recently generalised mixed logit models.

3.10.1 Nested Logit Model (NLM)

A nested logit model proves useful when the set of alternatives available to the individual can be decomposed into subsets, often called nests. According to Train (2009), two conditions need to hold:(i) IIA holds for alternatives within a set and (ii) does not hold for alternatives in different sets. In other words, the unobserved factors (or error terms) within a subset need to be correlated and outside a subset to be otherwise.

3.10.2 Generalized Mixed Logit Models/ Generalized Linear Multinomial Models

The generalised mixed logit model (GMIXL) (Fiebig *et al.,* (2010), Greene and Hensher (2010)) or generalised multinomial logit model builds on the history of logit models and is deemed capable of simultaneously capturing both taste and scale heterogeneity (Hossain *et al.,* 2018). The issue of scale heterogeneity has received increasing attention in recent years and is defined by Hess and Train (2017) as "variation across individual decision-makers in the impact of factors that are not included in the model, relative to the impact of factors that *are* included". Hence, respondents whose choices are affected by factors outside the model have smaller coefficients. Conversely, those whose choices are present in the model have larger coefficients.

According to Hess and Train (2017), the mixed logit model can do with ease what the GMIXL model can achieve as the mixed logit has not been defined as a model with uncorrelated coefficients. In other words, if a researcher wants to allow for correlation among utility coefficients, it can be achieved by estimating a mixed logit model with full covariance. Indeed, Hess and Train (2017) assert that researchers should not feel obliged that accommodating scale heterogeneity is somehow more important than other patterns of heterogeneity.

3.11 Welfare Measures

Most DCEs have the objective of estimating economic welfare to inform policy. Moreover, this can be done because DCEs produce quantitative measures of the trade-offs between the attributes under study. Most importantly, the inclusion of a price attribute makes it possible to come up with an estimate of respondents' marginal willingness to pay for specific changes in attribute levels.

3.11.1 Marginal Rate of Substitution (MRS)

The MRS between attributes can be calculated by obtaining the ratio of the partial derivatives of the indirect utility function and has been proven to follow standard economic theory (Hoyos, 2010). Bergmann *et al.* (2008) explain that it is merely a matter of dividing the coefficient (s) of one attribute by another.

3.11.2 Marginal Willingness to Pay (MWTP)

In discrete choice experiments, willingness to pay measures are essential for several reasons. Its importance in informing policy through the pricing of goods and services (Hanley *et al.*, 2003), as important inputs for economic valuations like cost-benefit analyses (Logar *et al.*, 2019) and assessing desirability of goods and services through relative comparisons and ranking (Hole and Kolstad, 2012) is well highlighted in literature.

The standard approach to calculate willingness to pay for a marginal change in the level of provision of an attribute by dividing the coefficient of the attribute by the coefficient of the price or cost attribute (sometimes referred to as implicit price).[30] Hence, the implicit price for an attribute *k* is given as

$$Implicit\ price\ for\ attribute\ k\ =\ -(\frac{\beta_k}{\beta_m}) \qquad \textbf{3.15}$$

where β_k and β_m is the estimated coefficient for the *kth* attribute and monetary (price) attribute respectively. In models like the mixed logit model, this entails obtaining the coefficients by estimating the model in preference space and going on to calculate willingness to pay. As Hole and Kolstad (2012) explain, depending on the choice of

[30] It is important to mention that measures such as implicit price or WTP are not affected by scale parameters because they cancel out.

assumptions for the coefficients, WTP measures can be highly skewed and fixing the price coefficient to circumvent the challenge is often a trade-off between reality and convenience as the latter suggests that no price sensitivities exist across observations.

Train and Weeks (2005) advocate for the derivation of willingness to pay in "WTP space" meaning that WTP estimates are estimated directly in the model where estimated parameters represent the WTP distribution directly and not the usual coefficients as seen in preference space. Though Train and Weeks (2005) observed a trade-off between model fit and plausibility of WTP estimates depending on what alternative is chosen (that is, preference space providing a better model fit), a later study by Scarpa *et al.* (2008) suggests that fit is not necessarily compromised in WTP space. Increasingly, more choice experiment studies are exploring the derivation of WTP in WTP space (see Tu *et al.*, 2016; Balogh *et al.*, 2016 and Kassie *et al.*, 2017).

3.11.3 Welfare change

Bergmann *et al.* (2008) mention that DCEs offer the ability to estimate the economic value of alternative projects by changing the levels of some or all attributes. Bennett and Blamey (2001) explain that the utility of any alternative project(V_1) can be calculated by subtracting it from the utility of a reference project(V_0) and subsequently dividing it by the coefficient of the price/cost attribute as depicted by the equation below.

$$\text{Welfare Change} = -{}^{1}/_{\beta_m}\,(V_0 - V_1) \qquad \textbf{3.16}$$

For this thesis, the welfare measure of interest is the marginal willingness to pay as this fits the objectives of the study. The next section in this chapter will detail the procedure and key stages employed in the DCE design following the best practice documented in the literature on constructing experimental designs for discrete choice experiments.

3.12 Designing the Choice Experiment

Many key researchers including Louviere *et al.* (2000), Hensher *et al.* (2005), Bliemer and Rose (2011) and Johnston *et al.* (2013) have found that stated preference estimates are sensitive to experimental survey design.[31] Experimental design for DCEs is the entire process of generating the specific combinations of attribute and levels used in the choice survey (Johnson *et al.*, 2013). It is also within the experimental design stage that alternative design approaches are considered, and the chosen alternative justified (Bridges *et al.*, 2011).

3.12.1 Selection of Attributes

In a choice experiments survey, one of the most critical steps is the identification of attributes and the assignment of levels (Ryan 1999, Hensher *et al.* 2005, Coast and Horrocks, 2007, Coast *et al.* 2012). Doing this efficiently ensures the success of the experiment and enhances the validity of the results. Attributes are themes concerning the subject of study that can be gathered based on interviews, groups discussions, expert opinions or a literature review (Coast and Horrocks, 2007).

The choice of which to use depends on the context and aim of the study being undertaken (Louviere *et al.* 2000). Coast *et al.* (2012), however, advise that a literature review alone is often inadequate to be exhaustive and relevant for the study and recommends using it in combination with other methods. The use of focus groups with other methods is often observed in DCE design in empirical work. Krueger and Casey (2014) assert that it affords the researcher, an opportunity to uncover people's attitudes, experiences and

[31] More specific evidence to support the argument that small changes in survey design can significantly affect willingness to pay estimates include, the type of question asked (Carson and Groves 2007; Champ and Bishop 2006), specificity and detail of information provided (MacMillan et al., 2006; Munro and Hanley,2001), payment mechanism used (Kovacs and Larson, 2008; Rolfe and Brouwer, 2011) and position of a good amongst a sequence of goods (Carson and Mitchell, 1995; Clark and Friesen, 2008).

biases and this is important for interpreting some trends in survey data which often do not say why. Similarly, this was done in this study and details of country focus group studies is detailed below.

3.12.1.1 Focus Groups

Three focus groups were carried out in the capital city of Ghana, Accra in January 2017. Focus groups lasted an average of 60 – 75 minutes. Groups consisted of 6 to 7 persons (Ghanaians) who made at least 15,000 cedis per annum. All participants were employed and had at least a University degree.

Purposive sampling was used to recruit participants making sure that they satisfied the income requirements i.e. participants should make at least $10 a day, a starting point for the global middle class[32]. In the recruitment, participants were either met face to face, or a preliminary telephone call was used to assess interest. This was done in all cases, followed by an email containing all the relevant materials concerning the study. A few days before the focus groups, participants were sent a reminder email and telephoned to reconfirm attendance. Usually, about nine to ten people are invited. There was about a 30% drop out rate before the day of the event.

Using an open-ended interview protocol, the group discussion was led by the facilitator (lead researcher) with the assistance of a graduate student of the University of Ghana who took notes. Interview questions (see Appendix B) were developed by the researcher with input from the Supervisor and the University of Dundee Research Ethics Committee. Informed consent was highlighted in all communications preceding the focus groups and later explained at the beginning of each of the focus group and consent forms (see Appendix B) distributed for signature. All focus groups were tape-recorded with the permission of participants. Participants were also assured of confidentiality in the report

[32] The exact definition of middle class is provided in the literature review and later in this chapter

of focus group results and all future reports generated from this study. Focus group interview tape-recordings were transcribed using NVivo transcription software and content analysis done to obtain the relevant attributes. The transcripts were manually coded and extract recorded in a table. The report for all three focus groups can be found in Appendix C.

The principal objective of each focus group was to identify the attributes that were important for investing in renewable energy power projects. The facilitator, also the researcher asked a series of introductory questions about the influence of erratic power supply, measures they took to adapt as well as knowledge of renewable energy technologies.

Participants in each focus group were asked to mention some renewable energy technologies and the answers were written on a flipchart by the facilitator. Technologies mentioned include solar, wind, biomass, hydro and geothermal. Majority of participants across all focus groups were most conversant with solar with some already owning the technology in the form of small installations such as lamps. In one of the focus groups, the conversation led to participants being asked to choose their best three (3). All participants mentioned solar and biomass as part of their choices. The others mentioned were mini-hydro and wind. Wind energy was known as being a renewable energy resource but appeared unfamiliar to many participants.

To investigate their interests further, participants were asked what technologies they would invest a sum of GHS100 (USD 25) if they had to choose. Participants had difficulty understanding this as many thought this amount was small to make an impact in funding any of these technologies. The moderator explained that the amount was to gauge their affinity for the technologies further and not to skew their interests from one they liked to another because the amount could not entirely finance that technology. It was further explained that the projects would most likely be crowd-financed and that all options were on the table.

With this understanding, participants proceeded to make their choice. Here also, the majority (at least 3 in every group) of the participants chose solar PV technology as to where they would invest their money. Two participants in one group opted for a combination of solar, wind and mini-hydro, splitting their investment among all three. A combination of biomass and wind as well as biomass only was also recorded amongst the choices. This exercise supports the hypothesis that participants allocate their resources based on their *a priori* knowledge and experiences about renewable technology type, and this affects their investment decisions**.**

3.12.1.2 Attributes and Levels

Six key attributes emerged after analysis of the three focus groups and detailed literature study. They are:

1. *Rate of return on investment*
2. *Track record of the project developer*
3. *Project viability*
4. *Price of investment*
5. *Hold time/holding period*
6. *Origin of project developer*

After attributes were identified, levels were specified for each attribute. A total of 21 levels were associated with the six attributes and can be found in Table 4.2 below. In the determination of levels for the range of rates of returns that would be realistic for the survey, a series of approaches were taken. Country research on the interest rate on treasury bills was considered. At the time of designing the survey (July 2017), treasury bill rates were approximately 12 % per annum for 91-day treasury bills (Data Bank

Research, 2017).[33] Investment news on renewable energy project yields from funds often report at least a 5% interest per annum in the UK and the US (Financial Times, 2018). For example, the UK crowdfunding platform Abundance in 2016 gave investors about 6% annual return for direct investment in renewable energy projects through bonds. It is well known that the average returns on projects in emerging economies can be double that of developing countries – perhaps reflecting the higher risk in these regions. Hence, a lower limit of 5% was included in levels with 3% increments to reflect old and prevailing country investment alternatives.

Track record of the developer was captured as a subset of developer reputation in focus group discussions. As Shefrin (2001) would argue, investors see companies with high reputational rating as excellent investment opportunities, and for a project developer, execution of projects to expectation is a key consideration. In other words, the track record is a good signal for competence and trustworthiness. A lower limit of “no track record” and higher limit of having completed more than five similar projects in the past was used.

[33] Data Bank is an investment bank in Ghana offering a range of investment products and research to organisations. It reported interest rates for treasury bills remained above 20% during the first three quarters of 2016. This was attributed to issues of inflation uncertainty, tight GHS liquidity, banks’ reduced desire for credit expansion and high refinancing risk faced by the government.

Table 3.2 Selected Attributes and Associated Levels

Attributes	*Description*	*Levels*
Rate of Return	This is a measure of how profitable the investment is. A high return denotes high reward and vice versa for a low return.	5%, 8%, 11%, 14% and 17% per annum
Track Record of the Project Developer	This captures the experience or achievements of the developer in delivering similar projects in the past. This is a subset of the overall reputation of the developer.	**None** (This will be the first project being undertaken) **Some (**Executed five similar projects in the past) **Lots (**Executed more than five similar projects in the past)
Project Viability	This is a measure of how a project will survive, remain profitable and grow. For power projects, certain rights and guarantees enhance the viability of a project, and the more of these guarantees exist for a project, the greater the likelihood of it surviving and remaining profitable. These include the right to grid access, a guaranteed feed-in-tariff (FiT), investment subsidies and a long-term contract (LTC).	**Low** (Right to grid access) **Moderate** (Grid access + FiT) **High** (Grid access+ FiT +Investment subsidies) **Very high** (Grid access + FiT + Investment subsidies + long term contract)
Price of Investment	This is the minimum amount required to partake or own a share in the investment.	GHS350, GHS500, GHS 650
Hold Time	This is the time between purchasing the investment and when it can be sold.	9, 18, 27, 36 months
Origin of project developer	This refers to where the firm developing the power plant originates. In this study, the options under consideration are domestic (local) or foreign (international). This is also a subset of the developer reputation characteristic.	Domestic (Ghanaian) International (Foreign)

The levels of “origin of developer” were clear cut in focus group discussions where respondents distinguished between local and foreign (international companies). Respondents viewed the developer origin as a component of developer reputation.

The price for investment was obtained by considering the minimum requirements for investing in well – known options like treasury bills. Research from financial institution showed a minimum of GHS500 (~ USD 110) for treasury bills. Mutual funds have lower minimums starting at around GHS50 (USD 12) depending on the institution. The minimum for treasury bills was used as a midpoint minimum, and GHS350 and GHS650 used as lower and upper limits respectively for the minimum price.

In choosing the levels for project viability, it was observed throughout the literature that the viability of most energy projects, including renewable projects, is affected by the presence or lack of support systems and policies. Issues such as regulatory uncertainty, demand uncertainty and permitting process uncertainty have been identified as problems that undermine the development and viability of projects (Lee and Zhong, 2015). The reduction of these risks often helps to boost investor interest (Dinica, 2008; Gatzert and Vogl, 2016). In the renewable energy space, access to the grid, guaranteed feed-in -tariffs, investment subsidies and long-term contracts have been employed to deploy renewable energy projects to varying degrees of success around the globe and especially in countries in the European Union. These support schemes were combined to give low, moderate, high and very high depending on the support the project has as already seen in Table 3.2.

The hold time/ holding period denotes the minimum time after a retail investor can withdraw the initial investment. Included were four levels starting at nine months to 36 months (3 years). This was to assess the preferred time horizons for renewable energy investment.

3.12.1.3 Selection of Profiles

The most complete design is the full factorial design which combines levels of attributes (Hensher, 2005). Given the six attributes and the 21 associated levels for this study, a full factorial will necessitate the use of 1440 possible profiles.[34] Using such a large number will be highly inconvenient and burdensome for respondents, and several approaches exist to reduce the number of profiles without affecting the integrity of survey outcomes. These include reducing the attribute levels, using a fractional factorial design or using a D-efficient design.

3.12.1.4 Fractional Factorial Designs (Orthogonal)

As stated above, a fractional factorial design is a subset of full factorial design that is often used due to its practicality and convenience. According to Rose and Bliemer (2009), the best known fractional factorial design is the orthogonal design. Orthogonality ensures that no correlation exists between attribute levels of one profile to another profile. Put another way, the change in one attribute in relation to another within one profile is independent of the change in one attribute to another in all other profiles in the selected fraction. As argued by Kuhfeld (2005) and Mangham *et al.* (2009), it ensures that attributes remain statistically independent, and variance is maintained between parameter estimates. Although recent stated preference literature document the statistical efficiency in efficient designs, they require the identification of appropriate scaled parameter priors (Bliemer and Collins, 2016). The difficulty in obtaining parameter priors from the literature and pilot surveys for the context being investigated made the orthogonal design the practical option.

In this experiment, a fractional factorial design was employed to reduce the full factorial of 1440 to 29 profiles that can be used to estimate main effects. Econometric software

[34] This is obtained by multiplying the levels for all six attributes: rate of return (5), track record (3), project viability (4), cost/price (3), hold time (4), Origin (2)= 5*3*4*3*4*2=1440.

(SPSS Version 22) was used to select the optimal choice profiles, which were combined to make up the choice sets (choice groups) used in the experiment. This set of profiles were also orthogonally designed, and each profile was examined for rationality. Here rationality means it should be realistic and practical as an alternative in the real world. After careful examination of profiles, the presence of irrational profiles was considered absent. Table 3.3 presents the 29 choice profiles (with four holdouts included).

Table 3.3 Attribute Profiles Designed for Choice Experiment

	Card ID	Developer Track record	Origin of developer	Price of Investment (GHS)	Return on Investment (%)	Project Viability	Hold Time
1	1	None	Domestic	500	17	Low	18
2	2	Some	International	500	14	Low	9
3	3	Lots	Domestic	500	14	Low	36
4	4	Some	Domestic	350	17	Moderate	36
5	5	Some	Domestic	350	17	High	9
6	6	None	Domestic	650	5	Low	9
7	7	Lots	Domestic	500	8	High	9
8	8	Lots	International	350	5	Moderate	18
9	9	Lots	Domestic	350	11	VHigh	9
10	10	Some	International	350	11	Low	9
11	11	None	International	500	8	Moderate	9
12	12	None	International	350	14	High	18
13	13	None	Domestic	500	11	Moderate	27
14a	14	Lots	International	350	8	Moderate	18
15	15	Lots	International	650	17	Low	27
16a	16	None	International	650	14	High	9
17	17	Some	Domestic	650	8	VHigh	18
18	18	Some	International	350	8	Low	27
19	19	Some	International	500	5	VHigh	36
20	20	None	Domestic	350	8	Low	36
21a	21	None	Domestic	500	8	High	9
22	22	Some	Domestic	500	5	High	27
23	23	None	International	500	17	VHigh	9
24	24	Some	Domestic	650	14	Moderate	9
25	25	None	Domestic	350	5	Low	9
26	26	Some	Domestic	500	11	Low	18
27	27	None	International	650	11	High	36
28a	28	Lots	Domestic	500	11	High	36
29	29	None	Domestic	350	14	VHigh	27
a Hold out							

3.12.1.5 Labelled and Unlabelled Alternatives

In a choice experiment design, the researcher will have to decide if whether they want to ascribe labels for the alternatives presented to respondents. Labelled alternatives come in handy when the researcher wants to estimate a utility function for each alternative in the choice set. Here, the use of orthogonal design becomes essential as the independent effect of each attribute in each alternative depends on the orthogonality within and between alternatives. The labelled design allows the researcher to estimate a constant term already mentioned earlier in the chapter as the alternative specific constant (ASC). This measures the utility respondents derive from unobserved attributes associated with the labels of the alternatives hence captures the component of utility that lies outside the attributes included in the design.

In unlabelled designs, the researcher may only be interested in estimating a single utility function. At certain times in unlabelled designs, an alternative specific constant can be included for the status quo alternative to measure any bias. A statistically significant constant suggests a preference for or against the status quo option depending on the associated sign.

This experiment opted for a labelled design to allow measuring of the utility associated with each alternative. As seen below in the example of the choice card presented (Table 3.4), four labelled alternatives were presented to respondents (A, B, C and D). Options A and B are associated with the change being measured (that is, investing in renewable energy projects); C is the status quo option while D is the opt-out option. The choice of best worst format (see Louviere et al., 2015) at the time of designing the survey was to obtain more information by asking respondents to not only choose their best (as used in traditional DCEs) but their worst choice as well. However, it was later decided that the responses from the best choice questions were enough to achieve study objectives as done in traditional DCEs.

Table 3.4 Example of a Choice Set

CHOICE CARD BROWN

Characteristics	**Option A**	**Option B**	**Option C**	**Option D**
Track record of developer	Some	None	Invest in Treasury bills at 12% for 91 days	None
Origin of developer	International	Domestic		
Cost of Investment	500GH¢	350GH¢		
Return on Investment	5%	8%		
Viability	Very High	Low		
Hold Time	36 months	36 months		

In which option would you **most likely** invest?

- ☐ A
- ☐ B
- ☐ C
- ☐ None
- ☐ Decline to Answer

In which option would you be **least likely** to invest?

- ☐ A
- ☐ B
- ☐ C
- ☐ None
- ☐ Decline to Answer

3.13 Survey Questionnaire Design

This section details the steps taken in the design of the survey questionnaires following guidelines present in what many consider the survey bible by Dillman (2009,2014) and other survey design books like Grooves *et al.* (2009) and Marsden and Wright (2010). Survey advice, guidelines and best practices remain standardised across the board with slight nuance depending on survey mode whether paper, mail or internet-based.

The first step in designing a survey is identifying what is to be measured or learned, and this often lies in the study goals or objectives. By identifying what is to be measured, the questions that best capture or quantify these measures are identified. Crafting of questions to optimally reflect what the researcher intends to measure can be challenging, but Champ (2017) advises the review and consultation of similar studies on the proposed topic to get a sense of appropriate questions for the researcher's outcomes.

Language and choice of vocabulary are issues that affect survey outcomes and must be dealt with at the design stage. Grooves *et al.* (2009) suggest that focus groups and other qualitative approaches can help the researcher identify the language most appropriate and easy to understand. As mentioned earlier in the chapter, focus groups and piloting of survey was done to check understanding of language and choice of vocabulary.

Equally important is the issue of question order and format. Generally, survey researchers have found the effect of these on survey completion and bias. Specifically, order effects have been reported in several stated preference studies including Chrzan (1994), Bateman and Langford (1997) and Powe and Bateman (2003). On the issue of question order effect on completion, Sudman and Bradburn (1982) suggest starting a questionnaire with easy, non-sensitive questions. Sensitive questions regarding respondents' income and demographic information are more likely to be completed if found at the end of the surveys[35](Dillman, 2009). For researchers keen on included demographic data in logit models that incorporate covariates for analysis, getting an appreciable sample to provide these details is crucial. With this in mind, demographic information including income were put at the end of the questionnaire with a statement depicting how important demographic information are to the interpretation of study findings.

[35] Indeed, this is the general practice in most surveys. Demographic questions are kept at the end and this is often completed because respondent have already invested a few minutes filling out the survey and feel obliged to complete it.

Questionnaire length must also be taken into consideration. Questionnaires need to be short as possible as unnecessarily long questionnaires are a put-off for respondents and issues of respondent fatigue can produce incoherent responses. Thus, a good practice is to include only what contributes to the survey goal and objective. Last but not least, some advice on questionnaire optics or aesthetics are equally important. The cover of the questionnaire must be given attention and well-thought-out as it will serve as the first avenue to connect with the respondent and inspire trust.

The questionnaire was designed with the title page having a photo illustrating what the survey was related to. Questionnaire length was also examined at the pilot phase to ensure clarity and that duration did not induce cognitive fatigue.

3.13.1 Validity tests

Validity tests for DCEs can be internal or external. Internal validity tests are made to check for standard assumptions about individual preferences that are, conformity to axioms on monotonicity and transitivity. When all the basic axioms are complied with, it is generally referred to as preference consistency (Hoyos, 2010). Many studies in stated preference literature that incorporate preference consistency assessments have obtained mixed results. For example, no evidence of violations of the assumptions about the stability of preferences and transitivity is reported by Carlsson and Martinsson (2001). Others, on the contrary, reported preference inconsistency in their studies (Deshazo and Fermo, 2002; McIntosh and Ryan, 2002). Specifically, Day and Prades (2010) find that the assumption on the individual preference stability in DCE choice tasks is compromised by ordering anomalies.

Other tests for measuring preference inconsistency are rationality tests. These tests often involve the inclusion of an additional choice task with a dominant alternative, and it is expected that respondents will choose that alternative as most optimal if they behave rationally. In many cases, however, irrational responses result, and these are capable of inducing bias as well as increasing variance (Foster and Mourato, 2002 and Hoyos, 2010). Although some level of bias can be introduced by irrational responses, removing such responses based on irrationality is more problematic, and this could reduce statistical efficiency and power of the estimated model and induce sample selection bias (Lancsar and Louviere, 2006).

3.14 Survey Components and Structure

The designed questionnaire for this study had nine(9) sections: an introduction and informed consent section, question on investor profiles, question on financial literacy, question of technology preference, description of attributes, steps in a choice survey and choice scenario and options, summary table of attributes and levels, ranking of attributes or characteristics, presentation of 8 choice sets of best and worst scale format and a final page for collecting respondents socio-demographic details. The complete survey detailing all these sections can be found in Appendix A. A brief description of each section is presented below.

i. The questionnaire begins by looking at the electricity access and reliability challenges in most countries in Sub-Saharan Africa and the solution that renewable energy technologies bring in securing energy supply cleanly and sustainably. It mentions the increasing use of renewable energy and how investment makes this possible. It focuses on Ghana and its national target to increase the share of renewable energy in the power mix and explains the aim of the study which is to find out the conditions under which citizens would like to invest in small -scale renewable energy power projects in Ghana. Following is a consent portion where respondents express their willingness to voluntarily participate in the survey.

ii. This section seeks to unearth respondents' level of experience and knowledge about investing. Specifically, it asks about respondents' style and nature of investing. Two questions feature here: a question of who makes the investment decision and investing style (frequency, risk and motive).

iii. The financial literacy test section tests respondents' knowledge of compound interest, risk diversification and inflation (time value of money).

iv. Respondents preferences for different renewable energy technology types are assessed here using a ranking exercise. Technologies assessed were solar, hydro, wind and biomass.

v. The six attributes discussed earlier are described here. This is followed by a description of the steps employed in a choice survey as well as the scenario and options to be considered in the next series of choice sets.

vi. A summary table or all the attributes with their associated levels are presented.

vii. An assessment of the importance respondents attached to each attribute is investigated in an attribute ranking exercise.

viii. The choice sets are then presented with four possible alternatives to choose from. Options A and B are different options for investing in the renewable energy power project described in the scenario. Option C is the status quo alternative, which is an investment in a 91-day government treasury bill at 12% per annum. Option D is the opt-out or "none" option, which is a preference for none of the three alternatives.

ix. The final section of the questionnaire collected details of respondents' socio-demographic information. Details requested include gender, age, occupation, the highest level of education and annual household income.

3.14.1 Survey Questionnaire Pilot

The questionnaire as described was subjected to review by an experienced non-market valuation practitioner as well as pre-tested with a small group of people to assess clarity, comprehension, cognitive burden and usefulness of data being requested. Feedback from the pre-testing process led to the redesign of the table for attributes and levels as some respondents confused it as a ranking table. Also, small changes in certain terminology and answer options for socio-demographic responses were done.

3.14.2 Sample Selection

On issues of sample selection, these fundamental issues feature prominently: the sampling frame, sample size, sample design and rate of response (Fowler, 2013). The sampling frame defines the researcher's population of interest. The type of people the researcher wants to survey is often referred to as the target population. Ensuring correct identification of the target population is critical for reducing bias and having results that reflect the researcher's objectives.

Sample size determination often requires some consideration depending on the aim and resources for the study. Many researchers highlight some points to consider during this process. According to de Bekker-Grob *et al.* (2015), the minimum sample size for DCEs depends on the hypotheses being tested. Lancsar and Louveire (2008) based on empirical experiences suggest that "one rarely requires more than 20 respondents per questionnaire version to estimate reliable models but undertaking significant post hoc analysis to identify and estimate co-variate effects invariably requires larger sample size."

Generally, certain elements must be known before the minimum sample can be calculated. These are the significance level(α), statistical power($1-\beta$), statistical model for DCE analysis, belief about parameter values and DCE design (de Bekker-Grob *et al.*, 2015). The significance level, which is the probability of rejecting the null hypothesis, is often set at 0.05 to obtain a 95% confidence level. With knowledge of the population proportion and required confidence level, minimum sample sizes can be obtained from statistical tables or software. Alternatively, Orme (1998) and Johnson and Orme (2003) assert that sample size required can be calculated using the choice tasks(T), the number of alternatives(A), the highest number of levels for any of the attributes(l) according to the equation:

$$Sample\ size(n) = \frac{500l}{TA}$$

Based on this power calculation, the suggested sample size would be 78 respondents. Despite the Orme (1998) calculation suggesting a sample size of 78, this study aimed for a bigger sample size. A larger sample was pursued because of the general understanding that larger sample sizes allow for greater precision and confidence and will enhance representation of the target population.

In several DCE literature produced from empirical work, such hard and fast rules or power calculations are just a part of the sample size decision. Factors such as time, budget and other research resource constraints feature in the decision. In healthcare (an area where many DCEs have been conducted), 100-300 respondents were often the limits (Johnson *et al.,* 2013; Marshall *et al.,* 2010). The sample size used in this DCE is 201 respondents.

Sampling Procedure

Generally, sampling is either probabilistic or non-probabilistic, and the choice of which to employ often depends on what inference one wants to draw between the sample and the general population. Probability sampling allows for each unit in the study population to have an equal probability of being chosen(nonzero). This property is what allows for inferences to be made from sample to the general population. Examples include simple random sampling, cluster sampling and stratified random sampling. Non-probability samples, however, have other objectives in mind than generalisation - often a sub-group of people are of interest. Economic experiments often use non-probability sampling techniques for recruiting survey respondents (Champ, 2017). Among them are convenience sampling, quota sampling and purposive sampling techniques. This study utilised a non-probability sampling approach.

Quota Sampling

Quota sampling occurs where individuals are recruited based on several predetermined characteristics. Many discrete choice studies employ this sampling approach (see Hanley *et al.,* 1998; Lee and Mjelde, 2007; Ladenburg and Olsen, 2008; Zanoli *et al.,*2013; Giles *et al.,* 2016) Often quotas are based on demographic variables like age, gender, educational attainment and income and designed to reflect key demographics of the target population. The discussion on sampling methods is incomplete without a brief look at sample error or biases the researcher should try to minimise.

Biases in stated preference research

Biased answers may cause serious distortion of the stated preference data from real behaviour. Tietenberg and Lewis (2012) describes five types of potential bias: strategic bias, information bias, starting-point bias, hypothetical bias and the observed discrepancy between willingness to pay and willingness to accept. Bias suggests that the respondents surveyed differ from the target population, while sampling error means data is collected from the sample rather than the whole population (Fowler, 2013). There are many sources of sampling bias in surveys with one of the most known being non-response bias.

Non-response bias occurs when respondents fail to answer a question or a series of questions and thus create a situation where the people who answered are different from those who did not. e.g. Income often suffers from non-response in surveys. Nonresponse can take two forms: total nonresponse due to individuals failing to return the survey or unit or item non-response which indicates that the survey was returned incomplete (Fraenkel and Wallen, 1993; Sax *et al.*, 2003). Either of these can lead to over-representation and under-representation of certain groups in the sample. This, in turn, has implications on the validity and objectivity of survey findings. Thus, it is good practice for the researcher to declare the non-response rate and how it could influence survey findings.

3.15 Sampling Procedure for DCE Questionnaire

The study sought to identify household investor preferences for renewable energy investments. With the common definition of investors being people who invest their savings, the relevant population of interest must have savings. National populations have people belonging to different income groups, including those below the poverty line. Targeting those with potential savings requires an approach that excludes those below the poverty line as their inputs concerning the survey aim may be flawed.

Excluding those below the poverty line, the middle class is considered a strong starting point as this group has consumption outside physiological needs such as food, water and shelter. More importantly, this class is likely to have more disposable income or larger savings than the poor (Chun *et al.*, 2017) enabling them to save and invest hence a more likely target group for investing.

In economic literature and studies, the middle class is regarded as an engine for growth and prosperity. Globally, the growth of the middle class is seen as a harbinger of economic growth due to increased consumption within the class (Mawdsley, 2004; Kharas and Gertz, 2010). The OECD (2019) argues that the presence of the stable middle class serves as a support to healthy economies especially through their investment in sectors of the economy and their contribution to social development (championing good governance and political stability).

However, there is little consensus on the definition of the middle class (lifestyle and income that is, relative and absolute measures exist). Definitions that use an income metric are however deemed more suitable for economic studies such as this. The relative definition defines the middle class as individuals or households that fall between the 20th and 80th percentile of a country's consumption distribution (Kharas, 2010; AfDB, 2011). The absolute approach definition for global members of the middle class is those that live on US$10 a day or above (Birdsall, 2010) or people who earn between US$10 and US$100 per day per capita in purchasing power parity terms (Kharas, 2010 and Kharas and Gertz, 2010). Studies such as Leke *et al.* (2010) and Deloitte (2012) have also reported on the African middle-class consumer. The report by Deloitte (2012) on the rise of the African middle class identified the middle class as follows:1. Have higher levels of tertiary education 2. Live in urban centres in bigger dwellings with modern equipment as well as harnessing technology 3. Young and in the acquisitive phase of life 4. Holding salaried jobs or are small business owners.

A key report by the African Development Bank (AfDB) (2011) adopts the absolute approach and classifies the African middle class into floating (US$2-US$4), lower-middle (US$4–US$10) and upper-middle (US$10-US$20). The report also cites other indicators such as the middle class being less likely to derive income from farming and rural economic activities. Instead, they tend to hold salaried jobs or operate small businesses. Combining all that is known about the middle class in Africa and globally, the study chose the US$10 a day per capita threshold in purchasing power parity terms (2017 PPP) which reflects the starting point of the global middle class rather than the floating and lower-middle classifications in the AfDB (2011) as the income qualification criteria in this survey.

At the minimum, participants had to make a gross annual household income of at least GHS15,000(US$3,489 and US$10 day using 2017 exchange rate) which is US$7,588 in

2017 PPP.[36] In Ghana, the annual household income and expenditure for an average household size of 4 persons is GHS16,645 (US$8,420 in 2017 PPP) and GHS 9,317 (US$4,713 in 2017 PPP) respectively (GLSSS, 2014). This leaves a potential saving of US$3,707 in 2017 PPP at the national level. At the quintile level, the fourth a quintile group have annual household income and expenditures of GHS16,910 (US$8,553 in 2017 PPP) and GHS9,238 (US$4,673 in 2017 PPP) while the fifth quintile group have GHS25,201 (US$8,553 in 2017 PPP) and GHS14,665 (US$8,553 in 2017 PPP). This leaves potential savings of US$3,880 and US$5,329 in 2017 PPP terms for the fourth- and fifth-income groups. Participants for the study at the lowest income band fell into the fourth- and fifth-income strata which represents at least US$10 a day (GHS15,000; US$3,489) and an annual household income of US$7,588 in 2017 PPP (See Appendix D-2).

The survey was administered in Accra, the capital city as it has the greatest percentage of households in the fourth- and fifth-income quintile (See Appendix D-2) who are most likely to meet the income requirement. A combination of recruitment methods was used, primarily setting up and advertising the survey at key event centres like the Accra International Conference Centre (AICC) that hosts many conferences from different industry groups annually. This was supplemented with visits to institutions and administering the questionnaire. With this need for screening for a set of criteria, the sample can be best described as a purposive sample. If the person approached did not meet the income criteria, the questionnaire was not administered.

Using this approach, only about 10% of persons approached failed the income screening. The sampling aimed for a balanced sample concerning gender and occupation, but the

---

[36] The World Bank PPP conversion factor (LCU per international $). Available at: https://data.worldbank.org/indicator/PA.NUS.PPP?locations=GH. For 2017, this is 1.977 GHS (LCU) per dollar.

income screening meant that people in professional occupations were more represented. Majority of the times, meeting the income criteria meant a tick on other criteria such as employment, education etc. The average time taken for filling each questionnaire was about 20 minutes.

3.16 Modes of Survey Data Collection

Another critical decision the researcher needs to consider is what mode to employ in collecting survey data as this has implications on response rates, e.g. non-response bias as discussed above. The survey modes available range from traditional paper and pencils surveys, mail and the use of technology such as telephone or internet-based (email) surveys. Work has been done by many survey researchers comparing these modes and how to improve response rates (see Claycomb *et al.*, 2000; Groves, 2002; Andersen and Blackburn, 2004; Shih and Fan, 2009; Dillman *et al.*, 2009; McPeake *et al.*, 2014).

Most notably, electronic surveys have been compared with traditional paper and pencil types. Some skew is observed in favour of paper-based surveys in terms of better response rates; however, other authors report no significant difference, perhaps due to improvements in techniques for eliciting better responses. Nonetheless, the ease of analysis and cost reductions make electronic surveys popular. A disadvantage for electronic, that is, internet surveys is the issue of sampling bias due to age related differences in internet use (see Hayslett and Wildemuth, 2004).

To utilise the internet for data collection requires good telecommunications infrastructure and connections – an environment that characterises higher-income areas. Thus, it is often difficult to employ this mode of data collection in developing countries where such infrastructure can be inefficient. Though paper-based surveys can be time-consuming and costly, response rates are high, and the target population can be reached. It must, however, be stated that improvements in technology continue to enhance the use of tablet computers in rural country surveys in Africa. Use in health and conservation studies is especially gaining momentum (see Leisher, 2014 and Lietz *et al.*, 2015). Though time and cost savings with data entry are clear advantages, theft risk and wifi instability, as well as a damaged tablet, could increase the risks (Leisher, 2014). Considering the developing country context of this study, length and content, an electronic survey was deemed unsuitable, and hence a paper and pencil survey mode was adopted.

3.16.1 Face to Face Surveys

Despite the rise in popularity of online surveys, face-to-face (in-person) interviews or surveys provide several advantages over other data collection methods depending on where the study is undertaken. The advantages include accurate screening, high cooperation and low refusal rates, ability to accommodate longer more complex interviews or surveys and amenability with other data collection methods. Clear disadvantages, on the other hand, include high cost, more extended data collection period and interviewer concerns.

3.16.2 Paper-Based Surveys

Paper-based discrete choice surveys are popular in developing country contexts, for example in Chaminuka *et al.* (2012) and Terris-Prestholt *et al.* (2013) (both in South Africa) and Kruk *et al.* (2009) in Tanzania. In collecting data, the minimum sample size should be taken into consideration and more than that given out to account for non-response. Aside from meeting the minimum sample size, the representativeness of the target population must be monitored to know when to sample more or less of a particular subgroup or demographic. Altogether about 250 paper-based questionnaires were administered. Two hundred and one questionnaires were obtained in all corresponding to an 80% response rate.

3.16.3 Incentives

Discussion of survey response rates is often incomplete without a brief look at incentives. It is not uncommon for survey administrators to counter non-cooperation by offering incentives to respondents at different stages along with the survey, especially in mail surveys (Singer *et al.*, 1999; Singer and Ye, 2013). The consensus is that both monetary and non-monetary incentives increase overall response rates. Attention has however, been given to the various types of incentives, issues with timing and the improvement in response rates.

The underlying theory or possible explanation for why incentives work is the rational cost-benefit analysis respondents make. An incentive that fails to elicit the response for which it was intended may have a distortion in its cost-benefit ratio from the respondents' perspective. At this point, it is essential to note that the effect of incentives may differ across groups. Groves *et al.* (2000) use the leverage-salience theory to explain the effect of incentives on different people positing that people vary in the importance they assign to different aspects of a survey request. For instance, for one individual, the topic may be what stimulates interest; for another, it may be the cash reward. Ryu *et al.* (2005) have found that incentives are instrumental in drawing in low income or lower education populations as well as minorities.

In the area of discrete choice surveys, Johnston *et al.* (2017) opine that incentives like cash may be less important than what respondents are told/understand about the consequentiality of their responses. They argue that a researcher's goal should be "to present respondents with an incentive-compatible valuation exercise that involves a plausibly consequential decision". Vossler *et al.* (2012) explain that two assumptions underly consequentiality: 1. That individuals care about the cost or benefit of some of the policies or changes being contemplated and 2. That the respondent/agent views the responses as influencing the agency's action. In other words, consequentiality provides an incentive for participants to take part in a DCE, and hence the survey design must ensure the information provided supports decision making and preference elicitation – hence reducing the need for incentives like cash. By doing so, true preferences are also revealed.

This survey did not utilise any cash incentives. For many respondents, a description of the survey and its aims were enough for subscription. Often, respondents stay after the survey to discuss what they thought about it and the implications if a real-life project like that existed. From what was observed, it can be deduced that the primary incentive for the middle class was of genuine interest in the topic. Though it may not be relevant, sweets were available at survey stands for respondents if they wanted them.

3.17 Summary

This chapter presented the design of the discrete choice experiment used to quantify the attributes relevant for household investment in crowdfunded renewable energy projects. The discrete choice methodology (a stated preference approach) was adopted due to its ability to assess the value of non-market goods in hypothetical setting and practical for the valuing of multiple attributes. The chapter addresses the conceptual framework for discrete choice experiments and briefly discusses Lancaster's characteristics theory of value and Random Utility Model (RUM). It further addresses the multinomial logit model and the mixed logit model (also random parameter logit model) within the RUM framework as well as other alternative models like the latent class model and others. It proceeds to discuss the welfare measures such as the marginal willingness to pay both in preference and WTP space.

Additionally, the chapter outlines the steps taken in designing the choice experiment with sections on how the attributes were used in the choice experiment. It proceeds to discuss how the target population (potential investors) for the survey were identified paying attention to the fact that national populations have people belonging to different income groups including those below the poverty line and targeting those with potential savings requires an approach that excludes those below the poverty line. Also, considerable attention was devoted to the mode of survey data collection and issues such as incentives.

CHAPTER 4 DISCRETE CHOICE EXPERIMENT SURVEY RESULTS

4.1 Introduction

This chapter presents the results of the discrete choice experiment designed in the last chapter. It uses econometric regression methods to quantify household or retail investors preferences for renewable energy project investments. The discrete choice study aimed to investigate the preferences of household or retail investors for crowdfunded renewable energy power projects. Specifically, it seeks to address the following key objectives:

1. To determine the marginal willingness to pay for renewable energy investment attributes.
2. To determine where heterogeneity exists, if any, in preferences for attributes.
3. To investigate the effect of demographic variables like age, education and income on the likelihood of investing.

In the following section, the respondent demographics and the preliminary survey questions are reported. Subsequently, the results of the discrete choice survey are presented. The preliminary survey questions cover: (A) Who makes the investment decision in the household; (B) Questions about respondents investing style; (C) The preferred choice of renewable energy technology, and (D) Ranking of attributes.

The results from the discrete choice survey comprise: 1. results on mean utility for the attribute levels as well as the significance of each attribute towards investment decision making; 2. results on the marginal willingness to pay for each attribute. 3. Results of mixed logit and a latent class model to assess preference heterogeneity.

4.2 Respondent Demographics (Descriptive Statistics)

Gender

Out of the 201 participants surveyed, 129 identified as male while 72 were females representing 64.2% and 35.8% respectively.

Age

Survey respondents spanned the ages of 18 to greater than 65 years of age as seen in Table 4.1 – a range exemplifying an active work population. The least represented are individuals older than 64, who represented 2% of total respondents. This is expected as many in this age category would be expected to be retired or nearing retirement. It may be noteworthy to add that many African countries have a young demographic population. According to UNECA (2016), persons aged 65 is still very low in most African countries; as at 2015 countries such as Mauritius, Seychelles, Tunisia, Egypt, South Africa, Cabo Verde, Morocco and Gabon were the only countries where persons aged 65 years and above made up at least 5 per cent of the total population.

Table 4.1 Age Distribution of Survey Respondents

Age distribution	18 – 24	25 – 34	35 – 44	45 – 54	55 – 64	< 65	**Total**
Number of Respondents	10	103	61	15	8	4	**201**
% Respondents	5.0%	51.2%	30.3%	7.5%	4.0%	2.0%	**100%**

Occupation

The occupational classification used in this study was adopted from the GLSS classification and is consistent with the International Standard Classification of Occupation (ISCO-08) index. Majority of survey respondents from Table 4.2 identified as professionals/managers/legislators. The least represented were skilled agricultural workers or people with elementary occupations. Literature and empirical studies identify skilled agricultural workers, i.e. crop growers, livestock farmers as unlikely to be middle income in most African countries due to the subsistence nature or scale of farming. According to the GLSSS survey, professionals and managers/legislators receive the highest average monthly earnings, while the lowest-earning were among skilled agricultural/fishery workers (See Appendix D-3). This explains the dominance of professionals and managers in the survey and the underrepresentation of the skilled Agric class because respondents were screened for income.

Table 4.2 Occupational Categories of Respondents

Occupation Category	No. of Respondents	% of Respondents
Clerical support	5	2.5%
Elementary occupations	2	1.0%
Managers/Legislators	35	17.4%
Professionals	120	59.7%
Service or Sale workers	16	8.0%
Skilled Agric workers	4	2.0%
Technicians/Associate Professionals	19	9.40%
Total	**201**	**100%**

Education

More than 90% of respondents had at least a University degree or Diploma. Those with University education only represented 49% while those with a master's degree represented about 46% (as seen in Table 4.3). Least represented are those without a degree and those with more than a master's degree.

Table 4.3 Educational Distribution of Respondents

Education Category	No. of Respondents	% of Respondents
Below Degree/Diploma	3	1.5
University Degree/Diploma	99	49.3
Master's Degree	93	46.3
Above Master's Degree	6	3.0
Total	**201**	**100.0**

Annual Household Income

Lastly, Table 4.4 provides a breakdown of the annual household income for respondents, income category per day (2017 PPP) and how this compares with the AfDB and global middle-class income benchmarks.

4.3 Representativeness of Sample

This study was unable to generate a representative sample due to the absence of a reasonable sample frame from which to obtain a probability sample. Ordinary and available data sources such as national sample surveys often do not provide a detailed analysis that makes for a thorough identification of the middle class. Thus, many studies on the middle class have adopted a descriptive/lifestyle categorisation (see Deloitte, 2012; Tschirley *et al.*, 2015).

Though there was no sampling frame from which to draw a probability sample, income and other demographic data that characterise the middle class as earlier described were used to ensure that respondents who took part in the survey earned at least US$10 a day which represents the start of the middle class globally as shown in Table 4.4 below.

Table 4.4 Annual Household Income Distribution of Respondents

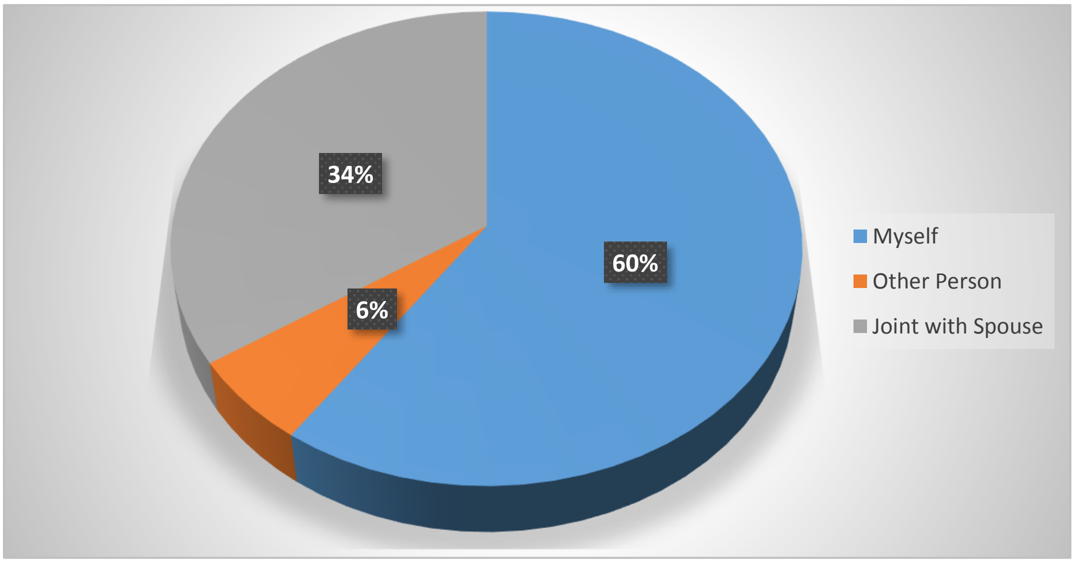
Income Category (GHS)	Income Category (USD, 2017 Exchange Rate)	Income Category Per Day (USD, 2017 Exchange Rate)	Income Category (USD, 2017 PPP)	Global Middle Class Benchmark (USD per day PPP)	AfDB Upper Middle-Class Benchmark (USD per Day PPP)	No. of respondents	% of Respondents
15,001-25,000	3,489-5,814	10-16	21-35	10	10-20	56	27.90%
25,001-35,000	5,814-8,140	16-22	35-49	10	10-20	25	12.40%
35,001-45,000	8,140-10,465	22-29	49-62	10	10-20	29	14.40%
45,001-55,000	10,465-12,791	29-35	62-76	10	10-20	20	10.00%
55,001-65,000	12,791-15,116	35-41	76-90	10	10-20	14	7.00%
65,001-70,000	15,117-17,742	41-48	90-104	10	10-20	14	7.00%
75,001-85,000	17,742-19,767	48-54	104-118	10	10-20	12	6.00%
>85,001	19,768	>54	118	10	10-20	31	15.40%
Total						**201**	**100**

Notes: The World Bank PPP conversion factor (LCU per international $). Available at https://data.worldbank.org/indicator/PA.NUS.PPP?locations=GH. For 2017, this is 1.977 GHS (LCU) per dollar.

4.4 Results on Preliminary Survey Questions

Below, an overview of participant responses to the preliminary questions is presented. First, respondents were asked about the person who makes the investment decisions in the household. Figure 4.1 below shows that 60% of respondents make this decision by themselves, 34% jointly with their spouse and 6% answered “other person in the household”. The distribution shows that 94% of the sampled population are directly involved in the making of financial decisions.

Figure 4.1 Distribution of Financial Decisionmaker in Household (N=201)



Secondly, respondents were asked about their investing style. Questions on investing style often help to tailor investor needs to different investment products. Responses to such questions provide preliminary information on the goals of investors and the level of risk they are willing to accommodate. Here, questions involved experience with investing, frequency, risk appetite and motives for investment. Participants were asked to tick all styles that apply.

Table 4.5 shows that while 13.43% considered themselves “experienced”, 8% described themselves as “Novice”. On the frequency of investment, almost 20% described themselves as occasional investors with less than 10% for both “often” and “rare” categories. This shows that the middle class have varying expertise in investing perhaps influenced by the differences in the frequency of investing.

Respondents’ description of their risk appetite was the most answered investment style category. About 35% of respondents described themselves as “balanced risk”, 10% for low risk with only 9% opting for “high risk”. Again, this attests to the fact that the middle class are not a homogenous group and the differing risks appetites hint on their heterogeneity.

Table 4.5 Distribution of Respondents’ Self-Described Investing Style[37](N=201)

Investing Style	Response Count	Response Percentage (%)
Novice	16	7.96%
Experienced	27	13.43%
Rare	12	5.97%
Occasional	39	19.40%
Often	18	8.96%
High Risk	19	9.45%
Balanced Risk	70	34.82%
Low Risk	20	9.95%
Only Returns Matter	23	11.44%
Recreational Investor	1	0.50%
Socially Responsible Investor	30	14.92%

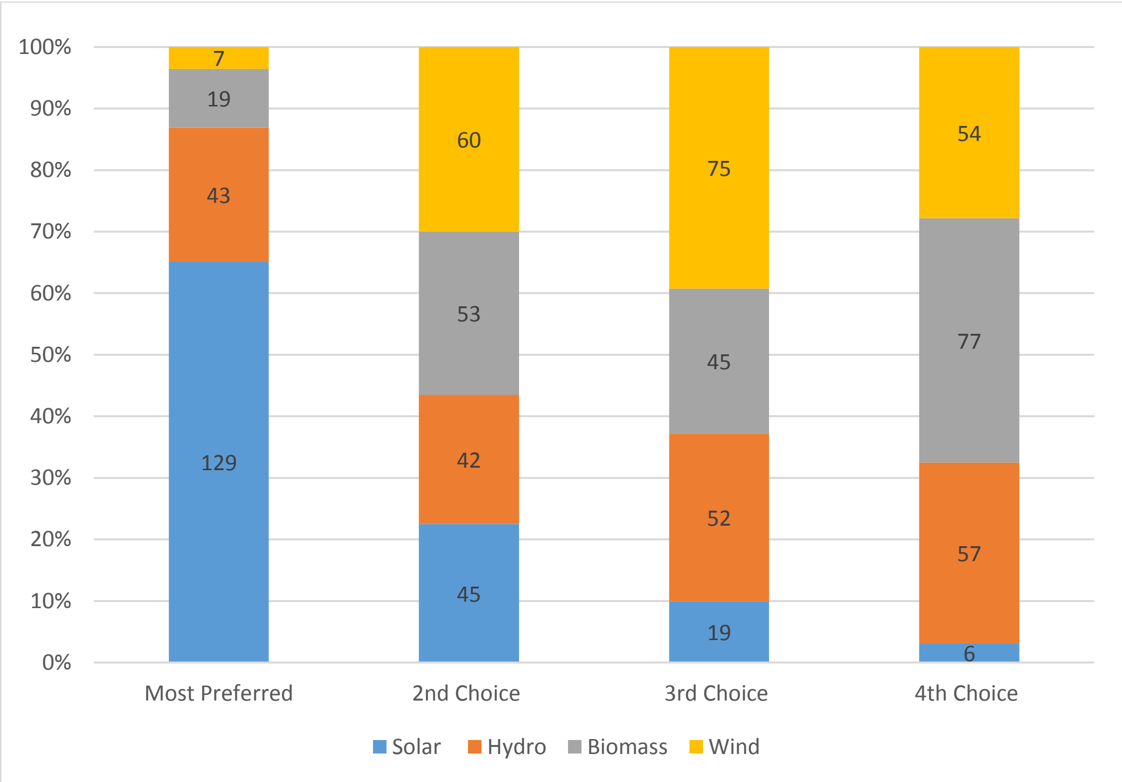
On motives, one person (0.50%) considered himself a recreational investor. The motive for investment is almost split between people who consider themselves purely profit-seeking and socially responsible investors, that is, 11.44% and 14.92% respectively. Again, this suggests that some people in the middle class will be more profit driven and

[37] Due to rounding errors, cumulated percentages may differ from 100%

others not entirely driven by the rate of return but consider other ethical reasons in their decision-making.

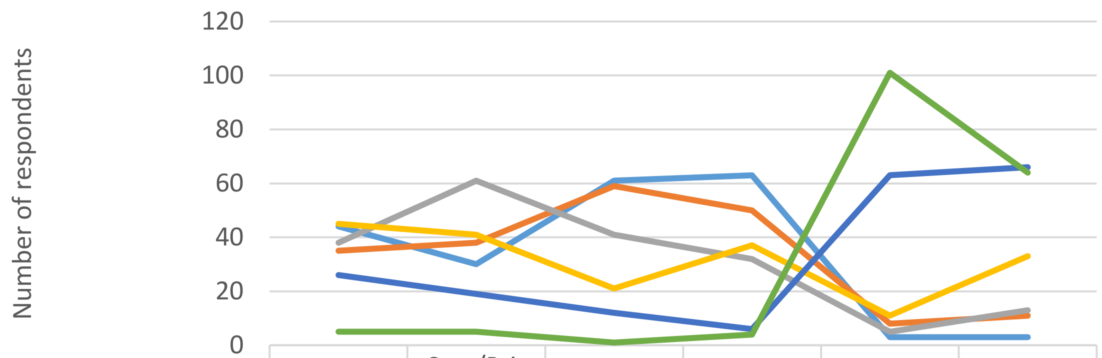
Thirdly, survey participants were asked about their most preferred choice of renewable energy technology amongst four renewable energy technologies (solar, wind, hydro and biomass) in a ranking exercise. This exercise was foremost to identify if household investors differentiated between different RE technologies and to give insights into what type of technology is likely to receive investments. Results shown in Figure 4.2 clearly show that solar photovoltaics was the most preferred technology type endorsed by more than 60% of respondents. This is followed by small hydro endorsed by 20% as their first technology of choice. In the third and fourth positions are biomass and wind energy respectively. These results validate the findings of the focus group study as well as studies like Aravena *et al.* (2012). Also, Salm *et al.* (2016) report that almost all respondents said they preferred solar PV the most for investment.

Figure 4.2 Respondent's Ranking of Renewable Energy technologies (N=199)



Finally, respondents were asked to rank the attributes used for the survey in order of what most influenced their decision to invest in renewable energy. Out of the six attributes, considered, almost 60% of respondents considered project viability and rate of return as the first and second factors feeding into their decision-making (Figure 4.3). This is not surprising as sentiments expressed during the focus groups suggested that participants viewed project viability and rate of return attributes as complementing each other. Price of investment and Track record attributes came in the third and fourth places, respectively. The hold time came in fifth and origin of the developer was the attribute considered least in ranking for attribute preference.

Figure 4.3 Attribute Preference for Renewable energy investments (N=195)



	Track record	Cost/Price of Investment	Rate of Return	Project Viability	Origin of developer	Hold Time
Most Important	44	30	61	63	3	3
2nd Choice	35	38	59	50	8	11
3rd Choice	38	61	41	32	5	13
4th Choice	45	41	21	37	11	33
5th Choice	26	19	12	6	63	66
Least Important	5	5	1	4	101	64

Attributes

4.5 Discrete Choice Data Analysis Approach and Interpretation

In summary, the analysis was done in four stages:

1. A simple conditional logit model incorporating only the attributes. Here the assumptions include the independence of irrelevant alternatives (IIA) property, error terms are independent and identically distributed across observations, and no preference heterogeneity is assumed.
2. An extended conditional logit incorporating demographic variables of gender, age, education and income are included in the model. This has similar assumptions as in the simple model.
3. A mixed logit model (also random parameter logit model) is employed. This mixed logit choice model relaxes the IIA assumption and allows for the incorporation of preference heterogeneity (that is, preferences are heterogeneous across respondents).
4. A latent class model is also estimated to complement the mixed logit model as it does not require the analyst to make an assumption about the distribution of parameters but segregates the sampled population into a set of classes that reveal their preference heterogeneity.

In the interpretation of coefficients in the models, the sign of each coefficient denotes the effect or influence the attribute has on choice likelihood or probabilities. A positive coefficient(utility) represents a positive preference associated with a specific level of an attribute compared with a reference level. In the same vein, a negative coefficient suggests a negative preference(disutility) associated with a level of the attribute concerned (still compared to a reference level). Additionally, it must be mentioned that the model estimates must be interpreted with care; that is, the absolute values of preference weights or numerical values of coefficients cannot be meaningfully interpreted. Preference weights only connote relative preference, and thus, only changes between attribute-level estimates as well as relative sizes can be interpreted. In models 1 and 2, parameters are fixed; hence, only means are reported. In the mixed logit model, means and standard deviations (SDs) are reported.

A p-value <0.05 associated with a positive or negative coefficient denotes statistical significance different from zero. P-values >0.05 denotes non-significance. Thus, non-significant attribute levels indicate respondents' indifference between the specific level and the reference level of each attribute.

All estimated models include alternative specific constants (ASCs). Thus, utilities for attributes are reported in addition to the utilities for alternative specific constants (ASCs) for the choice alternatives with None or No Investment (Option D) acting as the base alternative.[38] ASCs were included to remove the assumption that the means of the error terms are identical across alternatives.[39]Also, the inclusion of a complete set of alternative specific constants allows for unobserved attributes to be correlated with observed covariates. In other words, any utility associated with ASCs can be interpreted as the respondent's inherent preference for that alternative irrespective of other covariates in the model.[40] For all models, positive values for ASCs for option A and B denotes a general preference for investing in renewable energy or specifically the solar project presented in the scenario. A positive for ASC for option C denotes a preference for the status quo option, which is, investment in government treasury bills.

Attributes price, rate of return and hold time enter the analysis as continuous variables. All others were categorical variables which were dummy coded rather than effects coded.

---

[38] A typical approach in this context is to set the ASC for one alternative (e.g. the last) to zero, and estimate the remaining ones using dummy coding for the ASCs, with the value of one ASC set to 0 and all others being estimated.

[39] See Daly et al. (2016)

[40] In daily living, decisionmakers tend to hold a certain choice irrespective of any new options presented. A preference for the status quo is mentioned in Scarpa et al. (2005) as the status quo effect and this must be captured in the model. Similarly, decisionmakers may hold a preference for renewable energy in general, hence the inclusion of the Alternative Specific Constant (ASCs) to capture these preferences.

The choice of the former was made based on the ease of interpretation. Dummy and effects coding share some similarities in that one attribute level must be omitted, and the non-omitted attribute is granted one (1) if present in the corresponding profile and zero otherwise. The difference is that with effects coding, all non-omitted levels are coded -1 when the omitted level is present. Experts assert that dummy and effects coding yield the same estimates of differences between the preference weight and the omitted category.[41] The theoretical equivalence of the two coding approaches has been established, including how one model with one normalisation can be transformed (after estimation) to another with a different normalisation.

The attribute levels (*none)* for track record, (*international)* for the origin of developer and (*low)* for project viability were omitted from the analysis and served as reference levels for interpretation of coefficients with respect to that attribute.

The general utility formula applied to the models when respondent *q* chooses alternative *i* is specified as:

$$\begin{aligned} U_{qi} = {} & \beta_A ASC_{A,q} + \beta_B ASC_{B,q} + \beta_C ASC_{C,q} + \beta_{q1} d_{None} + \\ & \beta_{q2} d_{Some} + \beta_{q3} d_{Lots} + \beta_{q4} d_{Local} + \beta_{q5} d_{International} \\ & + \beta_{q6} d_{Low} + \beta_{q7} d_{Medium} + \beta_{q8} d_{High} + \beta_{q9} d_{Very\ high} \\ & + \beta_{q10} X_{Price} + \beta_{q11} X_{Rate\ of\ Return} + \beta_{q12} X_{Hold\ Time} + \varepsilon_{qi} \end{aligned} \quad \textbf{4.1}$$

where ASC_A , ASC_B and ASC_C is the dummy for alternative specific constants for options A, B and C. $d_{None}, d_{Some}\ and\ d_{Lots}$ are the dummy variables representing no track record, some track records and lots of track record for the developer track record attribute, respectively. Similarly, d_{Local} and $d_{International}$ are the dummy variables representing local and international developer origin for the attribute origin of developer

---

[41] See Daly (2016) and Hauber *et al*. (2016) for a discussion on the theoretical equivalence of dummy and effects coding.

respectively. Again, the dummy variables d_{Low} , $d_{Medium}, d_{High}, d_{Very\ high}$ representing low, medium, high and very high project viability for the project viability attribute. Lastly, X_{Price} , $X_{Rate\ of\ Return}$ and $X_{Hold\ Time}$ are the variables representing price, rate of return and hold time attributes.

4.5.1 Results for Model 1 (Conditional Logit Model)

To understand the trade-offs household investors were willing to make in their preferences for renewable energy power investments, an assessment of the influence of the attributes on utility is important. Additionally, this is necessary to see if signs are as expected (signs of coefficients) as documented in the economic literature.

The results for the simple conditional logit model can be found in Table 4.6. The ASCs for options A, B and C are all positive and statistically significant indicating that there is a preference for both options, that is, investing in renewable energy projects (A and B) and investing in government treasury bills (C) which is the status quo investment choice.

Given the use of dummy coding, the reported results for each of the attribute levels denote the difference between the mean of the attribute and the mean of the reference category. As previously mentioned, a positive coefficient indicates preference and a negative coefficient, a disutility for a specific attribute with respect to a reference category. Non-significant coefficients indicate indifference between the associated attribute and reference category.

Table 4.6 Summary of Conditional (fixed effects) logit results for DCE attribute levels (n=201)

Attribute	**Level**	**Coefficient**	**SE**	**p-value**
Track record	Some	1.19711	0.1332823	0.000**
	Lots	0.41804	0.1172952	0.000**
Origin of project developer	Domestic	0.316416	0.1000235	0.002**
Price	All levels (continuous)	-0.002791	0.0003951	0.000**
Rate of Return	All levels (continuous)	0.0578925	0.0115504	0.000**
Project Viability	Moderate	0.392504	0.1206806	0.001**
	High	1.636583	0.1314492	0.000**
	Very high	1.104634	0.1231715	0.000**
Hold time	All levels (continuous)	-0.00990	0.0041119	0.016*
ASC-Option A		2.101606	0.2098912	0.000**
ASC-Option B		1.819108	0.229778	0.000**
ASC-Option C		2.479911	0.1502449	0.000**
Observations		**1599**		
Pseudo R2		**0.1668**		
Log-Likelihood		**-2692.149**		
AIC		**5408.297**		
BIC		**5489.466**		

*p< 0.05; **p < 0.01; SE, standard error. Omitted levels are “No track record”, “International developer(origin)” and “Low project viability”.

All attribute coefficients are in line with *a priori* expectations in that they are consistent with economic theory. The results show statistically significant positive preferences for a project with “Domestic origin of developer” , “Some” and “Lots” of developer track record, an increasing “Rate of return” and projects with “moderate”, “High” and “Very high” project viability corresponding to projects with support systems of grid access plus feed-in-tariffs only, grid access, feed-in-tariffs with investment subsidies only and grid access, feed-in-tariffs, investment subsidies and a long term government contract respectively. Relative to others, a project with grid access, feed-in-tariffs and investment subsidies was associated with the highest utility for that attribute (that is, Project viability with level “high”).

On the other hand, projects with increasing “Hold time” and “Price” were associated with statistically significant negative preferences. In other words, respondents prefer investment options with shorter holding time and lower minimum price for the investment.

Altogether, the attribute that is relatively valued the most in the choice of investment is “high project viability” (β=1.63 $p = 0.00$), followed by “some track record” (β=1.19 $p = 0.00$). The relatively low magnitude for “Price” and “Hold time” suggest that respondents may be willing to consider an increase in “Price” and “Hold time” if any of the positive statistically significant determinants of investment choice are present.

4.6 Results for Model 2 (Conditional Logit Model with Covariates)

In Table 4.7, the results of an extended conditional logit model are presented. This model, with covariates, combines choice attributes in the simple model with socioeconomic/ demographic variables: annual household income, age and education of respondent into the regression. The interaction of respondent socioeconomic variables with choice attribute variables was done as respondents’ socioeconomic variables do not vary between choice alternatives and thus cannot be separately estimated in a utility function. All socioeconomic variables presented in the choice survey were regrouped by combining some categories and hence entered the model as follows:

- Household Income: Base Income (GHS15,001 – GHS25,000); Mid Income (GHS25,001- GHS45,000); Upper Income (GHS45,001 - GHS 75,000) and *High Income* (GHS75,001 to more than GHS 85,000)
- Education: *General* (lower than a degree and University degree*)* and High education (Master's degree and above)
- Age: Young (18 to 34 years), Middle Age (35 to 44 years) and *Old* (45 to older than 65years)
- Gender: *Male* and Female.

These socioeconomic variables were included on substantial theoretical and social policy grounds as past empirical works have studied the influence of these variables on household financial and investment behaviour. All variables were dummy coded. Italicised categories were omitted and will serve as reference categories in the interpretation of regression coefficients.

After analysis, all attributes earlier estimated maintained their previous signs and stayed in line with expectation from economic theory. There were statistically positive preferences (utility) for "Some" and "Lots" of Track record of the developer as well as the "Rate of return", "Domestic" origin of developer and all levels of "Project viability" as seen in Model 1. Alternatively, there were negative preferences associated with longer "Hold time" and increasing minimum "Price" for investment.

Thus, shorter hold times and lower minimum price for investment are deemed preferable for investment. Additionally, positive alternative specific constants (ASCs) for renewable energy options (A and B) and status quo option, that is, government treasury bills (option C) suggests a positive preference for both types of investment. However, relatively, the status quo option is more valued with (β=3.32 p = 0.00) compared to that of option A and B which are (β=2.67 p = 0.00) and (β=2.51 p = 0.00) respectively.

Gender was not found as a statistically significant determinant of preferences for all investment options. Hence being male or female does not influence the type of investment one is likely to opt for. Compared to Old people, persons considered *Young* (18 to 34 years) have statistically positive preferences for both renewable energy options (A and B) as well as the status quo alternative, C. Being *Middle-aged* (35 to 44 years) had no consequence on the likelihood of investment in any of the three alternatives due to non-significant p-values. Persons with "*High education*" (Master's degree and above) have a statistically significant positive preference for investing in renewable energy options (A and B) as well as in Option C (government treasury bills).

Observing income effects, the trend shows that as income increases, the likelihood of investing across all alternatives increases. Persons in the Base Income category show the most negative preference for investing in both renewable energy options (A and B) and this was significant at the 1% level. This is followed by people in the Mid Income category. People in the Upper-income category though show a less negative preference for the renewable energy alternatives, this was not significant at the 5% level.

Table 4.7 Summary of Extended Conditional logit results for DCE attribute levels (n=201)

Attribute	Level	Coefficient	SE	p-value
Track record	Some	1.20254	1.3377	0.000**
	Lots	0.4231	0.1176	0.000**
Origin of project developer	Domestic	0.319971	0.10035	0.001**
Price	All levels (continuous)	-0.00279	0.00039	0.000**
Rate of Return	All levels (continuous)	0.0583471	0.011589	0.000**
Project Viability	Moderate	0.3959398	0.1210075	0.001**
	High	1.645859	0.1320239	0.000**
	Very high	1.115237	0.1237123	0.000**
Hold time	All levels (continuous)	-0.0099938	0.0041253	0.015*
ASC_A		2.6780	0.8006143	0.001**
ASC_B		2.518935	0.8055355	0.002**
ASC_C		3.328832	0.7842312	0.000**
ASC_A*Female		-0.4105656	0.3677775	0.264
ASC_B*Female		-0.2299691	0.3680251	0.532
ASC_C*Female		0.1978129	0.3654191	0.588
ASC_A*Young		2.116065	0.537966	0.000**
ASC_A*Middle Age		0.2110922	0.4675995	0.652
ASC_B*Young		2.055996	0.5371699	0.000**
ASC_B*Middle Age		-0.1781751	0.4672824	0.703
ASC_C*Young		2.030387	0.5372617	0.000**
ASC_C*MiddleAge		-0.2683385	0.4673242	0.954
Attribute	Level	Coefficient	SE	p-value
ASC_A*HighEduc		0.8948207	0.369595	0.015*

ASC_B*HighEduc		1.001266	0.369915	0.007**
ASC_C*HighEduc		1.128495	0.368522	0.002**
ASC_A*BaseInc		-2.464174	0.830259	0.003**
ASC_B*BaseInc		-2.756929	0.8311391	0.001**
ASC_C*BaseInc		-2.869873	0.8272708	0.001**
ASC_A*MidInc		-2.024119	0.7917032	0.011*
ASC_B*MidInc		-1.962153	0.7914981	0.013*
ASC_C*MidInc		-2.620414	0.7894447	0.001**
ASC_A*UpperInc		-1.361082	0.7949678	0.087
ASC_B*UpperInc		-1.44473	0.7949136	0.069
ASC_C*UpperInc		-2.238555	0.7933328	0.005**
Observations	**1599**			
Pseudo R2	**0.1830**			
Log-Likelihood	**-2639.9652**			
AIC	**5345.93**			
BIC	**5569.144**			

*p< 0.05; **p < 0.01; SE, standard error. Omitted levels are “No track record”, “International developer(origin)” and “Low project viability”, “Male”, “General Education”, “Old” and “High Income”.

4.7 Goodness of Fit

Log-Likelihood test

A log-likelihood test was employed to compare the simple or restrictive model (Model 1) with the model with covariates or less restrictive (Model 2) to ascertain if the models are significantly different from each other. The assumption used is that Model 1 is nested in Model 2. The log-likelihood test rejects the null hypothesis[42]; thus, the two models are significantly different from each other.

Model	**Observations**	**ll(null)**	**ll(model)**	**df**	**AIC**	**BIC**
Model 1	1599	-3231.117	-2692.149	12	5408.297	5489.466
Model 2	1599	-3231.117	-2639.965	33	5345.93	5569.144

Akaike's information criterion (AIC) and Bayesian information criterion (BIC)

4.8 Pseudo R^2 Estimate

The McFadden's pseudo-R^2 provides a measure of relative model fit. Looking at the estimates for the simple (0.166) and extended (0.183) model, the extended model can be said to provide a slightly better model fit than the former.

4.9 Mixed Logit Model: Investigating Preference Heterogeneity

Due to the possibility of taste or preference varying across different individuals as is seen in everyday living, it is logical to specify a choice model that can account for such heterogeneity. This is achieved using the mixed logit or random parameter logit model[43] which relaxes the Independence of Irrelevant Alternatives assumption (IIA), allowing for the incorporation of preference heterogeneity.

---

[42] The null hypothesis states that the restrictive model is equal to the less restrictive model at the 95% significance level.

[43] Also mixed multinomial model

The Mixed Logit Model has been described in Chapter 3, and given that income, age and education were identified as a source of heterogeneity, they were further investigated. Considering that the sample data is already segregated or deconstructed to reflect subgroups in age, income and education, these entered the model as is. In estimating the mixed model, some assumptions, as well as examination, is needed as findings are influenced by the set of random parameters, the number of random draws, the distributional assumptions as well as whether a correlation is incorporated (Hensher and Greene, 2001).

On the issue of distribution, random coefficients can take on forms such as normal, lognormal, triangular or uniform. There is no hard or fast rule regarding choice of distribution and analyst is required to make an informed decision based on what distribution is appropriate for the study guided by sound behavioural assumption (Hensher, 2001; Hensher *et al.*, 2015). The normal distribution is considered more appropriate for this study as it has no constraints on range and sign. Thus, the variables under study can have coefficients that take logically take either sign for a given individual.

Hence, the mixed logit model with random parameters is chosen where utility parameters for β are assumed to be normally distributed with density f(β) (Hensher and Greene, 2003). A log-normal distribution that constraints parameters to be positive was not considered optimal in this case as it was reasonable to assume that some respondents might have a negative utility towards some attributes. In short, the choice of the distribution must be chosen not neglecting what economic theory suggests regarding the choice distribution.

Mixed logit estimations produce random coefficients with distribution around the mean to indicate preference heterogeneity with larger variances signalling more heterogeneity in the sample (Greene and Hensher, 2010). Two mixed logit models were estimated, one with the price coefficient fixed (Model I) and another with the price coefficient randomised (Model II). Though fixing the price coefficient is convenient and useful, it may be untenable in many cases. Indeed, there are good reasons on both common sense and theoretical grounds to consider the assumption of different price sensitivities across respondents despite the presence of other observed socio-economic covariates (Scarpa *et al.*, 2006). Thus, both models were estimated to investigate, which fits the data better. All attributes, including ASCs, were randomised, and random parameters were assumed to be normally distributed (Hensher and Greene, 2003). Model II where a random parameter is estimated for the alternative specific constants (ASCs) can be referred to as an error component model. To ensure the robustness of results, estimation was done using 1000 Halton draws.

Table 4.8 details the results of the estimation of the two mixed logit models. The fixed price model (Model I) is found to the left and the random price model (Model II) to the right. The second column of both models report the estimated coefficients with the p-values of the coefficients with asterisks to denote significant parameters. The third column reports the associated standard errors for the estimated parameters. Standard deviations are reported for variables that were randomised during the estimation. Statistically significant p-values associated with standard deviation show preference heterogeneity for that variable within the sample.

As previously explained in the interpretation of coefficients, the estimates describe the contribution of the attributes to choice probabilities. Hence, a positive coefficient shows an increase in choice probability and vice versa. Qualitative variables were dummy coded, so the omitted level is equal to zero and used as the reference for interpretation.

From Table 4.8, Models II, where the price coefficient was randomised has a very slight improvement in the goodness of fit than Model I where the price coefficient was fixed.

More importantly, the standard deviation of the price coefficient suggests that preferences for the price of investment attribute across respondents are indeed heterogeneous. Also, significant heterogeneity is registered for attributes “rate of return”, “domestic origin of developer”, “Track record (level some)” and “Track record (level lots)” and the alternative specific constant associated with the status quo investment choice “ASC_C”. The non-significant standard deviations for parameters for attributes hold time, and project viability (moderate, high and very high) show that the preferences concerning these are homogenous.

Generally, the high statistical significance associated with all included attributes suggests that they all have an impact on choice decision and all coefficients have the expected sign. As expected, the coefficient for minimum “Price” for investment is negative and highly statistically significant. This shows that on average, respondents shy away from investments that require a higher minimum price for the investment. Similarly, the negative coefficient associated with “Hold Time” suggests that respondents on average dislike investments with longer holding times. In terms of developer track record, the positive coefficient for levels “Track record_Some” and “Track record Lots” show that respondents favour investments whose developers have “some” and “lots” of track record which translates into a developer having completed five similar projects for the former and more than five similar projects for the latter.

Also, respondents prefer project developers of domestic origin to foreign counterparts as can be seen from the positive coefficient. On the project viability attribute, respondents prefer investments characterised by “Moderate”, “High” and “Very high” measures of viability compared to none. Moderate, high and very high viability are associated with increasing renewable energy support systems, which in this instance may act as a proxy for the perceived risk associated with RE projects.

The significant positive sign of the alternative specific constants (ASCs) for renewable energy options (A and B) and status quo option, that is, government treasury bills (option C) suggests a positive preference for both types of investment. In implied ranking, however, the status quo alternative is relatively more valued with (β=3.43) compared to that of option A and B which are (β=2.99) and (β=3.06) respectively.

On the effect of socioeconomic variables on investment choice as earlier discussed in the literature review in Chapter 2, gender was not found as a statistically significant determinant of preferences for all investment options. Hence being male or female does not influence the type of investment one is likely to go for. With age, the model finds that being “Young” (18-34) was associated with a significant positive coefficient for renewable energy options A and B. Though a positive coefficient was registered for the status quo option, this was not significant.

This suggests that being “Young” (18 to 34) enhances the likelihood of choosing the renewable energy alternatives or options. The non-significance of the coefficient for “MiddleAge” (35- 44 years) implies that being middle age had no consequence for the choice of investment made. Also, the effect of high education (Master’s degree and above) on investment in renewable energy is quite mixed, as only one coefficient is significant at 5% (ASC_B). At 10%, however, high education enhances the likelihood of investing in renewable energy projects. High education had no consequence for investing in the status quo (option C) even at the 10% level.

Compared to people in the High-Income category (reference), respondents in the base income showed the most negative preference for supporting renewable energy projects. Though still negative, a slightly higher preference is showed by respondents in the Mid-income category for investing in renewable energy. Being in the Upper-income category had no consequence for investing in renewable energy due to the non-significant p-values.

Finally, it is important to note the size and statistical significance of the ASCs in the model. As already mentioned, ASCs capture the endogenous values respondents have for the alternatives which range from one to six times larger than attribute or covariate coefficients. These ASCs show a strong positive preference for investing in renewable energy projects as well as the status quo, which is government treasury bills.

In summary, respondents show a strong preference for renewable energy projects as well as the status quo. Respondents who are Young (18-34) are more likely to invest in renewable energy. The effect of high education for investing in renewable energy is not clear, and people in the base income category are the least likely to invest in renewable energy projects.

Table 4.8 Estimation Results for Mixed Logit Models

Model I (Fixed)			Model II		
Choice	**Coef.**	**Std. Err.**		**Coef.**	**Std. Err.**
Fixed Variables	**Mean**		**Fixed Variables**	**Mean**	
Price	-0.004**	0.001	Price	-0.004**	0.001
ASC_A*Female	-0.612	0.504	ASC_A*Female	-0.565	0.534
ASC_B*Female	-0.414	0.513	ASC_B*Female	-0.344	0.526
ASC_C*Female	0.688	0.842	ASC_C*Female	0.676	0.858
ASC_A*Young	1.774*	0.718	ASC_A*Young	1.835*	0.771
ASC_B*Young	1.720*	0.732	ASC_B*Young	1.780*	0.76
ASC_C*Young	1.226	1.407	ASC_C*Young	1.107	1.198
ASC_A*MiddleAge	-0.027	0.639	ASC_A*MiddleAge	0.113	0.738
ASC_B*MiddleAge	-0.416	0.653	ASC_B*MiddleAge	-0.257	0.729
ASC_C*MiddleAge	-0.902	1.427	ASC_C*MiddleAge	-0.694	1.285
ASC_A*BaseInc	-2.048*	0.985	ASC_A*BaseInc	-2.035*	1.025
ASC_B*BaseInc	-2.418*	1.001	ASC_B*BaseInc	-2.392*	1.022
ASC_C*BaseInc	-2.472	1.424	ASC_C*BaseInc	-3.037*	1.506
ASC_A*MidInc	-2.028*	0.917	ASC_A*MidInc	-2.019*	0.952
ASC_B*MidInc	-2.043*	0.929	ASC_B*MidInc	-2.033*	0.945
ASC_C*MidInc	-3.437*	1.398	ASC_C*MidInc	-4.016**	1.393
ASC_A*UpperInc	-1.494	0.935	ASC_A*UpperInc	-1.25	0.966
ASC_B*UpperInc	-1.649	0.949	ASC_B*UpperInc	-1.448	0.96
ASC_C*UpperInc	-3.292*	1.438	ASC_C*UpperInc	-3.531**	1.358
ASC_A*HiEduc	1.069*	0.483	ASC_A*HiEduc	0.945	0.514
ASC_B*HiEduc	1.133*	0.493	ASC_B*HiEduc	0.996*	0.508
ASC_C*HiEduc	1.281	0.94	ASC_C*HiEduc	1.248	0.862
Rate of Return	0.081**	0.023	Rate of Return	0.082**	0.024
Origin_Domestic	0.624**	0.155	Origin_Domestic	0.651**	0.161
HoldTime	-0.028**	0.008	HoldTime	-0.030**	0.008
TrackRecord_Some	1.859**	0.201	TrackRecord_Some	1.879**	0.206
TrackRecord _Lots	1.773**	0.211	TrackRecord _Lots	1.802**	0.217

Viability_Moderate	0.545**	0.176	Viability_Moderate	0.535**	0.178
Viability_High	1.199**	0.205	Viability_High	1.222**	0.21
Viability_Very high	0.938**	0.174	Viability_Very high	0.969**	0.177
ASC_A	2.957**	0.982	ASC_A	2.992**	1.007
ASC_B	2.989**	0.995	ASC_B	3.063**	1
ASC_C	3.056*	1.599	ASC_C	3.434*	1.345
Randomised Variables	**Standard Dev.**	**Std. Err.**		**Standard Dev.**	**Std. Err.**
			Price	0.002**	0.001
Rate of Return	0.099**	0.024	Rate of Return	0.104**	0.021
Origin_Dom	-0.880**	0.178	Origin_Dom	0.967**	0.169
HoldTime	-0.031*	0.012	HoldTime	0.021	0.021
TrackRecord_Some	0.537*	0.225	TrackRecord_Some	0.527*	0.223
TrackRecord_Lots	0.628*	0.304	TrackRecord_Lots	-0.704**	0.269
Viability_Moderate	0.023	0.382	Viability_Moderate	-0.191	0.34
Viability_High	-0.356	0.581	Viability_High	0.514	0.42
Viability_Very high	0.347	0.414	Viability_Very high	0.382	0.338
ASC_A	-0.037	0.396	ASC_A	0.029	0.287
ASC_B	0.249	0.224	ASC_B	-0.145	0.328
ASC_C	4.520**	0.517	ASC_C	4.518**	0.516
Observations	**1599**			**1599**	
Log-Likelihood	**-1343.615**			**-1340.007**	
AIC	**2775.23**			**2770.014**	
BIC	**3072.787**			**3074.333**	

*Note: **, * = Significance at 1% and 5% level*

4.10 Marginal Willingness to Pay Estimates for Mixed Logit Model

The marginal willingness to pay (WTP) as previously discussed in Chapter 3 measures the relative importance of a unit change in an attribute in monetary terms. In other words, it represents a 1% or 1 unit increases in the quantity of the attribute being measured. If the attribute is qualitative, this represents a discrete change. Hence for this thesis, the WTP can be used to indicate the extent to which household investors would be willing to pay for a range of renewable energy investment attributes.

Table 4.9 Marginal WTP estimates with mixed logit model in WTP space

Attributes	**Estimates in GHS**	**[95% Conf. Interval]**	**Standard error**
Rate of Return (%)	**19.47****	9.39 - 29.53	5.14
Track record (some) (as compared to a developer with no track record)	**476.16****	334.14 - 618.18	72.46
Track record (lots) (as compared to a developer with no track record)	**442.53****	287.05 - 598.01	79.33
Developer origin (domestic) (as compared to a developer of international origin)	**147.92****	52.87 - 242.97	48.50
Viability (moderate) (as compared to a project with low project viability)	**154.34****	50.27- 258.41	53.10
Viability (high) (as compared to a project with low project viability)	**315.18****	164.21 - 466.16	77.03
Viability (very high) (as compared to a project with low project viability)	**252.56****	143.98 - 361.13	55.40
Hold Time	**-7.85****	-12.05 - 3.64	2.14

*Note: **= Significance at the 1% level. Values in GHS (GHS 1 approx. US$0.22).*

Table 4.9 reports the marginal willingness to pay or implicit prices of the attributes used in the choice experiment calculated using the mixed logit model with randomised price coefficient (Model II). The conventional approach of dividing an attribute coefficient by the price coefficient that is, WTP in preference space often results in a skewed distribution in mixed logit models where two randomly distributed parameters are under consideration (Hole and Kolstad, 2012; Tu *et al.* 2016). Train and Weeks (2005) suggest estimating the mixed logit model in WTP space. Considering that WTP to pay measures in WTP-space have been well-documented as producing more realistic WTP estimates than in preference space (see Train and Weeks, 2005; Hole and Kolstad, 2012), the generation of WTP estimates was done in WTP space which is directly at the estimation stage(i.e. simulation).

All estimated variables are statistically significant at the 1% level and associated with a positive willingness to pay except the hold time variable. The highest willingness to pay is associated with the track record attribute, precisely a developer with "some track record" interpreted as a project developer who has completed five similar projects in the past. Conversely, the lowest willingness to pay is associated with the hold time attribute implying that respondents are willing to pay less (GHS -7.85) for increases in investment hold time.

From the results, all other attributes/variables being equal, respondents are willing to pay GHS19.47 more for every 1% increase in the investment rate of return. With regards to the track record of the project developer, on average, respondents are willing to pay more for an investment whose developer has "some" and "lots" of track record (GHS476 and GHS422 respectively) compared to a developer with no track record.

Similarly, on average, respondents are willing to pay more for an investment with a moderate, high and very-high project viability metric compared to a project with low viability (that is, a power project with only guaranteed grid access). The highest willingness to pay among the level of project viability is "project viability (level high)" denoting a project with grid access, guaranteed feed-in-tariff and investment subsidies. Within this attribute, the lowest WTP is associated with the level "moderate" which is a project with grid-access and a feed-in-tariff. Presently, this is the support system available for many renewable energy projects in Ghana, and this has proven insufficient in driving the necessary investment in the sector.

Lastly, respondents show a preference for a project developer of domestic origin compared to a developer of international origin. On average, all other variables being equal, respondents are willing to pay GHS147 more for an investment with a domestic project developer.

4.11 Latent Class (LC) Model Analysis

To further explore preferences within the sample, a latent class model is estimated. By grouping preferences for renewable energy investments into mutually exclusive groups, the latent class model already explained in Chapter 3 allows for the existence of profiles of distinct consumer groups which the mixed logit model cannot accomplish.

Estimating a latent class model requires the prior identification of the optimal number of classes based on a statistical fit assessment (Louviere *et al.,* 2000; Green and Hensher, 2003). This entails comparing the Bayesian Information Criterion (BIC), Akaike Information Criterion (AIC), consistent AIC (CAIC) for a number of classes. The best class is deemed the one with the lowest values for information criterion.

In this case, parameters were estimated for different models (2 and 3) for attributes only, attributes with status quo predictor and attribute with covariates (age, education and income). The model involving attributes with status quo predictor had the lowest AIC and BIC. More so, a preliminary estimation found parameters mostly insignificant in the attributes with covariates model with some data points missing due to boundary estimates. This is not too surprising as increasing predictors though increases the number of response patterns, can often lead to data sparseness and increase the number of boundary parameter estimates whose standard errors and confidence intervals may be difficult to estimate (Wurpts and Geiser, 2014). With one of key objectives in this thesis to investigate the heterogeneity in preferences for renewable energy investment attributes, the attributes with status quo predictor was deemed sufficient to provide information on attribute preferences across classes as well as their preference for the status quo investment.

A further class investigation into the attributes plus status quo predictor for 2 to 4 classes show the three-class model as more appropriate as evident from both the AIC and BIC measures in Table 4.10. The latent class choice model was estimated using Stata Lclogit model, which utilises an expectation-maximization (EM) algorithm for parameter estimation (see Pacifico and Yoo, 2012).

Table 4.10 Fit statistics information used to compare models from which a 3-class latent class model was selected.

Models	Log-likelihood	BIC	AIC
Latent class model (2 class)	-1441.14	2993.66	2924.29
Latent class model (3 class)	-1387.84	2945.38	2839.68
Latent class model (4 class)	-1418.27	3064.58	2922.539

The sample size is 201 respondents

The latent class model presented below is considered the best addition to the mixed logit model reported earlier in identifying unobserved preference heterogeneity among respondents. There could however, be further scope for analysis and investigation for the inclusion of more predictors, although it would be more suited to a larger sample size.

In the LC model, the variables “Track record (some)”, “Track record (lots)”, “Project Viability (high)”, “Hold Time” and “Status Quo” are significant across all classes. The positive coefficient associated with the track record of developer attribute levels (“some” or “lots”) shows that respondents prefer renewable energy project developers who have “some” or “lots” of track record in having completed such renewable energy power projects in the past.

Here, this translates into having completed five or more similar renewable energy power projects in the past. Again, the positive coefficient of the attribute "Project Viability (high)" suggests that respondents prefer RE projects that have high viability which denotes availability of support systems such as guaranteed grid access, feed-in tariff and investment subsidies to support projects. The preference for this attribute signals the preference for reduced risks associated with RE projects.

The negative preference associated with the "Hold Time" attribute for Class 1 and 2 signal the preference of members of this class for shorter investment hold times. The positive coefficient for the "Hold Time" attribute in Class 3 should be interpreted as less sensitivity to longer hold times than a preference for longer investment hold time. Studies like Enzenberger et al. (2003), and McNulty et al. (2002) suggest that investors who opt for longer-time horizons for investments often have a higher risk appetite. Additionally, members of Class 1 and 2 have a significant positive preference for the status quo investment alternative, which are government treasury bills (members of Class 2 more than Class 1 in relative terms).

Table 4.11 Parameter estimates for the Three Class Latent Class Model

Variable	Class 1	Class 2	Class 3
Status Quo (ASC_C)	1.060** (0.208)	6.072**(1.285)	-1.374**(0.539)
Track record_some	1.658 **(0.287)	1.036*(0.481)	1.881**(0.253)
Track record _lots	1.362**(0.308)	2.567*(1.190)	1.755**(0.326)
Origin of developer_domestic	0.978**(0.228)	-0.311(0.568)	0.872**(0.209)
Rate of Return	0.013(0.026)	0.548**(0.146)	-0.015(0.038)
Viability_moderate	0.347(0.299)	2.22 ** (0.658)	0.639*(0.273)
Viability_high	1.641**(0.307)	1.721**(0.548)	1.190**(0.352)
Viability_very high	0.652**(0.239)	0.016(1.143)	0.509*(0.214)
Hold Time	-0.024**(0.010)	-0.137**(0.045)	0.052**(0.017)
Price	-0.002*(0.001)	-0.006(0.003)	.000(0.001)
Class Share	**0.271**	**0.274**	**0.455**
No of Observations	1599		
Log-Likelihood	-1387.84		
AIC	2839.68		
BIC	2945.38		

*Note: **, * = Significance at 1% and 5% level. Omitted levels are "No track record", "International developer(origin)" and "Low project viability".*

Members of Class 3 have a significant negative preference for the status quo and thus are more likely candidates for considering alternative investments like renewable energy investments. Members of this class show slightly less preference for chasing rate of return though this is not statistically significant at 5%. Similarly, this class are less sensitive to the minimum price for investment though not significant. This group also have a strong preference for project developers of domestic origin. Finally, members of these group are less sensitive to longer hold times. Making up 45.5% of the sample population, this investor group can be regarded as less risk averse. Additionally, they could be regarded as a group whose motivations for investment are not purely financial and hence have characteristics of individuals who are likely to invest in renewable energy.

The characteristics of members of this class support previous findings of motivations for partaking in citizen renewable energy projects as seen in Aitken (2010), Walker and Devine-Wright(2008), Walker *et al.*(2010) and Yildiz (2014) who allude that other motivations aside the rate of return feed into the decision making of people who invest in renewable energy or join community renewable energy groups. This finding also aligns with the study by Lindenberg and Steg (2007) on pro-environmental behaviour which finds that the hedonic goal "to feel better, feel comfortable" and normative goal "to act appropriately" as additional goals to the gain goal or making a return.

Members of Class 2 may be regarded as "return chasers" and have the largest positive preference for the status quo investment as well as the rate of return. They also have a negative preference for a developer of domestic origin though this is not statistically significant. This group is also the most sensitive to investment hold time and increases in minimum price of investment though the latter is not significant. Members of this class also have a strong statistical preference for a developer with a lot of track record. This group (27% of the sample) can be regarded as the most risk-averse and less likely to invest in renewable energy projects all things being equal.

Members of Class 1 also have a preference for the status quo investment alternative, are sensitive to the increases in minimum price of the investment as well as investment hold time. They also prefer a developer of domestic origin and well as a developer with some and lots of track record. They have a positive preference for increasing rate of return though this is not significant. This group, although have a positive preference for the status quo, demonstrate a relatively smaller preference compared to members in Class 2.

Members in this class can be likely investors of renewable energy projects if the investment profile fits their needs.

In summary, the results of the latent class model have identified an investor group who have characteristics of individuals who are likely to invest in renewable energy. This group is not entirely driven by the rate of return and are less sensitive to longer hold times. The results of the latent class model also support the existence of preference heterogeneity as earlier shown in the mixed logit model.

4.12 Test for Validity and Consistency

In DCE studies, it is often advisable due to the hypothetical nature of such studies to incorporate a test for reliability and consistency. This helps in improving the confidence in results. If an inconsistency is discovered, potential problems may exist. Reliability, according to Bateman *et al.* (2002) and Freeman (2003) refers to reproducibility while validity reflects how the method applied measures what the researcher set out to achieve. Due to the relatedness of reliability and validity, one affects the other that is, a study with low reliability will often be less valid.

Several avenues exist for validity and consistency checks in DCE literature and include the test-retest approach which involves using the same survey at different times (see Liebe *et al.,* 2012) to compare results between the same sample group, comparison of results to other revealed preference data on the same topic (see Mark and Swait,2004). Another is checking the signs of estimated parameters to see if they are consistent with *a priori* expectations from economic theory and conform to the axioms of consumer theory (Lancsar *et al.,* 2013). Lastly, including a dominant alternative among alternatives to show preference consistency or otherwise – this is also regarded as a rationality test (Hoyos, 2010).

Conducting this choice experiment at different points in time for comparison was deemed too time-consuming and costly and thus was not pursued. An alternative to this is to include a consistency test within the same survey instrument at the time of administering the survey. This can be in the form of a rank consistency test, as explained in Foster and Mourato (2002), and results can be compared with the choice of respondents in the choice experiment. In line with this, a ranking of attribute exercise was included as part of preliminary questions in the survey questionnaire (see Table 4.12). Respondents were given a listing of the six attributes and asked to rank from 1 to 5 based on the importance to them in making an investment decision. The attribute left out is assumed to be the least important.

Table 4.12 Validation question presented (ranking exercise for attributes)

Having been informed of the characteristics and their meanings under this study, please rank the characteristics from 1 to 5 based on their **importance to you** in making an investment decision: 1 being the most important and 5 being the least important.

Characteristics	Rank
Track record of developer	
Cost of investment	
Return on investment	
Project viability	
Origin of project developer	
Hold time	

The preference order of the attributes, as determined by the majority of the respondents was:

1) Project viability;

2) Rate of return;

3) Price of investment;

4) Track record of the developer;

5) Hold time; and

6) Origin of developer

Table 4.13 Ranking of Implicit Price with Rank order of Attributes in Validation Test

Attribute	Rank order	Rank by implicit price	Implicit price
Rate of Return	2	4	GHS 19.47
Project Viability	1	2	GHS 154.34 (Level "moderate") GHS 315.18 (Level "high") GHS 252.56(Level "Very high")
Price of investment	3	*	
Track record	4	1	GHS 476.16 (Level "some") GHS 442.53(Level "Lots")
Hold time	5	5	GHS -7.85
Origin of developer	6	3	GHS 147.92 (Level "Domestic")

NB: Implicit price for the price coefficient is always equal to 1.

Secondly, a dominant alternative was presented among one of the choice cards to test for preference inconsistency. This alternative was A in choice card "RED". A sample of choice card "RED" is presented below in Figure 4.4.

Figure 4.4 Dominant Choice Card for Validation

CHOICE CARD RED

Characteristics	Option A	Option B	Option C	Option D
Track record of developer	Lots	Some	Invest in Treasury bills at 12% for 91 days	None
Origin of developer	Domestic	International		
Cost of Investment	350GH¢	350GH¢		
Return on Investment	11%	11%		
Viability	Very High	Low		
Hold Time	9 months	9 months		

Option A in choice card red is considered a dominant alternative because it comprises of the highest level of track record, the preferred origin of the project developer, the lowest cost or price for the investment, the highest level of project viability and the lowest level of hold time included in the survey. The rate of return is comparable to the status quo which is 12% per annum with lots of developer track record, but a minimum price of investment set at GHS 500, higher than what is offered in option A.

Out of 201 respondents who answered this question, 128 respondents chose A, 18 chose B, 53 chose C and 2 chose option D. 64% of respondents stated a preference for option A, 26% for option C, 8.9% for B and 0.99% for D.   This outcome overall suggests that the majority of respondents are rational. Comparable rates of failure have be found in stated preference literature to different degrees. For example, Foster and Mourato (2002) report failure rates of 32% for rank consistency as well as 13% in their dominance tests. Gerard *et al.* (2015) also report a failure of about 22% for the dominance test on their discrete choice study. Foster and Mourato (2002) argue that comparable rates of failure have also been reported outside stated preference literature. They show that in Sippel

(1997), respondents in a revealed preference study generated failure rates of between 40 to 90% in violation of the standard axioms of revealed preference.

Respondents that fail validity tests, that is, not give a rational or consistent response can be explained in several ways. In Hanley *et al.* (2002), he explains that testing rationality with a random utility framework assumes that choices indeed can be random and thus is expected. Foster and Mourato (2002) attribute such failures to three key issues: the well-known view in psychology literature that human decision-making is less than optimal and does not conform to the economic model of rational choice. The second issue is that human rationality is bounded in real situations culminating in the use of simplifying heuristics and simple rules of thumb, which can violate economic principles. Last but not least is the inability of respondents to express indifference to alternatives due to a limitation in methodology.

These inconsistencies and irrational preferences altogether deemed randomness is what is often captured in the error terms in multinomial and other random models (Hanley *et al.,* 2002). It is also regarded as a likely cause of heterogeneity and the reason the IIA assumption is violated.

4.13 Discussion and Implications

Looking at innovative ways for bridging the investment gap in power sector financing in Sub-Saharan Africa is a matter of great concern, and an often-overlooked aspect is the potential of household investors to contribute to addressing this challenge. Central to addressing this challenge is understanding the preferences of household investors for renewable energy power projects in several jurisdictions and assessing points of convergence and divergence. This thesis has analysed the preferences of household investors for renewable energy power project investments using Ghana as a case study. It investigated attributes pertinent to the discussion, the trade-offs such investors are willing to make, the marginal willingness to pay for the different attributes as well as the preference for technology.

Research findings from this study underscore the role that household investors can play in financing renewable energy as results show that a segment of the middle class have characteristics similar to what is known about investors in renewable energy. The discrete choice experiment showed that attributes such as the investment rate of return, track record of the project developer, project viability assessed by the degree of renewable energy policy and financial support offered for the renewable energy project, the origin of the project developer, price of the investment and hold time are important attributes that influence investor decisions.

Evidently, some respondents show satiation (that is, where an individual has no further interest in an attribute once a specific level has been achieved) with respect to the highest level of project viability and track record, an occurrence seen as a violation of microeconomic theory assumption of non-satiation. Scott (2002) explains this as target setting behaviour, like the Tversky's "elimination of aspects" model (Tversky, 1972a; Tversky, 1972b) and Simon (1959) satisficing model. Because of this, the highest marginal willingness to pay was obtained for a level lower than the highest levels of track record and project viability presented in this study. It is worth considering though that the levels with the highest WTP values reflect rather satisfactory conditions in real situations. Project viability with level "high" is associated with guaranteed grid access, feed-in-tariff and investment subsidies - the disregarded level was an addition of a long-term contract which in many instances is the exception rather than the norm. Similarly, respondents considered a developer having completed five similar projects in the past as a good target for consideration.

Track record and origin of the developer were classed under developer reputation in this study. Track record had the highest marginal willingness to pay across all attributes. Though this was not considered most important in the ranking exercise by respondents, Loock (2012) and Gamel *et al.* (2016) assert that in RE investment decisions "experience" or a "track record" is often more important than the lowest price of the investment or best technology. In other discussions on developer reputation in the literature, the issue of trustworthiness features prominently and is a crucial concept in civic engagement and collaboration. Ostrom (2003) describes trust as a necessary ingredient for building strong and cohesive communities. Walker *et al.* (2010) also underscore the need for trust in community renewable energy projects. Finally, Kalkbrenner and Roosen (2016) in investigating the motivations behind community renewable energy projects, find that interpersonal trust features prominently in the non–financial motivations for participation. This is even more pertinent in developing countries like Ghana where such investment alternatives are novel and a "proof of concept" and more is required to boost investor confidence.

A positive WTP for a developer of domestic origin also hints on the importance of trust, credibility and some level of familiarity as found in a large section of finance and investment literature. The many explanations for "home biased" investments or preference for domestic project development companies include the assumption of the ease of obtaining information and knowledge compared to international firms/companies as seen in Brennan and Cao (1997), Zhu (2002), Barbar and Odean (2011), Bekaert *et al.* (2014) and Oehler *et al.* (2017). Though "home bias" is often discussed as a less optimal occurrence in investment literature, it should be considered a positive signal to build the expertise of local renewable project developers as this is more likely to produce more significant synergistic effects in building a sustainable local energy ecosystem.

Also, the association of a high WTP with a project of "high" viability (with support systems that mitigate risk) highlights the importance of eliminating power market risk, grid integration risk and other governance risks. An interview study conducted on investors by the United Nations Development Programme emphasises that investors placed more importance on power regulation and management risks than on general political risks (Waissbein *et al.*, 2013). Other studies on RE developers in Africa also show that governance-related risks continue to hamper investment (Komendantova *et al.*, 2012; Baker and McKenzie, 2013). This outcome highlights the importance of support systems such as feed-in -tariffs, guaranteed grid access and investment subsidies in mitigating the risks associated with many RE power projects.

The hold time for investment was also considered necessary by investors and associated with a negative willingness to pay. In Gamel *et al.* (2016), it was also found that investors preferred a shorter hold time, referred to as "exit" in that study. Hence investors generally do not favour investments which lack flexibility in terms of when one can exit. Several studies and commentators in African countries have lamented over the lack of long-term financing for projects (not just in energy or power sector) in Sub-Saharan Africa. This disfavour for long term investments may potentially be a lot higher in African economies where the cost of capital and inflation rate is high. High levels of inflation induce uncertainty and discourage investment in long term investment projects.[44]

When dealing with investors, there is no doubt that the rate of return is one of the most essential criteria for the choice of investment. This is validated in the ranking of attributes in this study, where respondents consider this attribute second to only the project viability attribute. The positive willingness to pay associated with the rate of return underscores

---

[44] In development economics theory, the described mechanism is referred to as the *McKinnon-Shaw doctrine*, suggesting that "financial repression" and negative real interest rates hinder mobilization of savings, the extent of investment, and hence economic growth. See McKinnon (1973) and Shaw (1973) and Bruno and Easterly (1998).

its importance to respondents. In other words, renewable energy projects must tick the profitability box in addition to their green credentials to attract investment . Studies by Clark-Murphy and Soutar (2004) and Aguilar and Cai (2010) also find that though the rate of return is highly valued by investors, it is often not the most important attribute in renewable energy investments as shown in this study.

On the issue of how certain demographic variables influence the likelihood of investing in renewable energy projects, this thesis finds that gender does not influence the choice of investment. This outcome is similar to Sardianou and Genoudi (2013) who found the willingness to adopt renewable energy to be independent of gender. On the contrary, Aguilar and Cai (2010) find that females are willing to pay more for renewable energy than males. Hence overall, gender effects on renewable energy investment have been mixed. Some researchers have found that the influence of gender on investing (especially in areas financial risk aversion) may not be direct but an effect of cultural, political and social factors on the gender ratio (see Hibbert *et al.*, 2013; Almenberg and Dreber, 2015). Deducing from this logic, the absence of the influence of gender may stem from the inclusion criteria adopted for this study, that is, respondents meeting a certain income for inclusion. As found by Fraune (2015) that a gender wealth gap between men and women may be the reason why more men participate in citizen power projects than women in Germany, the “income homogeneity” in this sample may erode any gender difference in investment due to culture and social factors.

Age is found to impact the likelihood of investing in renewable energy with young people found more likely than their middle age counterparts. Studies on how age affects attitudes toward green energy (including investing) have been mixed at best – some studies show an increase and decrease in WTP as age increases (Borchers *et al.*, 2007 and Zarnikau, 2003). Specifically, studies like Mahaptra and Gustavvson (2008), Mills and Schleich (2012), Michelsen and Madlener (2012) report a reduction in the inclination to adopt renewable energy/energy-saving technologies as age increases, other studies find that middle-aged people are more likely to adopt renewable energy or pay for renewable energy services than younger counterparts (Kostakis and Sardianou, 2012). Zarnikau (2003) also finds that younger respondents were more interested in paying a premium for renewable energy resources than older respondents. Research by ClimateXchange in the UK also finds that young people are more likely to hold positive attitudes towards the use of renewable energy[45].

In this study, the effect of education on the likelihood of investing in renewable energy is somewhat ambiguous if the 5% level is adhered to, as only one coefficient associated with the renewable energy constant was significant at that level. The plausible hypothesis though is that no significant effect of education is expected with this sample as about 90% have a University degree. Many studies that cite education as influencing the likelihood of adopting renewable energy like Michelsen and Madlener (2012) capture impacts of education through a discrete indicator for secondary school attainment of the income earner. The comparison of university education against even higher levels of education like a master's and even a PhD may not provide the same effect seen in other studies that utilise a much lower educational attainment. Interestingly, higher education was observed to positively influence the likelihood of investing in government treasury bills, which is the status quo investment alternative.

By and large, many studies have found a positive correlation between income and the likelihood of investing in renewable energy technologies (Mills and Schleich, 2010; Sardianou and Genoudi, 2013). Without regarding statistical significance, the trend observed was that the likelihood of investing across all alternatives increased with increases in income. With investing in renewable energy, respondents in the mid-income

---

[45] See https://www.climatexchange.org.uk/media/1734/shaping_our_energy_future_-_how_the_public_feels_about_renewable_energy.pdf.

category showed a less negative preference for investment than people in the base-income category. Respondents in the upper-income category though show an even less negative preference for the renewable energy alternative though this was not significant.

What is evident in terms of statistical significance is that respondents in the base income category are the least likely to invest in renewable energy as they have the most negative preference. This finding for people in the base income category is not surprising as access to credit is crucial for investment, and these respondents may have less disposal income for investment.

In the study of heterogeneity, the latent class model suggests the existence of three distinct classes. One class (Class 3) similar to the “local patriots” in Salm *et al.* (2016) appear less motivated by the rate of return and have less sensitivity to longer hold times and increasing minimum price of investment. This class can be regarded as less risk-averse (risk-tolerant) and form 45% of the sampled population. The existence of this class suggests that there are investors that are not entirely profit-seeking who may be interested in investing in alternative investments like renewable energy. Another class (Class 1) though slightly sensitive to price and hold times have slightly less preference for the status quo (treasury bills) and can be won over with well-designed renewable energy support systems that ensure that renewable energy investments are competitive to government treasury bills.

On technology preference, this study confirms numerous prior research that suggests that solar PV is preferred over other renewable energy sources for investment (see Borchers *et al.,* 2007 and Gracia *et al.* 2012). Solar energy came up tops in the focus groups conducted in Ghana and the reasons for the belief in the technology according to participants were positive experiences with use (many participants stated they owned small solar gadgets like torches and lamps) and *a priori* knowledge. Further lending support to the popularity of solar technology is the evidence of global investment trends, as discussed in the earlier sections in Chapter Two.

In conclusion, the results in this chapter suggest that there is a section of the middle class that are likely to invest in renewable energy power projects if some key factors are present. This includes familiarity and belief in the technology to be financed (solar was found popular in focus groups and ranking exercise), a project developer with track record of having completed five similar projects with domestic origin, a project with high project viability with good support systems including guaranteed grid access, feed-in tariff and investment subsidies to reduce the associated risks. In the presence of these features, the risk premium on the rate of return reduces, and people can consider it a possible worthwhile investment. On demographics, young people in this study have a higher likelihood of investing in renewable energy than other counterparts. Also, people who fall in the base income category are the least likely to invest in renewable energy.

So, what does this mean for promoting private investment by citizens in renewable energy power projects? On the issue of developer reputation which comprises track record and origin of project developer, the findings show that a developer of domestic origin is more likely to promote investment in renewable energy. This is a good and positive signal indicating that building local technical expertise is likely to be rewarded as investor preference lies predominantly with a domestic developer. However, such a developer must have a proven track record of having completed at least five similar projects in order to enhance willingness to pay. Currently, in many SSA countries, local project developers are very few and lack the track record in delivering such projects.[46] To bridge this gap,

[46] The World Bank (2018) writes about the need to address the skills gap to ensure energy access. See https://blogs.worldbank.org/energy/bridging-skills-gap-key-energy-access-new-jobs

local project developers will need be considered in the design of renewable energy policy and given avenues to develop experience if local capacity is to be developed.

Again, the study emphasises the importance of renewable energy support systems for improving the project viability of renewable energy investments. For example, in Ghana, the target of 10% renewable energy by 2030 will be hard to reach if efforts remain business-as-usual. Over the last few years, there have been news reports of many registered renewable energy companies with nothing to show on the ground. This presupposes that the current policy support measure of guaranteed grid access and a feed-in-tariff is not enough to spur investment. The findings of this study support the addition of greater support measures (investment subsidies, among others) to reduce the risk for investors and project developers.

The importance placed on the developer track record also has implications for crowdfunding platforms. If crowdfunding platforms support developers with good track record, they are more likely to have successful campaigns and thus enhance their profitability since platforms charge projects a share of what is raised. The association of platforms with developers with good track record is likely to improve the platform’s reputation and legitimacy within the industry. Similarly, a platform’s reputation can be damaged if any of the projects on the platforms turns out to be fraudulent; hence, crowdfunding platforms have an incentive to ensure that projects offered on the platforms are credible. Here, due diligence measures are necessary though it may come at additional operational costs and other costs depending on the competition and level of regulation in the industry. It is important that policymakers set some minimum criteria governing what checks platforms should do before hosting projects to safeguard investors and prevent damage to the industry as a whole.

4.14 Summary

The findings have revealed that there is a group of household investors that are fit the criteria to be funders - interested in investing in renewable energy power projects. This notwithstanding, certain factors or attributes need to be present to enhance the likelihood of investment. Key amongst these is a developer with some track record, a project with high viability , a domestic project developer and a project with a good rate of return. The results also show that young people are more likely than their middle-aged counterparts to invest in renewable energy. On technology preference, findings reveal that respondents prefer solar PV over biomass, wind and hydro for investment.

Taken together, this suggests that household investors percieve the risks with RE projects and require safeguards like a developer with proven track record and an environment with good RE support systems to attract their financing. The results also revealed the heterogeneity of household investors and the need for further engagement and research to understand the motivations of these different investor classes to design bespoke and segregated policies more suited to their investment needs.

CHAPTER 5 FINANCIAL LITERACY AND INVESTMENT DECISION MAKING

5.1 Introduction

Day in and day out, many individuals around the world are required to make financial decisions. These decisions, including how to save, how to invest and plan for retirement, often have implications on the quality of life one can have now and in the future. Unfortunately, a plethora of literature point to the lack of financial literacy across many populations in the world and the urgent need to remedy the problem (Lusardi and Mitchell, 2011; Atkinson and Messy, 2012; Brown & Graf, 2013; Thaler, 2013; World Bank, 2014). The urgency in remedying the problem is brought about by the increasing complexity of financial products brought about by a rapidly growing Fintech world. Hence, the need for sound financial decisions is more necessary to avoid plunging people into poverty or retirement without an income (Grohmann, 2018).

The middle class by virtue of their income, education and geographical location (urban) centres are more likely to encounter and engage with these complex alternative investments or complex financial products. These products are often opaque and very few people understand them. This problem may be more magnified in developing country contexts where individuals may encounter these investments without the support and protection of a matured financial and regulatory infrastructure (Miller *et al.,* 2009). Hence, if financial literacy is deemed important in developed countries, it is even more critical in developing countries where people have escaped poverty just by the margins (Gray *et al.*, 2009).

In this chapter, the financial literacy of the middle class is examined to assess their understanding of basic financial concepts considering that online alternative investments like crowdfunding requires investors to make their own financial investment decisions often without the expert advice that traditional investments such mutual funds and treasury bills come with.

By and large, the middle class is largely underrepresented in empirical studies on financial literacy as the focus has often been on the poor in developing countries (Grohmann, 2018), populations in industrialized countries (Lusardi and Mitchell, 2014) and mainly college and university students (Chen and Volpe, 1998, 2002; Beal *et al.*, 2003; Murphy, 2005; Cude, 2006; Albeerdy and Gharleghi, 2015; Sarpong-Danquah *et al.,* 2018). The relative neglect of the middle class in financial literacy studies is quite surprising as this group plays a crucial role in economic growth and development (Ravallion, 2009; Banerjee and Duflo, 2008). In some instances, the growth in this group has been associated with “Africa rising” narrative hinting once again on how important the middle class is for holistic development.

The effect the middle class has on a country’s growth and development signifies that the financial decisions made by this group has far-reaching consequences for the economy than perhaps the poor (Grohmann, 2018). Owing to the distinct characteristics of members of the middle class in terms of educational level and income, it is safe to say that policies will differ from what is often proffered for the general population or even the poor.

Hence, this chapter looks at the financial literacy of the middle class in Ghana using three standard questions of financial literacy, that is, questions on compound interest, risk diversification and inflation. Also, it examines the significant aspect of the relationship between socioeconomic and demographic variables and financial literacy. Several studies (see by Lusardi and Mitchell (2011), Atkinson and Messy (2012), Thaler (2013), OECD (2013) have sought to identify such relationships due to the opportunity to identify gaps in knowledge or otherwise by sub-groups and classifications. This thesis achieves the said objectives by employing a probit analysis using each of the three questions as the dependent variable to assess how the demographic variables contribute to the probability of answering that question correctly. In doing so, specific knowledge areas for development can be identified and worked on.

This study contributes to knowledge in two ways. Firstly, it adds to the literature on financial literacy of the middle class in a developing country context. Secondly, it identifies and offers insights into the relationship between demographic variables like gender, age, education and income and financial literacy or knowledge. This is important for research and policy design as interventions will be better targeted to the right crowd for better outcomes.

The rest of the chapter is structured as follows; the key concepts between financial literacy and demographic variables are explored within the context of household financial decision-making. This is followed by the methodology used, analysis and discussion of results. Finally, the conclusions and implications of the study are presented.

5.2 Financial Literacy: The Theoretical Framework

Financial literacy and its importance for financial decisions is well recognised throughout the world. More recently, in the G20 summit, countries through their recognition of the importance of financial literacy have developed programs to help specific target groups in their countries.[47] Financial literacy though accepted universally, is interpreted in many ways, primarily due to the lack of consensus of its definition. Definitions in the literature include the following:

[47] The Independent reports on German officials developing a financial literacy programme for Germans based on G20 commitments. See at https://www.independent.co.uk/voices/g20-summit-world-leaders-trump-may-merkel-a8660731.html

1. “The ability to use knowledge and skills to manage financial resources effectively for the lifetimes of financial well-being” (The President’s Advisory Council on Financial Literacy (PACFL, 2008)
2. The understanding ordinary investors have of market principles, instruments, organisations and regulations (FINRA, 2003)
3. “The ability to evaluate the new and complex financial instruments and make informed judgements in both choice of instruments and the extent of use that would be in their own best long-run interests” (Mandell, 2007)
4. Familiarity with “the basic economic concepts needed to make sensible saving and investment decisions” (Lusardi and Mitchell, 2007c)
5. “Knowledge of basic financial concepts, such as the working of interest compounding, the difference between nominal and real values and the basics of risk diversification” (Lusardi 2008)
6. A person’s ability to understand and make use of financial concepts (Servon and Kaestner, 2008)
7. Confidence with managing money[48]
8. How well an individual can understand and use personal finance-related information (Huston, 2010).

As seen in the definitions above, financial literacy is sometimes used interchangeably with financial education and financial knowledge. The definition by Huston (2010) considers financial literacy from two angles: first “understanding” and second “using or applying” this knowledge for one’s personal financial management. This is conceptually related to the definition by the PACFL (2008), which also underscores the use of financial knowledge for one’s personal financial benefit.

[48] Australian Securities and Investments Commission, Financial Literacy in Schools (2003)

According to Potrich *et al.* (2015), the varying and overlapping definitions may be due to the many concepts covered by financial literacy such as financial awareness and knowledge, financial skills, and financial capability which makes it hard to capture in research in a reasonable length of time as a result of time constraints. Robb *et al.* (2012) in their attempt to clarify the different concepts state that financial literacy concerns the ability to understand financial information and make optimal decisions while financial education/financial knowledge is primarily about recalling a set of facts.

On another hand, Capuano and Ramsay (2011) define financial literacy by considering six key competencies and proficiencies. These are (1) money basics, including numeracy and money management skills; (2) budgeting and living within means; (3) saving and planning; (4) borrowing and debt literacy; (5) choosing and understanding financial products; and (6) understanding consumer recourse and self- help. They argue that the ability to link these for financial decision-making is what financial literacy truly entails. Though no definite answer exists, what emerges is that financial literacy goes beyond financial education. In that vein, the OECD (2013) defines financial literacy as a combination of awareness, knowledge, skill, attitude, and behaviour needed to make sound financial decisions and how this is used to enhance financial wellbeing. Thus, it encompasses financial knowledge, financial behaviour, and financial attitude. Considering all the definitions described, the OECD definition accommodates all variations and is a central point for progress.

5.3 Relationship between Financial Literacy and Socio-demographic Variables

Within the scope of household financial behaviour, the study of the influence of socioeconomic and demographic variables has not been left out. There is a considerable amount of literature dedicated to the effect of race, ethnicity, age, gender, education and income on financial behaviour and financial literacy. Generally, studies of financial literacy and gender have established that women have lower levels of financial literacy than men (Fonseca *et al.* 2012; OECD, 2013; Klapper *et al*., 2015).

According to Lusardi and Mitchell (2011), women are more likely to answer questions incorrectly and say they do not know the answer. This stylised fact is unfortunately found in both developed and developing country studies worldwide. One explanation given for the gender gap in financial literacy studies is the gender role in marriage as well as men making the financial decisions most of the time; hence accumulating more knowledge over time (Fonseca *et al.* 2012).

The socialisation of individuals has also been implicated in the difference found in gender. Edwards *et al.* (2007) conclude that parents maintain different expectations for sons and daughters; from sons, they expect making money and working harder while daughters are seen as future dependents on sons hence a lowering of expectation and conversations largely devoid of monetary issues. Thus, women grow to be more passive about money, while men desire and work hard for it because it is a symbol of pride and power (Calamato, 2010).

Age patterns have also been established in the literature. Most studies have shown that young and old people typically have lower levels of financial literacy compared to middle-aged counterparts, an inverted U-shaped pattern (Almenberg and Säve-Söderbergh, 2011 and Lusardi and Mitchell, 2011). Scheresberg (2013) also found that young adults (25-34 years) have used loans with high costs; perhaps an indicator of their financial literacy as this negatively affects their personal finances. Also, Lusardi and Mitchell (2011) found that respondents aged between 25 and 65 tend to answer 5% more questions than those under 25 or over 65 years in financial knowledge assessments.

Almost all country studies confirm a strong correlation between financial knowledge and higher education attainment (Klapper *et al*., 2015; Mitchell and Lusardi, 2015). For adults with at least 15 years of schooling, 73 per cent are financially literate, and this trend is true for developed and emerging economies (Klapper *et al*., 2015). Lusardi and Mitchell (2011) again find that individuals with low education are more likely to say they do not know the correct answers to financial literacy questions.

Regarding income, studies have found that people with higher incomes are reported to have higher financial literacy. This is unsurprising, considering the strong correlation between education and income in most countries. Additionally, low-income levels are often associated with lower financial literacy levels (Atkinson and Messy, 2012). Being wealthy was found by Monticone (2010) to have a positive effect on financial literacy. Another dimension worth considering, in this case, is the possibility of reverse causation: individuals with high financial literacy levels, when making better financial decisions, achieve higher income levels than individuals with low financial literacy levels.

In support of Monticone's findings, Hastings and Mitchell (2011) provide evidence to show that financial literacy is related to wealth. Other studies have also explored the financial literacy of those from wealthy or high-income families. They find that students from high-income families had significantly higher knowledge levels than students from low-income families (Johnson & Sherraden, 2007). Alternatively, students from low-income families are more likely to drop out of school which in the long run, contributes to their financial illiteracy (Calamato, 2010).

Other demographics metrics studied in the literature include the role of occupation, marital status and parents. Concerning occupation, Chen and Volpe (1998) found that individuals who have spent a long time in the labour market tend to have more financial literacy due to the propensity to encounter more financial situations. Married people are regarded as having better literacy levels than their single counterparts (Brown and Graf, 2013). Dew (2008), who also studied the relationship between financial literacy and marriage, explains that marriage couples found that consumer debt harmed marital satisfaction and hence, married people acquired more financial literacy to better their marriages. Also, parent's knowledge about money management has been used to study how this influences financial literacy in their children. Concerning this, Mandell (2008) found that financial literacy of individuals is related to parent's education.

5.4 Importance of Financial Literacy

According to Capuano and Ramsey (2011), the benefits of financial literacy can be characterized with respect to its impact on three primary beneficiaries: the individual, the financial system and economy and lastly the community.

5.4.1 Benefit to the Individual

For the individual, they mention 1. Greater capacity for savings and retirement planning 2. More realistic assessments of financial knowledge by consumers 3. Life skills and bargaining power 4. Financial efficiency (a) Lifetime utility and financial wellbeing, (b) Active debt management. 5. Activity in financial markets 6. Choosing the right financial products with confidence. 7. Consumer rights and regulatory intervention.

The benefits to savings are supported by studies like Jonubi and Abad (2013) who find that one's level of financial literacy has a significant positive impact on individual saving. Again, Bernheim and Garrett (2003) find that individuals exposed to financial education in high school or at work at more likely to save than those who have not. Other benefits such as activity in financial markets are corroborated by van Rooji *et al.* (2011) who studied financial literacy and investments and suggest that individuals with low literacy are less likely to invest in stocks. Low financial literacy has also been associated with portfolio under- diversification (Abreu and Mendes, 2010).

5.4.2 Benefit to the Financial System and Economy

For the financial system and economy, they mention (1) Greater competition, innovation and quality products and market discipline (2) Coverage of risk (3) Self-funding of retirement and (4) Overcoming “procyclicality” in lending.

5.4.3 Benefit to Community

The benefits to the community are also outlined as follows: 1. Financial inclusion, 2. Understanding government financial policies. Regarding financial inclusion, Gupta and Kaur (2014; 64) quote the Reserve Bank of India “Financial literacy creates awareness in common man regarding the financial products and services, thereby generating demand for the same. It makes them to understand the needs and benefits of the products and services offered by the banks and accelerate the pace of financial inclusion”.

5.5 Measuring Financial Literacy

As is to be expected, the variation in defining financial literacy affects how it is measured. Different measurement strategies have made way for inconsistency and incomparability of financial literacy results. Financial literacy measurement across studies reveal two main methods: performance tests and self – report methods. The former is often knowledge-based while the latter measures the confidence in knowledge or perceived knowledge (Hung *et al.*2009; Remund, 2010).

Measurement of perceived knowledge is however fraught with some challenges as according to the OECD (2005), consumers often think that they know more than they do - a phenomenon observed in non-financial circles in various disciplines. Though studies like Agnew and Szykman (2005) established a correlation between perceived and actual financial knowledge, this differs substantially depending on the demographic group with variations of 0.10 to 0.78 encountered. Such variation weakens the use of perceived knowledge as a proxy for actual knowledge and hence, financial literacy.

Coming back to the measurement of actual financial knowledge, the breadth and depth of such examination have also varied. Variations include percent correct on 10 multiple-choice items (Volpe *et al.* 1996), percent correct on 36 multiple-choice items (Chen and Volpe, 1998), correct responses to 10 true/false items (FINRA, 2003), correct responses to 3 multiple choice and true/false items (Lusardi and Mitchell, 2008), correct responses to 3 individual multiple-choice items (Lusardi and Mitchell, 2011).

According to Capuano and Ramsay (2011), for financial literacy surveys to yield more accurate results, steps must be taken to eschew the use of complex questions containing no definition, self-assessments and subjective questions as well as not considering a "pass score" for financial literacy. They explain that the order of words in a question has implications for its understanding and subsequently impacts scores. For example, in a Dutch study by van Rooji et al. (2007), they argue that the low literacy score was more a consequence of lack of understanding rather than not answering incorrectly.

Self-assessments have also been found quite problematic, in that, self-assessment scores are almost always higher than actual financial literacy scores which create room for inconsistencies. As an example, the European Commission in a Communication on financial literacy stated that "in an Australian survey, while two-thirds of respondents believed that they were financially literate, only around one quarter understood compound interest".[49] This inconsistency in perceived versus actual financial literacy is often attributed to people overestimating their abilities. However, a combination of actual and

49 European Commission (communication), Financial Education (COM/2007/0808 final). See https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52007DC0808:EN:HTML

self-assessed scores has been found by Allgood and Walstad (2016) as a holistic measure for investigating financial behaviour.

Explaining the scoring method used and setting a passing score for financial literacy is recommended by Capuano and Ramsay (2011). This is to ensure that studies that seek to compare scores do not compare, unlike terms. Thus, the question of how to measure financial literacy in the form of score becomes key. This is not as easy, and many researchers abstain from prescribing a threshold for determining whether an individual is financially literate as seen in Huston (2010) where almost 90% of 71 reviewed studies did not provide an indicator for when one was deemed financially literate. The other studies set a threshold below which one is considered to have failed — for example, 60% for the US JumpStart survey.

5.6 Method

The methods applied in measuring financial literacy is composed primarily of actual financial literacy tests, perceived or self -assessment test or both depending on what is being studied. In economic research; however, the dominance of the test measures of financial literacy is evident. For example, test measures have been applied to study retirement planning (Lusardi and Mitchell 2007; Lusardi and Mitchell, 2008; van Rooij *et al.* 2011; Lusardi and Mitchell 2011), banking (Grimes *et al.* 2010), stock investing (Abreu and Mendes 2010; van Rooij *et al.* 2007), wealth accumulation (Gustman *et al.* 2012) and inflation expectations (Bruine de Bruin *et al.* 2010). Also, the number of questions span as few as three questions often compound interest, risk diversification, and inflation effects to as many as sixteen questions (Allgood and Walstad, 2012). For this thesis, an actual financial literacy test is used in assessing knowledge of financial concepts as used in Lusardi and Mitchell (2011).

This study adopts the three financial literacy questions, as seen in Lusardi and Mitchell (2011). Lusardi and Mitchell (2011) emphasise the importance of simplicity, relevance, brevity and differentiation in designing questions to test for financial literacy. They designed three questions which have become a benchmark for measuring financial literacy (see Table 5.1). The content of the questions span:

a) numeracy and the ability to perform calculations relating to compound interest
b) understanding of inflation
c) gauging knowledge of risk diversification

To reduce cognitive burden and make it easier for respondents to make a choice, choice options are provided, including "do not know" and "refuse to answer" options to eliminate forced choices. It is noteworthy to add that these questions can be reworked or paraphrased to suit the setting and audience without affecting the content domain that is, the key sections being assessed.

Table 5.1 Financial Literacy questions on compound interest, inflation and risk diversification

(1) Suppose you had US$100 in a savings account and the interest rate was 2% per year.
After 5 years, how much do you think you would have in the account if you left the money to grow?
More than US$102
Exactly US$102
Less than US$102
Do not know
Refuse to answer
(2) Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, how much would you be able to buy with the money in this account?
More than today
Exactly the same
Less than today
Do not know
Refuse to answer

(3) Please tell me whether this statement is true or false. 'Buying a single company's stock usually provides a safer return than a stock mutual fund'.
True
False
Do not know
Refuse to answer

The three questions above test basic yet fundamental financial concepts. The first question tests interest rate and the concept of compounding. The second question tests the understanding of "inflation" – a measure that shows that individuals understand the effect of their economic environment on their financial and investment decision making. The third and equally important question is on risk diversification, which tests the understanding of risk by the individual. As simple as these questions are, they are effective in differentiating between naive and sophisticated respondents (Lusardi and Mitchell, 2008).

For use in this study, the three (3) literacy questions were reworked for the country setting for which it was to be used. These changes include the change of dollars to Ghana Cedis and tweaking of the risk diversification question from the true or false in Lusardi and Mitchell (2011) to an identification of the riskier asset. The wording and order used in the financial literacy test are as shown below.

*Suppose you had **GH¢**1000 in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow?

A. More than GH¢1020
B. Exactly GH¢ 1020
C. Less than GH¢1020
D. Do not know
E. Decline to answer

* Which is the riskier asset to invest in?

A. A single company share
B. A portfolio of different company shares
C. The risk is the same
D. Do not know
E. Decline to answer

*Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, how much would you be able to buy with the money in this account?

A. More than today
B. Exactly the same
C. Less than today
D. Do not know
E. Decline to answer

5.7 Analysis of Responses

Following the administration of the survey and input of survey responses, a multivariate analysis was conducted to determine which of the demographic variables measured influenced the knowledge of the financial literacy concepts under study. In doing the empirical analysis, several considerations informed the selection of variables for inclusion in the regression. First, gender and age (in subgroups) were included to see whether these were related to financial literacy. Prior research has reported differences in financial literacy for gender and age categories. Also included are respondent educational levels. This is important to examine whether financial knowledge is related to educational experiences spent during the time spent schooling. Finally, the relationship between financial knowledge and income level is examined by incorporating income variables in the regression.

Descriptive Findings

Table 5.2 reports the result from the three questions that measured respondent levels of financial literacy. Out of the 201 respondents, only 175 answered the questions with a few dropouts for the risk diversification and inflation questions. Survey responses were dummy coded in preparation for further analysis. All correct responses took the value of 1 and wrong/do not know responses coded as zero.

Although 89% of respondents answered the compound interest rate question correctly, only 75% answered the risk diversification question correctly, and about 24% did not know the answer to the risk diversification question or answered incorrectly. Also, only about 79% of respondents answered the inflation question correctly. With an average for correct responses in all three questions at 81%, our survey population can be deemed to possess a good grasp of the financial concepts tested. More specifically, only 62% of respondents answered all three questions correctly (110 out of 175 respondents). Additionally, 72% of respondents answered the first two questions correctly (126 out of 175). Thus, it can be said that the middle class in Ghana have sound financial knowledge concerning the three concepts tested. Of the questions examined, risk diversification appears to be the concept that people have the most difficulty grasping. This appears to be a common trend in several surveys as people are most likely to say they ‘do not know’ or incorrectly answer to the risk diversification question.

Table 5.2 Patterns of Responses to Financial Literacy Questions

Distribution of responses to financial literacy questions (%)			
	Compound Interest	**Risk Diversification**	**Inflation**
Correct Responses	89.71	75.72	79.07
Incorrect/Do not Know	10.29	24.28	20.93
Total Responses (N)	**175**	**173**	**172**

For a preliminary analysis of the association between socioeconomic and demographic variables and financial literacy, the Pearson's chi-square test is conducted. Table 5.3 displays Pearson's chi-square association measure – $\chi 2$ (p-value in brackets) between each pair, i.e. the predictor variable and financial literacy question. It is important to add that since this is a bivariate analysis, the chi-squared measure does not account for changes in other predictor variables.

From the association measure presented, it can be seen that no relationship exists between demographic variables and the ability to answer the compound interest question at the 5% level. Education only becomes relevant at the 10% level. For the risk diversification question, a strong relationship is seen for education and occupation variables only. This suggests that occupation type and education level may influence an individual's knowledge related to risk diversification. Finally, in the case of inflation, all variables except occupation show a relationship with knowledge on inflation. Specifically, age and education have a significant association with financial literacy (inflation knowledge) at a 1% level, while income and gender are significant at 5% level.

Table 5.3 Pearson's chi-square association measure between financial literacy and sociodemographic variables(N=175)

	Compound Interest	**Risk Diversification**	**Inflation**
Gender	1.165 **(0.280)**	0.071 (**0.789**)	3.995 (**0.046**)
Age	8.765 **(0.119)**	7.714 (**0.173**)	15.092 **(0.01)**
Occupation	5.976 **(0.426)**	15.992 (**0.014)**	9.892 **(0.129**)
Education	7.573 **(0.056)**	22.006 (**0.000)**	16.428 (**0.001)**
Income	10.339 **(0.170)**	9.989 (**0.189**)	17.317 (**0.015)**

5.8 Results of Multivariate Analysis

This section discusses results from multiple multivariate regressions conducted to assess how sociodemographic characteristics interact with financial literacy. A probit model was used for the analysis, as seen in Lusardi *et al.* (2010). The regression model used is as follows:

$$y^{*} = x\beta + \varepsilon, \quad y = \begin{cases} 1 \\ 0 \end{cases} \quad \text{if } y > 0 \text{ or else} \qquad \textbf{5.1}$$

where y^{*} is an unobservable characteristic which represents a respondent's tendency to answer a financial literacy question correctly. y represents a binary outcome variable when the respondent gave a correct response and is above zero. The vector **x** represents respondent characteristics, **β** is a vector of parameters to be estimated, **ε** is a continuously distributed variable independent of **x**, and the distribution of **ε** is symmetric about zero.

The above regression generates a binary response model of the form:

$$P(y = 1|x) = \Phi(x\beta) \qquad \textbf{5.2}$$

where Φ is a cumulative distribution function (cdf). The main objective was to explain the effects of the respondent characteristics x_j on the probability of responding correctly to a financial literacy question. For a given variable, say x_N which is a binary explanatory variable, the marginal effect from changing x_N from 0 to 1, holding all other variables fixed, was

$$\Phi(\beta_1 + \beta_2 X_2 + \cdots + \beta_{K-1} X_{K-1} + \beta_K) - \Phi(\beta_1 + \beta_2 X_2 + \cdots + \beta_{K-1} X_{K-1}) \quad \textbf{5.3}$$

It is important to note that the above expression depends on all other values of the other x_j. The marginal effects were calculated by setting all the other independent variables to their mean value. By doing this, the model ensures that the marginal effect from changing a discrete explanatory variable x_N from 0 to 1 can be interpreted as the change in probability of responding correctly to a financial literacy question. Again, the marginal effect of change in x_j is given by the sign of β_j.

The marginal effects calculated are reported in Table 5.4 and the graphical representation shown in Figure 5.1, 5.2 and 5.3. The sample consists of about 172 observations for which data are available for all variables, and the same specification is used for all regressions. Dependent variables are dummy variables characterising respondents who correctly answer the question on compounding/interest, inflation, and risk questions. Covariates include controls for gender, age education and income. Standard errors for estimates are in parentheses and significance is denoted with asterisks (*** p<0.01, ** p<0.05, * p<0.1).

Table 5.4 Multivariate Analysis of Financial Literacy: Probit Marginal Effects of Association with Correct Responses (standard error in parentheses)

	Compounding (Interest Rate)	**Risk Diversification**	**Inflation**
Female	-0 .0480 (**0.0475**)	-0.0424 (**0.066**)	-0.0989* (**0.0601**)
Young (18 to 34)	- 0.0167 (**0.0906**)	0.0390 (**0.1112**)	-0.1423 (**0.1263**)
Middle age (35 to 44)	0.0059 (**0.0924**)	0.0459 (**0.113**)	-0.0246 (**0.1331**)
High Education	0.0839 (**0.0532**)	0.2329***(**0.0644**)	0.1281**(**0.641**)
Mid Income	0.0704 (**0.0574**)	0.0144 (**0.0826**))	-0.0077 (**0.0748**)
Upper Income	0.1114*(**0.0678**)	0.0896 (**0.0827**)	0.1151 (**0.0832**)
High Income	0.0688 (**0.0788**)	0.1294 (**0.1113**)	0.1559 (**0.1084**)
Observations	175	173	172
R-squared	0.121	0.111	0.155

*Note: Baseline categories dropped in the regression: Male, Old (45 to greater than 65 years), General Education (University Degree and below), Base income (15,001 to 25,000). *** p<0.01, ** p<0.05, * p<0.1*

The empirical estimates show several interesting patterns. Firstly, there are no gender differences in the responses to the financial literacy questions at the 5% level. This is interesting as many studies, even after accounting for different sets of demographic and economic characteristics often find that women are less likely to correctly answer each of the three financial literacy questions or be financially literate compared to their male counterparts as evidenced in Lusardi and Mitchell (2008), Fonseca *et al.*(2012), OECD(2013) and Klapper et *al*. (2015).

Figure 5.1 Effects of Demographic Variables on the Probability of Answering the Compounding Question Correctly

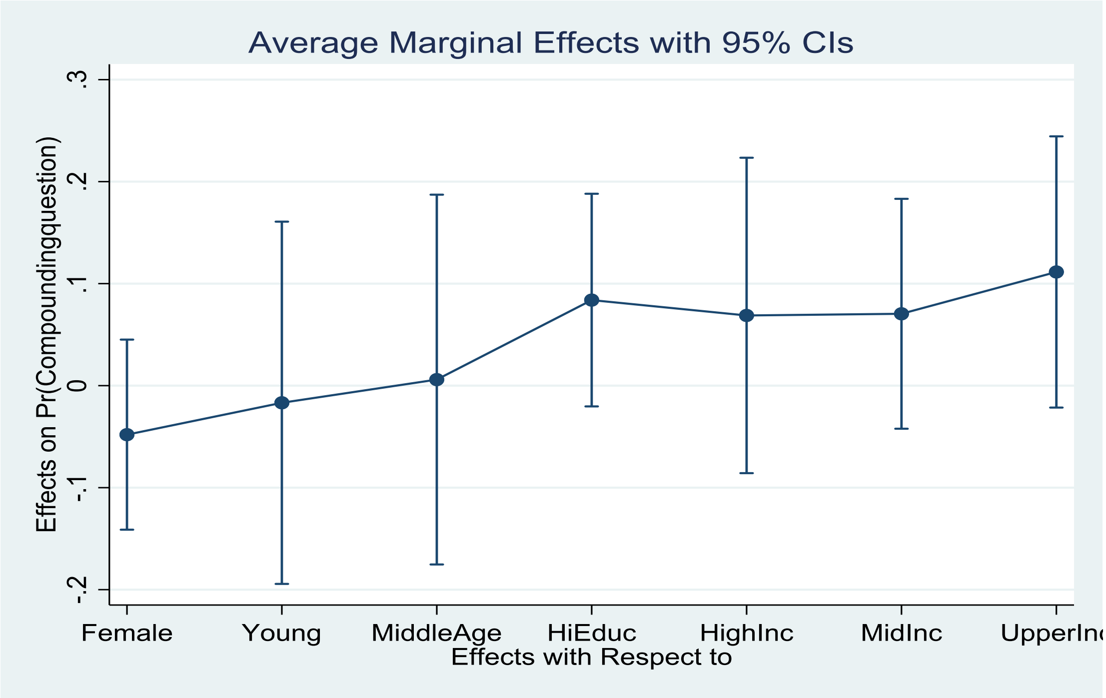


Figure 5.2 Effects of Demographic Variables on the Probability of Answering the Risk Diversification Question Correctly

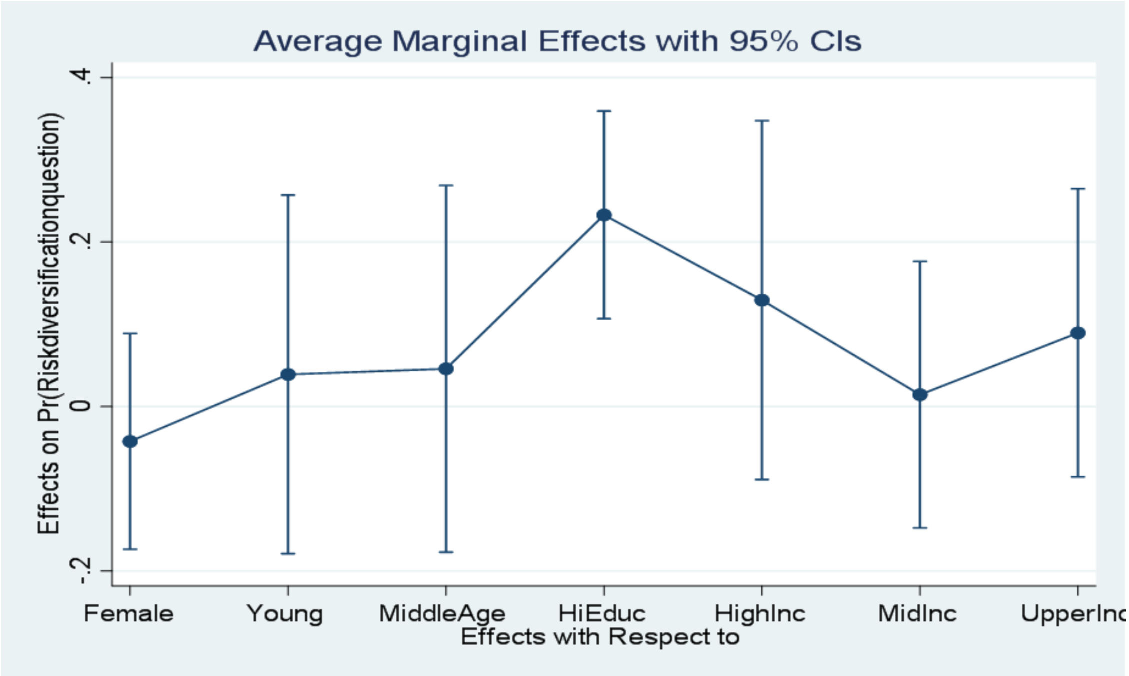
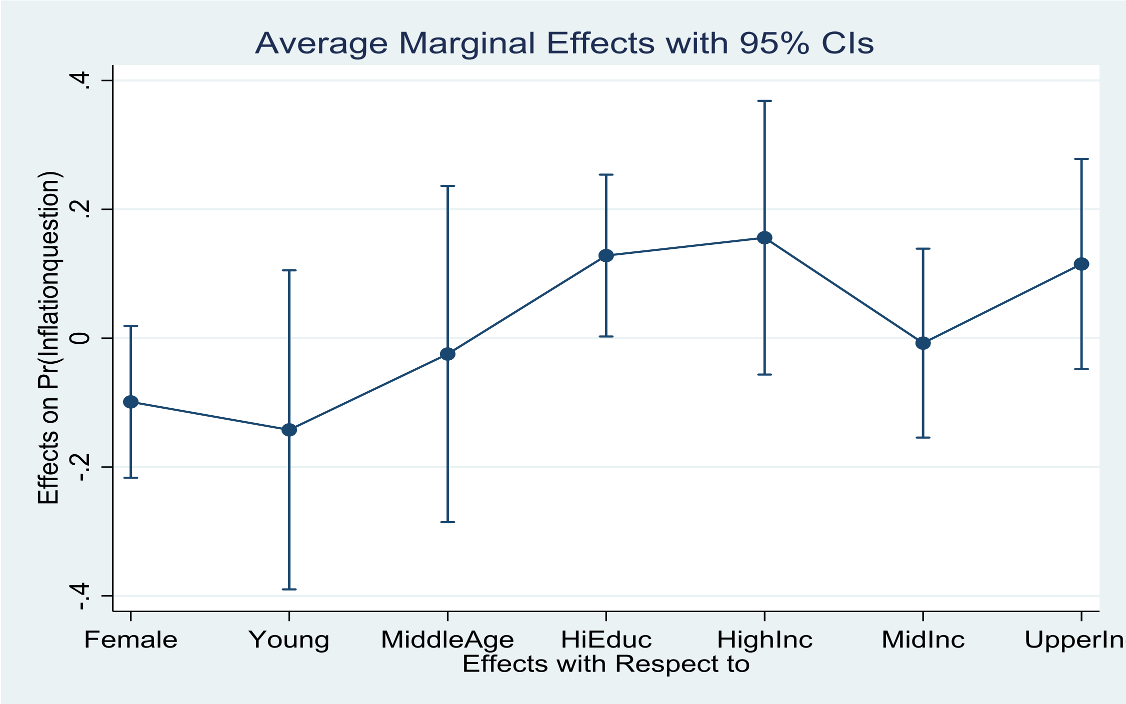


Figure 5.3 Effects of Demographic Variables on the Probability of Answering the Inflation Question Correctly



Though no significant differences were found between gender as already mentioned; it is important to observe that female respondents were found to be 9.8 percentage points less likely to answer the inflation question correctly. A smaller difference is found for the risk diversification question, which showed a difference of about 4.2 percentage points. Lastly, on the compounding question, a 4.8 percentage point difference was found. These results, therefore, show, that gender is not a strong predictor for financial literacy among the middle class in Ghana.

Similarly, on age effects on financial literacy, results show that no significant differences exist between age categories young and middle age across the three financial literacy questions at the 5% and even 10% levels. However, being young reduces the likelihood of answering the compounding question correctly while being middle-age improves the likelihood. Results also show the being young, and middle age enhances the likelihood of answering the risk diversification question correctly though they are both not significant.

The trend for inflation question, however, tells a slightly different story showing that compared to the older counterparts (reference group), both young and middle-age have a reduced likelihood of understanding or answering the inflation question correctly though estimates were not significant. Studies on inflation knowledge, perception and expectations in the literature appear to argue that older people may be better at perceiving inflation due to the longer experiences accumulated over their lifetime compared to the young and middle age (Malmendier and Nagel, 2015).

On education, results show that there is a strong positive relationship between the level of education attained particularly for the risk diversification and inflation questions, which showed significance at the 1% and 5% level respectively. Estimates suggest that those with high education (master's degree and above) were 2.3 percentage points more likely to answer the risk diversification question correctly and 1.2 percentage points likely to answer the inflation question correctly. Educational attainment or level could thus be argued as a strong determinant of financial literacy or knowledge. This result follows a similar trend in what was observed in Lusardi and Mitchell (2011) when examining financial knowledge across education groups. They find that for the risk diversification question, only those with at least a college degree display a high proportion of correct answers and almost a third of these did not know the answer or answered incorrectly to this question.

Finally, although income level was not found to be strongly associated with financial literacy, there still was a positive relationship between increasing income and the ability to answer the risk diversification and inflation questions correctly.

5.9 Discussion

This chapter has contributed to knowledge by exploring what middle-class individuals in Ghana know and do not know about the three simple questions used widely to assess the basic financial literacy, that is, compound interest, risk diversification and inflation. Though researchers around the world increasingly document the low levels of financial literacy in many populations, we found that financial literacy was not lacking among the middle class in Ghana; more than 75% of respondents could answer the compound interest, risk diversification and inflation questions. Interestingly, women in the middle class were not worse off than their male counterparts, as seen in numerous studies. Though very few studies have looked at financial literacy among the middle class and even less so in a developing country context, it is comforting to observe that a study of Thai middle-class women also does not show a gender gap in financial literacy (Grohmann *et al.*, 2016). Hence, it appears that reasons given for female underperformance in literacy studies such as the gender role in marriage, men making the financial decisions and hence accumulating more knowledge over time (Fonseca *et al.* 2012) and well as socialization (Edwards, 2007) has been overcome by other characteristics of being in the middle class. Indeed, studies that document a gender gap also show a positive impact of income and education, and as such, some scholars argue that a gender gap may instead reflect an income or educational gap.

Particularly, country characteristics may offer insight as to some reasons. In most Universities in Ghana, there is "affirmative action" where females who obtain a grade above the normal cut off point for certain programmes are still considered for admission. The University of Ghana reports a ratio of 1.4 :1 for male to female enrolment. [50] Estimates according to media reports during the University's congregation in 2016 report undergraduate enrolment of 50.47 % males and 49.53% females as well as 57.89 % males and 42.11% females at the graduate degree level.[51] Complementing efforts are the many

[50] See https://www.ug.edu.gh/about/enrolment-and-graduation-statistics
[51] See https://www.ghanabusinessnews.com/2016/11/20/university-of-ghana-makes-progress-in-reducing-gender-gap/

non-governmental organisation such as Campaign for Female Education (CAMFED)[52] in bridging the educational gender gap. Labour force participation is also hypothesised to affect financial literacy indirectly. This is because stronger participation of women leads to greater responsibility for personal finance and BucherKoenen *et al.* (2014) argue that this may be because of experience and learning, which impacts financial literacy. The UNDP in its human development report for 2017 cites labour force participation for females and males at 74.8% and 79.2% respectively for people aged 15 years and above in Ghana which suggests some parity in accessing the labour market for both sexes.[53]

Further buttressing this assertion about the possible influence of educational policies and action is what the study found with regards to high education and financial literacy. Here, high education meant having a secondary degree or above that is, master's degree or above. High education was observed as a significant predictor for understanding the least understood concept, i.e. risk diversification. Other studies across the European Union also suggest that the risk diversification concept is the most difficult to grasp and find that people who understand risk concepts are twice as likely as those without to make better financial decisions.[54] According to Lusardi and Mitchell (2011), understanding of risk diversification is related to possession of advanced financial knowledge which may be correlated with the higher contact hours for the sample that has a Master's degree and above. Abreu and Mendes (2010) also find that investors' educational level has a positive impact on investor diversification.

The study also found that income level and age were not significant predictors for financial literacy. On income, it is logical to argue that income on its own does not guarantee high financial literacy or that people will make better financial decisions.

---

[52] See https://camfed.org/our-impact/ghana/

[53] See http://hdr.undp.org/en/composite/GII

[54] Report by Global Financial Literacy Excellence Centre. See http://gflec.org/wp-content/uploads/2017/01/AGI-IPP_1-17_Financial-Literacy_FINAL.pdf?x87657

However, studies on financial literacy that include other measures of financial behaviour find that groups that have often been associated with low financial literacy also have limited access to financial services. In other words, the majority of these groups are financially excluded.

For low-income households or populations, not having enough money precludes people from owning an account or participating in other savings and investment services offered by the mainstream financial system (Zhan *et al.,* 2006). If financial inclusion (access and use of financial services) is deemed relatively equal across the individuals in income categories (controlling for all other variables) considered in this study, it may provide a reason for the outcome (absence of the effect of income) observed.

Lastly, age was not found as a determinant of financial literacy among the middle class. Since people in employment were considered for this study as an inclusion criterion for being in the middle class, the age group was relatively homogenous (compared to general population surveys). Hence, it is not surprising that differences in financial literacy may be insignificant after controlling for other variables. It is also important to highlight that comparison across age groups in different studies must be done carefully as young in some studies may be considered middle age in another.

5.10 Implications for online alternative investments like crowdfunding

Overall, the findings of this study have important implications for research related to financial literacy and household investment decision making, especially in this digital era. Though brick and mortar or traditional financial institutions continue to play a role in the financial landscape, their boundaries are continually being breached by the Fintech revolution which is affecting how consumers interact with traditional institutions and how they access other financial products online. Retail investors, hence, are exposed to products that hitherto only professional investors could access, and this increases the risk that customers do not understand the risk, costs and return of the products they are buying. It may also be essential to recognise that the middle class are not a thoroughly homogenous group, although sharing some similarities. Differences in gender, education, income and other characteristics suggest that careful consideration and planning needs to go into the research and design of policies to promote functional financial literacy that works for the environment in which the middle class thrive.

Though overall financial literacy across the middle class in Ghana is not lacking, a careful look at the results considering the increasing research on financial behaviour and knowledge suggests that some groups among the class are more advantaged than others in understanding certain concepts. Notably, this study underscores that it is more likely for people with a master’s degree and above to understand risk diversification and inflation. The concept of compound interest appears to the easiest to grasp across all groups, evidenced by the high percentage of accurate responses. This leaves the people without such educational attainment worse off in their understanding of risk diversification and inflation.

Understanding of risk, however, is the foundational step to dealing with the complex financial products available today and the findings have implications for policymakers and regulators. First, policy and regulation must guide and/or compel financial service providers who offer complex financial products to exercise greater responsibility and a duty of care towards their clients. This essentially boils down to ensuring that investment risks are well managed and understood to ensure that consumers are not harmed. As detailed in the FCA (2018), this means minimising any mismatch of expectations between what the “between what an investor thinks they are getting, and what they are actually getting in practice”.

Again, regulators (e.g. the Securities and Exchange Commission and the Bank of Ghana) in designing policies must pay attention to the marketing and sale of complex financial products as this is a crucial area in investor protection. Such policies could also address the financial organisation and internal controls, how to assess the suitability of certain products for certain consumers, disclosures and communication in relation to products and then lastly how to ensure compliance for products sold.[55] In assessing suitability of certain products for certain consumers, enforcement of strict know-your-customer (KYC) norms on all digital platforms and investments that fall outside what is considered conventional investments is required. The design of KYC must take into consideration ease and convenience to encourage compliance.

Secondly, on investor capacity to analyse risk, financial education and the design of financial education programs comes into focus. In the USA, the JOBS Act 2015, mandates crowdfunding platforms to provide "most current and up-to-date educational materials that explain, among other things, the process for investing on the platform, the types of securities being offered, and the risks associated with each type of security".[56] Thus, further strengthening of educational requirements to enhance investors ability to identify risk is important.

Though a relatively small sample is used in this study, the relative difficulty in grasping the basic concept of risk diversification may mean that more knowledge gaps may exist for more advanced risk questions. This means that the middle class should not be ignored when it comes to financial education but have financial education programmes tailored

[55] These areas are covered in detail by the European Securities and Markets Authority in their "Opinion" on MiFID practices on 7th February 2014 for firms selling complex project. See opinion at https://www.esma.europa.eu/sites/default/files/library/2015/11/ipisc_complex_products_-_opinion_20140105.pdf

[56] See JOBS Act. Part III, Requirements for Intermediaries at https://www.sec.gov/divisions/marketreg/tmcompliance/cfintermediaryguide.htm

to their needs in workplaces and financial institutions taking into consideration the sophisticated financial products this group is exposed to.

5.11 Summary

In this chapter, we measured the financial literacy of Ghanaian middle class using three simple questions on literacy aimed at gauging their understanding of compound interest, risk diversification and inflation. This was considered relevant as many online alternative investments essentially puts the making of sound investment decisions in the hands of the individual often without expert advice. We find that financial literacy as a composite of all three questions is not lacking among the middle class in Ghana. Further investigation using demographic variables of gender, age, education and income show that a gender gap does not exist between males and females as documented in many financial literacy studies. In addition, having a master’s degree and above improved the chances of answering the risk diversification and inflation questions correctly. This is important because many studies have documented the relative difficulty in grasping the concept of risk diversification even for other advanced economies. This, therefore, means individuals who might not have attained that level of education may be more vulnerable to understanding risk, and this may affect their financial decision making and portfolio choice.

The role of financial intermediaries in reducing the risks to the investor is also highlighted. In that vein, policymakers and regulators must regulate intermediaries (for example, crowdfunding platforms) to ensure continual growth within the sector as well as protect the interest of investors. This entails crafting regulation for the intermediaries built on disclosure of useful information that equips investors to make sound investment decisions. Also highlighted is the role of financial education by intermediaries as well as the design of financial education programs by other educational stakeholders as even the middle class can benefit from education tailored to the understanding of investment risks.

It is hoped that this study has provided a foundation for further studies to explore more detailed assessments of financial literacy among the middle class - to understand how this affects day to day financial behaviour and decision making. Follow up work can be conducted into the understanding of risk among the middle class, which will also offer better insights into what regulatory and educational support these people need to make good and sound financial decisions.

CHAPTER 6 CONCLUSIONS AND POLICY RECOMMENDATIONS

6.1 Introduction

Increasing concerns about climate change and the need to provide clean, affordable electricity to address both electricity access and reliability challenges indicate that significant investments in cleaner energy sources like renewable energy are necessary. Presently, studies that have sought to estimate the level of investment required to achieve universal energy access suggest that additional financing will be required to bridge the gap. This requires a look at other possible innovative financing sources to complement current efforts.

Since 2009, the role that households or citizens can play in the renewable energy financing space has become more apparent – most notably in developed countries in Europe. In many instances, citizens invest and own renewable energy power projects contributing to developing the local energy systems and contributing to climate change mitigation. This trend is seen in many European countries and relatively less existent in countries in Sub-Saharan Africa, where about 600 million people lack access to electricity.

To leverage household investments for renewable energy power projects, understanding the preferences of such private investors is essential – more so when many previous studies on investor preferences in the power sector have been highly skewed toward institutional investors like commercial trusts, hedge funds, pension funds among others.

To fill this gap, the first section of the thesis was concerned with identifying and valuing the attributes associated with household investor preferences for renewable energy investments using a discrete choice experiment. Questions relevant for understanding such preferences for investment included, what are the key attributes that enhance the decision to invest in a renewable energy project, and what is the marginal willingness to pay for the different attributes? Are preferences for these attributes homogenous? Are some renewable energy technologies more preferred over others?

With one of the well-elaborated risks of online alternative investments being the inexperience of funders coupled with the absence of expert advice that traditional investments such mutual funds and treasury bills come with; the second part of this thesis was to assess the basic financial literacy of the sampled population. This was done by assessing respondents’ understanding of compound interest, risk diversification and inflation and how the understanding of these concepts differ by variables such as gender, education and income. In examining these questions, it is hoped that any future policies crafted around household investment in renewable energy would engage from a more informed stance regarding what projects were likely to be funded.

In all, the thesis makes several contributions. The first part of this thesis fills the gap in the academic literature regarding preferences of household investors for renewable energy investments in a developing country context. It contributes to the existing literature in two main ways: firstly, it identifies key renewable energy investment attributes and the marginal willingness to pay for these attributes hence contributing to knowledge in the renewable energy investment literature.

Secondly, it makes a valuable contribution to the applied discrete choice (stated preference) literature on renewable energy preferences among household investors. Regarding the second part, it contributes to the literature on financial literacy among the middle class as well as the online alternative finance literature by offering insights into how government regulators and perhaps platforms could contribute to minimising the risks for household investors. Overall, the thesis provides holistic insights for policymakers to design policies that seek to engage citizens, looking at both financial and non-financial considerations to attract the necessary investments for renewable energy.

The process and results of the entire study is presented in this Chapter. There are six chapters in this thesis. Chapter 1 is an introductory chapter that covers the background, research aim and objectives and the significance of this thesis. Chapters 2 details the relevant literature concerning renewable energy investment by households. Chapter 3 presents the study methodology: specifically, the description of the econometric models used and issues of experimental design for the choice experiment. Chapter 4 and 5 presents and discusses the results from the two empirical sections, as earlier mentioned.

In the sections below, the findings from the two empirical findings are summarised. In section 6.2, key findings and implications from the two empirical parts of this thesis are presented. Following from this, the limitations of the studies and future research recommendations are presented in section 6.3. Next, in section 6.4, some policy recommendations are proffered for government, crowdfunding platforms, investors and project developers. Lastly, section 6.5 concludes and reflects on the contribution of this thesis.

6.2 Key Findings and Implications

6.2.1 Valuing of Household Investor Preferences using Discrete Choice

To understand the preferences of household investors for renewable energy investments, the study has established that there is a section of the middle class that fit the criteria to be funders for renewable energy projects. This is confirmed by the latent class analysis in Chapter four that revealed a class similar to what literature describes about investors in renewable energy. More aligned to the research objective on assessing the marginal willingness to pay (MWTP) for the different renewable energy investment attributes, results have shown that among the attributes considered, track record of the developer was associated with the highest willingness to pay. This is followed by the project viability attribute, which encompasses the support systems respondents deem necessary to enhance the viability of RE projects. The high willingness to pay for this attribute highlights the importance of eliminating power market risk, grid integration risk and other governance risks.

Also, worth mentioning, is the appreciable willingness to pay for a project developer of domestic origin. The favouring of domestic or investments in one’s home country (home bias) is well known in literature and should be considered a positive signal to build the expertise of local renewable project developers as this is more likely to produce greater synergistic effects in building a sustainable local energy ecosystem.

On the other hand, the hold time was associated with a negative willingness to pay meaning that respondents preferred investments with shorter hold times. Interestingly, the rate of return although valued by respondents, was not associated with the highest willingness to pay when it comes to renewable energy investments. Altogether, a renewable energy project that will encourage citizen financing will have a project developer of domestic origin, have a developer with some track record (completed five similar projects in the past) and be supported by guaranteed grid access, feed-in-tariff and investment subsidies to enhance project viability. The said project should also have a short hold time compared to other market alternatives.

The thesis also revealed preference heterogeneity for some of the attributes. The heterogeneous preference for the minimum price of investment, rate of return, the origin of project developer and track record lends credence to the heterogeneity of RE investors and the need for policymakers to design more segmented policies that support the goals of each investor class.

In the assessment of demographic variables like gender, education, age and income on the likelihood of investing in renewable energy, the influence of gender is found to be non-existent. On the contrary, age and income were found to influence the likelihood of investing in renewable energy. The thesis established that young people (18 to 34 years) are more likely to invest in renewable energy whilst respondents belonging to the base income (GHS 15,000 – GHS 25,000) category are least likely to invest in renewable energy power projects.

Also, investigation of technology preference showed that solar PV was the technology of choice among the sampled population. The least preferred renewable energy technology was wind energy. The finding on technology suggests that the choice of technology influences investor choice of investment and must be considered along with all other factors in designing initiatives that seek to attract household investor financing.

6.2.2 Financial Literacy Assessment

The second part of this thesis assessed respondents' knowledge on basic financial literacy using questions on compound interest, risk diversification and inflation. Unlike in numerous other financial literacy studies, this study has shown that the middle class in Ghana has a good understanding of the basic literacy concepts tested. Indeed, more than 75% of respondents could answer the compound interest, risk diversification and inflation questions. The least understood concept based on the percentage of incorrect and do not know responses was the risk diversification question which has been also found in other developed economies to be the most difficult concept for participants to grasp.

Of importance in the financial literacy literature is the effect of demographic variables like gender, age, education and income on the propensity to understand the three basic literacy concepts. Interestingly, financial literacy among females in the middle class did not lack behind that of their male counterparts, as seen in numerous studies. Owing to the characteristics of people in the sample, it was deduced that the lack of a gender gap could be attributed to the reduced impact or effect of cultural, political and social factors on the gender. Studies that observe a gender gap attribute this to socialisation, the gender role in marriage, men making the financial decisions and hence accumulating more knowledge over time. The apparent homogeneity of the sampled population in terms of education and income is a plausible factor in the absence of the gender gap.

On age effects on financial literacy, this thesis finds that no significant differences exist between age categories young and middle age across the three financial literacy questions at the 5% and even 10% levels. However, being young reduces the likelihood of answering the compounding question correctly whilst being middle-age improves the likelihood. On the inflation predictor, both young and middle age respondents showed a reduced likelihood of answering the inflation question correctly, suggesting that older people may understand inflation better.

Lastly, the findings show that having a high education enhances the likelihood of answering the risk diversification question. This, therefore, suggests that individuals who do not have master’s degree and above may be more vulnerable to understanding risk, and this may affect their financial decision making and portfolio choice. The risks associated with renewable energy projects, the possible risks of investing on crowdfunding platforms and the relative gaps in understanding risk diversification as shown in the financial literacy assessment suggest that more will have to be done from the angle of regulation and education to ensure that investors are well-equipped to assess the risks associated with investment. Aside regulation, financial education programmes more focused on risk diversification will help the middle class identify and understand alternative investments like renewable energy and other financially complex financial products this group may be exposed to.

6.3 Limitations and Future Research

As with any research, this study is fraught with some limitations that can serve as useful starting points for consideration by other researchers for future research. Thus, this section presents a discussion of the limitations of each study conducted in this thesis. Where possible, remedies or solutions will be discussed. The discussion of limitations will be done two-fold: limitations for the DCE survey and the financial literacy study.

Perhaps, one of the fundamental limitations of this work was the limited budget which constrained the sample size. Had the budget allowed, the study would have reached for a much higher sample size. Again, while it is significant to note that respondents who participated in the survey did so voluntarily without the use of incentives, they might not fully represent household investors in Ghana as participants were pre-screened for income, surveyed from Accra alone and perhaps might have particular interest in renewable energy or possess other attributes of persons with pro-environmental behaviour. In that vein, it is important to highlight that the sample used could suffer from self-selection bias which may affect the generalisability of findings.

Also, the study would like to highlight that though the valuation exercise had a status-quo and opt-out alternatives to remove forced options, it did not account for zero protests which is increasingly used to enhance validity through the identification of serial non-participation. Additionally, due to small sample size, all observations were used after consistency test and this could introduce some bias in parameter estimates.

On limitations regarding findings of the DCE survey, it is important to note that though the study provides powerful insights for middle-class countries in Sub-Saharan Africa on what household investors might value in renewable energy investments, a strict comparison between countries is not encouraged. Though the middle class exists in middle-income countries in the region, other contextual factors could influence how these attributes are valued. As many countries in the region have renewable energy targets, it would be interesting for future research to investigate how relevant these renewable energy investment attributes are in other middle-income countries; this could hint on whether a regional policy or approach would be relevant in encouraging citizen investment.

Secondly, though the discrete choice results presented may provide useful information to inform policy in on how to attract private investor financing, some limitations exist that researchers and policymakers must be made aware of to prevent misinterpretation. The general criticism concerning discrete choice experiment is often hypothetical bias brought on by its hypothetical nature. Willingness to pay measures from DCEs have often being deemed overstated, meaning that the true willingness to pay lies below such measures (see Herriges *et al.,* 2010; Loomis, 2011). As a result of this, WTP measures in this DCE are likely to be larger in magnitude than what may truly pertains. Though this study sought to reduce hypothetical bias by stating that findings will be used to inform policy(consequentiality), inclusion of methods such as cheap talk and honest and realism approaches have been seen as more effective in reducing hypothetical bias.

Further, because estimates of WTP depend on theoretical assumptions, model specification and even sampling approach, care must be taken in the use of these estimates. Specifically, the use of only WTP measures in the design of policy is inadequate and may lead to less optimal results on the ground. One of the key advantages to draw from such preferences and estimates is their direction that is, is more preferred rather than less; as well as the trade-offs investors are willing to make taking into consideration the specific local conditions.

Thirdly, although discrete choice experiments must do well to identify and include the relevant attributes required for investigating the trade-offs people are prepared to make under a certain phenomenon, there is a limit to how many attributes can be incorporated in a discrete choice experiment. Studies by numerous experts including the work by Johnson *et al.* (2013) on constructing experimental designs for discrete choice experiments underscore that most DCEs use three to seven attributes with majority using six attributes. Including more than six attributes has often led to a greater cognitive burden for respondents, thus increasing the probability of fatigue, inattention to attributes and the use of simplifying heuristics.

Ultimately, this leads to measurement error, which can affect the validity of results. What this therefore means is that, some other attributes may exist that influence the decision to invest in renewable energy projects that was not explored in this thesis – although dire efforts were made through extensive literature review, use of focus groups and expert opinions in identifying the relevant attributes for the study context. Policymakers must therefore, endeavour to the best of ability to comprehensively consider all attributes that may influence decisions in their jurisdictions. Future research could also explore how other investment attributes influence renewable energy investment decision making.

Finally, DCEs are prone to strategic behaviour, which could result in strategic bias. With strategic behaviour, one should be concerned about how respondents' choices would differ if other respondents' choices were revealed to others. With strategic behaviour, attributes with public good characteristics can suffer from free-riding possibilities which are not reflected in stated preference surveys. Answering whether free-riding will be exploited if others were aware of other people's choices can be further explored using game theory as well as other economic methods designed to investigate such behaviour.

On the financial literacy study, though the three questions employed are well recognised for the assessment of basic financial literacy worldwide, they only measure knowledge and limited in how such knowledge translates into financial behaviour. The questions used are more amenable for use as part of a main study and do not cover how financial knowledge affects behaviour or choice of investment – which is more useful in linking financial literacy to other causes and effects. Secondly, the possible limitation brought about by measurement error should be noted. This encompasses error due to guessing of answers or misunderstanding the question. In other words, some correct answers may be due to guessing and hence may not be a true reflection of true financial literacy levels.

6.4 Recommendations

The research has identified that there is an opportunity to bridge current financing gaps using household investments as the study has established that a section of the middle class that fit the criteria to be funders. However, the choice to invest is based on a number of conditions or factors which can be influenced by governments and other key stakeholders. Below are some recommendations.

6.4.1 Governments

1. The very nature of renewable energy projects exposes it to various risks at various stages which require addressing to attract investment. Policymakers will thus need to provide a stable policy environment and support systems that reduce the risks associated with RE investments. Support systems like feed-in-tariffs and government grants are necessary for enhancing the profitability of renewable energy investments and should be employed to ensure that investors are duly rewarded for the associated risks.
2. The positive marginal willingness to pay for a developer of domestic origin coupled with the preference for developers with a track record suggests that there must be measures to build the skills, technical expertise and track record of domestic project

developers. Hence government agencies can provide training and opportunities for local developers to gain the experience.

3. To signal support for crowdfunding renewable energy, government can provide incentives for developers that offer citizen financial participation. This can be introduced in the tendering process. Other measures like promoting co-investment (bringing together funds from individual and institutional investor sources) have worked in more established jurisdictions.
4. Government agencies involved in building the local renewable energy system should also consider engaging household investors to further understand their diverse needs and motivations, as shown in the heterogeneity in preference for attributes.
5. Government will need to pass the necessary legislation to ensure that investors are safeguarded and well-equipped to assess the risks associated with RE investment. The financial literacy assessment indicates that there are relative gaps in understanding risk diversification in addition to the fact that investing via crowdfunding also carry significant risks.
6. Targeted financial education programmes that are focused on risk will help the middle class identify and understand alternative investments like renewable energy and other financially complex financial products.

6.4.2 Funders or Investors

1. Investors must have a good understanding of financial principles, especially the concepts of interest rates and inflation as well as understand the terms and conditions governing the investment. This includes understanding the contractual relationship between the project developer and investor.

2. Investors in renewable energy must be aware of how factors such as technology, feed-in-tariffs, investment hold time or maturity affect interest rates. This is to ensure that returns are commensurate with the risks.

6.4.3 Project Developers

As the track record of the developer is important in signalling credibility to investors, taking on small-scale projects and executing them successfully is a way to build a proven track record of local developers. The decision to seek funding via the crowd also requires assessing what regulation governs developers, the prospectus requirement and the level of information to be shared with the public.

6.5 Conclusions

This thesis has studied the preferences of household investors for renewable energy projects via crowdfunding. By valuing the attributes for renewable energy investments, it has contributed to knowledge on what attributes household investors value and are willing to pay for in renewable energy investments. This thesis has also looked at the basic financial literacy of household investors as they would most likely rely on their own financial knowledge in assessing the opportunities and risks within the online crowdfunding space.

The first study through a discrete choice survey has established that household investors prefer renewable energy project developers with appreciable track record, projects with high viability that is, projects with support systems such as guaranteed grid access, feed-in-tariff and investment subsidies and minimum price for investment. The WTP measures underscore the importance of non-financial attributes in the decision-making concerning investment in renewable energy projects. The existence of preference heterogeneity for some attributes lends credence to the heterogeneity of RE household investors and the need for segregated policies and programmes tailored to their needs.

The assessment of basic financial literacy establishes that generally basic financial literacy knowledge is not lacking among the middle class. The findings, however, suggest that risk diversification is the least understood concept, and this has implications for understanding renewable energy project risks as well as the risks that exist with investing via crowdfunding. Overall, the thesis provides holistic insights for policymakers to design policies that seek to engage citizens, looking at both financial and non-financial considerations to attract the necessary investments for renewable energy.

REFERENCES

Abidoye, R. B., & Chan, A. P. (2017). Critical review of hedonic pricing model application in property price appraisal: A case of Nigeria. *International Journal of Sustainable Built Environment*, *6*(1), 250-259.

Abreu, M., & Mendes, V. (2010). Financial literacy and portfolio diversification. Quantitative finance, 10(5), 515-528.

Acheampong, T., & Ankrah, F. (2014). Pricing and deregulation of the energy sector in Ghana: challenges and prospects. *Ghana Energy Situation Report, Q1 2014*.

Adamowicz, W. L. (2004). What's it worth? An examination of historical trends and future directions in environmental valuation. Australian Journal of Agricultural and Resource Economics, 48(3), 419-443.

Adamowicz, W., & Deshazo, J. R. (2006). Frontiers in stated preferences methods: An introduction. Environmental and Resource Economics, 34(1), 1-6.

Adamowicz, W., Boxall, P., Williams, M., & Louviere, J. (1998). Stated preference approaches for measuring passive use values: choice experiments and contingent valuation. *American journal of agricultural economics*, *80*(1), 64-75.

Africa Development Bank (2018). African Economic Outlook www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/African_Economic_Outlook_2018_-_EN.pdf. Accessed on 20th July 2019

Africa Progress Panel (2015). Power people planet: seizing Africa's energy and climate opportunities: Africa progress report 2015.

African Development Bank (2011), “The Middle of the Pyramid: Dynamics of the Middle

Agnew, J. R., & Szykman, L. R. (2005). Asset allocation and information overload: The influence of information display, asset choice, and investor experience. The Journal of Behavioral Finance, 6(2), 57-70.

Aguilar, F. X., & Cai, Z. (2010). Exploratory analysis of prospects for renewable energy private investment in the US. *Energy Economics*, *32*(6), 1245-1252.

Aitken, M. (2010). Wind power and community benefits: Challenges and opportunities. *Energy policy*, *38*(10), 6066-6075.

Ajzen, I. (1985). From intentions to actions: A theory of planned behavior. In *Action control* (pp. 11-39). Springer, Berlin, Heidelberg.

Ajzen, I. (1991). The theory of planned behavior. *Organizational behavior and human decision processes*, *50*(2), 179-211.

Akinlo, A. E. (2008). Energy consumption and economic growth: Evidence from 11 Sub-Sahara African countries. *Energy economics*, *30*(5), 2391-2400.

Albeerdy, M. I., & Gharleghi, B. (2015). Determinants of the financial literacy among college students in Malaysia. *International Journal of Business Administration*, *6*(3), 15.

Allgood, S., & Walstad, W. B. (2016). The effects of perceived and actual financial literacy on financial behaviors. Economic inquiry, 54(1), 675-697.

Alleyne, P. (2011). Using the theory of planned behaviour and risk propensity to measure investment intentions among future investors. *Journal of Eastern Caribbean Studies*, *36*(1), 1-21.

Almenberg, J., & Dreber, A. (2015). Gender, stock market participation and financial literacy. Economics Letters, 137, 140-142.

Almenberg, J., & Säve-Söderbergh, J. (2011). Financial literacy and retirement planning in Sweden. Journal of Pension Economics & Finance, 10(4), 585-598.

Altman, M. (2012). Implications of behavioural economics for financial literacy and public policy. *The Journal of Socio-Economics*, *41*(5), 677-690.

Andersen, P. A., & Blackburn, T. R. (2004). An experimental study of language intensity and response rate in e mail surveys.

Aravena, C., Hutchinson, W. G., & Longo, A. (2012). Environmental pricing of externalities from different sources of electricity generation in Chile. *Energy economics*, *34*(4), 1214-1225.

Arguelles, M., Bennet, N., Daniels, C., Mee, J., and Samper, E. (2018). 2017 UNDP-GEF Annual Performance Report. United Nations Development Programme. Available at http://www.undp.org/content/undp/en/home/librarypage/poverty-reduction/global-environmental-finance/2017-undp-gef-annual-performance-report.html

Arnold, U., & Yildiz, Ö. (2015). Economic risk analysis of decentralized renewable energy infrastructures–A Monte Carlo Simulation approach. *Renewable Energy*, *77*, 227-239

Arrow, K. J. (1969). The organization of economic activity: issues pertinent to the choice of market versus nonmarket allocation. *The analysis and evaluation of public expenditure: the PPB system*, *1*, 59-73.

Asian Development Bank and The World Bank (2015) Unlocking Indonesia's Geothermal Potential. https://www.adb.org/sites/default/files/publication/157824/unlocking-indonesias-geothermal-potential.pdf

Asmus, P. (2008). Exploring new models of solar energy development. *The electricity journal*, *21*(3), 61-70.

Atkinson, A. and F. Messy (2012), "Measuring Financial Literacy: Results of the OECD / International Network on Financial Education (INFE) Pilot Study", OECD Working Papers on Finance, Insurance and Private Pensions, No. 15, OECD Publishing, Paris, https://doi.org/10.1787/5k9csfs90fr4-en.

Baker and McKenzie(2013). The Future of Clean Energy in Africa. Available at http://www.cleanenergypipeline.com/Resources/CE/ResearchReports/TheFuturefor CleanEnergyinAfrica.pdf

Balogh, P., Békési, D., Gorton, M., Popp, J., & Lengyel, P. (2016). Consumer willingness to pay for traditional food products. *Food Policy*, *61*, 176-184.

Bamberg, S., Rees, J., & Seebauer, S. (2015). Collective climate action: Determinants of participation intention in community-based pro-environmental initiatives. *Journal of Environmental Psychology*, *43*, 155-165.

Banerjee, A and Dufflo, E. (2008). "What is Middle Class about, the Middle Classes around the World?" Journal of Economic Perspectives, Vol. 22, No. 2: Pages 3-28

Banerjee, S., Quentin W., Amadou D., Taras P., Hellal U., Clarence T., and Vivien F. (2008). "Access, Affordability, and Alternatives: Modern Infrastructure Services in Africa." Background Paper 2, Africa Infrastructure Sector Diagnostic, World Bank, Washington, DC.

Bang, H. K., Ellinger, A. E., Hadjimarcou, J., & Traichal, P. A. (2000). Consumer concern, knowledge, belief, and attitude toward renewable energy: An application of the reasoned action theory. *Psychology & Marketing*, *17*(6), 449-468.

Banja, M., Jegard, M., Monforti-Ferrario ,F., Dallemand, J.F., Taylor, N., Motola, V., & Sikkema, R. (2017). Renewables in the EU: The Support Framework Towards A Single Energy Market. Publications Office of the European Union. Available at https://e3p.jrc.ec.europa.eu/publications/renewables-eu-support-framework-towards-single-energy-market

Barasa, M., Bogdanov, D., Oyewo, A. S., & Breyer, C. (2018). A cost optimal resolution for Sub-Saharan Africa powered by 100% renewables in 2030. Renewable and Sustainable Energy Reviews, 92, 440-457.

Barber, B. M., & Odean, T. (2001). Boys will be boys: Gender, overconfidence, and common stock investment. *The quarterly journal of economics*, *116*(1), 261-292.

Barber, B. M., & Odean, T. (2013). The behaviour of individual investors. In *Handbook of the Economics of Finance* (Vol. 2, pp. 1533-1570). Elsevier.

Barberis, N., & Thaler, R. (2003). A survey of behavioural finance. *Handbook of the Economics of Finance*, *1*, 1053-1128.

Barradale, M. J. (2010). Impact of public policy uncertainty on renewable energy investment: Wind power and the production tax credit. *Energy Policy*, *38*(12), 7698-7709.

Bateman, I. J., & Langford, I. H. (1997). Budget-constraint, temporal, and question-ordering effects in contingent valuation studies. Environment and Planning A, 29(7), 1215-1228.

Bateman, I. J., Carson, R. T., Day, B., Hanemann, M., Hanley, N., Hett, T. ... & Pearce, D. W. (2002). Economic valuation with stated preference techniques: a manual. *Economic valuation with stated preference techniques: a manual*

Bauwens, T. (2016). Explaining the diversity of motivations behind community renewable energy. *Energy Policy, 93*, 278-290.

Bauwens, T., Gotchev, B., & Holstenkamp, L. (2016). What drives the development of community energy in Europe? The case of wind power cooperatives. *Energy Research & Social Science*, *13*, 136-147.

Bazilian, M., Rogner, H., Howells, M., Hermann, S., Arent, D., Gielen, D., ... & Yumkella, K. K. (2011). Considering the energy, water and food nexus: Towards an integrated modelling approach. *Energy Policy*, *39*(12), 7896-7906.

Beal, D. J., & Delpachitra, S. B. (2003). Financial literacy among Australian university students. *Economic Papers: A journal of applied economics and policy*, *22*(1), 65-78.

Beck, F., & Martinot, E. (2004). Renewable energy policies and barriers. *Encyclopedia of energy*, *5*(7), 365-383.

Bekaert, G., Hoyem, K., Hu, W. Y., & Ravina, E. (2014). Who is internationally diversified? Evidence from 296 401 (k) plans. Working paper no. w21236.

Ben-Akiva, M. E. and Lerman, S. R. (1985). *Discrete Choice Analysis: Theory and Application to Travel Demand*, MIT Press, Cambridge, Ma.

Benartzi, S., & Thaler, R. (2007). Heuristics and biases in retirement savings behaviour. *Journal of Economic perspectives*, *21*(3), 81-104.

Bennett, J., & Blamey, R. (Eds.). (2001). *The choice modelling approach to environmental valuation*. Edward Elgar Publishing.

Bergek, A., Mignon, I., & Sundberg, G. (2013). Who invests in renewable electricity production? Empirical evidence and suggestions for further research. *Energy Policy*, *56*, 568-581.

Bergman, N., & Eyre, N. (2011). What role for microgeneration in a shift to a low carbon domestic energy sector in the UK? Energy Efficiency, 4(3) 335-353.

Bergmann, A., Colombo, S., & Hanley, N. (2008). Rural versus urban preferences for renewable energy developments. *Ecological economics*,*65*(3), 616-625.

Bergmann, A., Hanley, N., & Wright, R. (2006). Valuing the attributes of renewable energy investments. *Energy policy*, *34*(9), 1004-1014.

Bernheim, B. D., & Garrett, D. M. (2003). The effects of financial education in the workplace: Evidence from a survey of households. Journal of public Economics, 87(7-8), 1487-1519.

Bertram, C., & Larondelle, N. (2017). Going to the woods is going home: Recreational benefits of a larger urban forest site—A travel cost analysis for Berlin, Germany. Ecological economics, 132, 255-263.

Bhalla, S. (2009). The Middle-Class Kingdoms of India and China. Peterson Institute for International Economics, Washington, DC

Bhatia, M., and Angelou, N. (2015). *Beyond connections: energy access redefined*. World Bank. Available at http://www.worldbank.org/content/dam/Worldbank/Topics/Energy%20and%20Extract/Beyond_Connections_Energy_Access_Redefined_Exec_ESMAP_2015.pdf

Bhattacharya, A., & Kojima, S. (2012). Power sector investment risk and renewable energy: A Japanese case study using portfolio risk optimization method. *Energy Policy*, *40*, 69-80.

Birdsall, N. (2010). The (indispensable) middle class in developing countries; or, the rich and the rest, not the poor and the rest. EQUITY IN A GLOBALIZING WORLD, Ravi Kanbur and Michael Spence, eds., World Bank, Forthcoming.

Birol, E., Karousakis, K., & Koundouri, P. (2006). Using a choice experiment to account for preference heterogeneity in wetland attributes: the case of Cheimaditida wetland in Greece. *Ecological economics*, *60*(1), 145-156.

Blamey, R. K., Bennett, J. W., Louviere, J. J., Morrison, M. D., & Rolfe, J. C. (2002). Attribute causality in environmental choice modelling. *Environmental and Resource Economics*, *23*(2), 167-186.

Bliemer, M. C., & Rose, J. M. (2011). Experimental design influences on stated choice outputs: an empirical study in air travel choice. Transportation Research Part A: Policy and Practice, 45(1), 63-79.

Bloomberg New Energy Finance(2018). Clean Energy Investment Trends, 2017. Available at https://data.bloomberglp.com/bnef/sites/14/2018/01/BNEF-Clean-Energy-Investment-Investment-Trends-2017.pdf

Bollinger, B., & Gillingham, K. (2012). Peer effects in the diffusion of solar photovoltaic panels. *Marketing Science*, *31*(6), 900-912.

Bolton, R., & Foxon, T. J. (2015). A socio-technical perspective on low carbon investment challenges–insights for UK energy policy. *Environmental innovation and societal transitions*, *14*, 165-181.

Bomberg, E., & McEwen, N. (2012). Mobilizing community energy. *Energy policy*, *51*, 435-444.

Bond, G., & Carter, L. (1995). Financing energy projects: experience of the international finance corporation. *Energy policy*, *23*(11), 967-975.

Boon, F. P., & Dieperink, C. (2014). Local civil society based renewable energy organisations in the Netherlands: Exploring the factors that stimulate their emergence and development. *Energy Policy*, *69*, 297-307.

Borchers, A. M., Duke, J. M., & Parsons, G. R. (2007). Does willingness to pay for green energy differ by source? *Energy policy*, *35*(6), 3327-3334.

Bowen, H. R. (1943). The interpretation of voting in the allocation of economic resources. The Quarterly Journal of Economics, 58(1), 27-48.

Boyle, K. J. (2017). Contingent valuation in practice. In A primer on nonmarket valuation (pp. 83-131). Springer, Dordrecht.

Bradshaw, M. (2013). Global energy dilemmas. Polity.

Breitschopf, B., & Pudlik, M. (2013). Basel III and Solvency II: Are the risk margins for investments in PV and wind adequate? Energy & environment, 24(1-2), 171-194.

Brennan, M. J., & Cao, H. H. (1997). International portfolio investment flows. The Journal of Finance, 52(5), 1851-1880.

Briceño-Garmendia C, Smits K, Foster V. Financing public infrastructure in sub-saharan africa: Patterns and emerging issues. Africa Infrastructure Country Diagnostic (AICD) Background Paper No 15, World Bank; 2008.

Bridges, J. F., Hauber, A. B., Marshall, D., Lloyd, A., Prosser, L. A., Regier, D. A., ... & Mauskopf, J. (2011). Conjoint analysis applications in health—a checklist: a report of the ISPOR Good Research Practices for Conjoint Analysis Task Force. Value in health, 14(4), 403-413.

Brown Jr, G. M., & Hammack, J. (1972). A preliminary investigation of the economics of migratory waterfowl. In Natural Environments: Studies in Theoretical and Applied Analysis (pp. 171-204). Johns Hopkins Baltimore, MD.

Brown, M., & Graf, R. (2013). Financial literacy and retirement planning in Switzerland. Numeracy, 6(2), 6.

Browning, M., & Lusardi, A. (1996). Household saving: Micro theories and micro facts. *Journal of Economic literature*, *34*(4), 1797-1855.

Bruine de Bruin, W., VanderKlaauw, W., Downs, J. S., Fischhoff, B., Topa, G., & Armantier, O. (2010). Expectations of inflation: The role of demographic variables, expectation formation, and financial literacy. Journal of Consumer Affairs, 44(2), 381-402.

Bürer, M. J., & Wüstenhagen, R. (2009). Which renewable energy policy is a venture capitalist's best friend? Empirical evidence from a survey of international cleantech investors. *Energy Policy*, *37*(12), 4997-5006.

Burgess, L., & Street, D. J. (2005). Optimal designs for choice experiments with asymmetric attributes. Journal of Statistical Planning and Inference 134: 288–301.

Calamato, M. P. (2010). Learning financial literacy in the family.

Campbell, D., Hutchinson, W. G., & Scarpa, R. (2008). Incorporating discontinuous preferences into the analysis of discrete choice experiments. Environmental and resource economics, 41(3), 401-417.

Campbell, J. Y. (2006). Household finance. *The journal of finance*, *61*(4), 1553-1604.

Canova, L., Rattazzi, A. M. M. & Webley, P. (2005). The hierarchical structure of saving motives. *Journal of Economic Psychology*, *26*(1), 21-34.

Capellán-Pérez, I., Campos-Celador, Á., & Terés-Zubiaga, J. (2018). Renewable Energy Cooperatives as an instrument towards the energy transition in Spain. *Energy Policy*, *123*, 215-229.

Capuano, A., & Ramsay, I. (2011). What causes suboptimal financial behaviour? An exploration of financial literacy, social influences and behavioural economics. An

Exploration of Financial Literacy, Social Influences and Behavioural Economics (March 23, 2011). U of Melbourne Legal Studies Research Paper, (540).

Carlsson, F., & Martinsson, P. (2001). Do hypothetical and actual marginal willingness to pay differ in choice experiments?: Application to the valuation of the environment. Journal of Environmental Economics and Management, 41(2), 179-192.

Carson, R. (2011). Contingent valuation: a comprehensive bibliography and history. Edward Elgar Publishing

Carson, R. T. & Louviere, J. J. (2011). A common nomenclature for stated preference elicitation

Carson, R. T., & Groves, T. (2007). Incentive and informational properties of preference questions. *Environmental and resource economics*, *37*(1), 181-210.

Carson, R. T., & Mitchell, R. C. (1995). Sequencing and nesting in contingent valuation surveys. *Journal of environmental economics and Management*,*28*(2), 155-173.

Carson, R. T., Hanemann, W. M. (2005), “Contingent Valuation,” in Mäler, K. G., Vincent, J. R., ed., Handbook of Environmental Economics. Valuing Environmental changes. Vol. 2. Amsterdam: Elsevier, pp. 821-936.

Carson, R. T., Mitchell, R. C., Hanemann, M., Kopp, R. J., Presser, S., & Ruud, P. A. (2003). Contingent valuation and lost passive use: damages from the Exxon Valdez oil spill. *Environmental and resource economics*, *25*(3), 257-286.

Carson, R. T., Mitchell, R. C., Hanemann, W. M., Kopp, R. J., Presser, S., & Ruud, P. A. (1992). A contingent valuation study of lost passive use values resulting from the Exxon Valdez oil spill (No. 6984). University Library of Munich, Germany.

Carson, R., & Czajkowski, M. (2014). The discrete choice experiment approach to environmental contingent valuation (Doctoral dissertation, Edward Elgar Publishing).

Castellano, A., Kendall, A., Nikomarov, M., & Swemmer, T. (2015) Brighter Africa: The Growth Potential of the Sub Saharan Electricity Sector, McKinsey.

Chaminuka, P., Groeneveld, R. A., Selomane, A. O., & Van Ierland, E. C. (2012). Tourist preferences for ecotourism in rural communities adjacent to Kruger National Park: A choice experiment approach. *Tourism management*, *33*(1), 168-176.

Champ, P. A. (2017). Collecting Nonmarket Valuation Data. In A Primer on Nonmarket Valuation (pp. 55-82). Springer, Dordrecht.

Champ, P. A., & Bishop, R. C. (2006). Is willingness to pay for a public good sensitive to the elicitation format? *Land Economics*, *82*(2), 162-173.

Chen, H., & Volpe, R. P. (1998). An analysis of personal financial literacy among college students. Financial Services Review, 7(2), 107-128. Retrieved on April 13, 2013, from http://www2.stetson. edu/fsr/abstracts/vol_7_num2_107.pdf

Chen, H., & Volpe, R. P. (2002). Gender differences in personal financial literacy among college students. *Financial services review*, *11*(3), 289-308.

Cheng, S., & Long, J. S. (2007). Testing for IIA in the multinomial logit model. Sociological methods & research, 35(4), 583-600.

Chontanawat, J., Hunt, L. C., & Pierse, R. (2008). Does energy consumption cause economic growth? Evidence from a systematic study of over 100 countries. *Journal of policy modeling*, *30*(2), 209-220.

Chrzan, K. (1994). Three kinds of order effects in choice-based conjoint analysis. Marketing Letters, 5(2), 165-172.

Chun, N., Hasan, R., Rahman, M. H., & Ulubaşoğlu, M. A. (2017). The Role of Middle Class in Economic Development: What Do Cross-Country Data Show?. Review of Development Economics, 21(2), 404-424.

Cicchetti, C. J., & Smith, V. K. (1976). The costs of congestion: An econometric analysis of wilderness recreation. Ballinger Publishing Company.

Ciriacy-Wantrup, S. V. (1947). Capital returns from soil-conservation practices. *Journal of farm economics*, *29*(4 Part II), 1181-1196.

Clark, J., & Friesen, L. (2008). The causes of order effects in contingent valuation surveys: An experimental investigation. *Journal of environmental economics and Management*, *56*(2), 195-206.

Clark-Murphy, M., & Soutar, G. N. (2004). What individual investors value: Some Australian evidence. *Journal of Economic Psychology*, *25*(4), 539-555.

Class in Africa", Market Brief.

Claycomb, C., Porter, S. S., & Martin, C. L. (2000). Riding the wave: response rates and the effects of time intervals between successive mail survey follow-up efforts. *Journal of Business Research, 48*(2), 157-162.

Coast, J., & Horrocks, S. (2007). Developing attributes and levels for discrete choice experiments using qualitative methods. *Journal of health services research & policy, 12*(1), 25-30.

Coast, J., Al-Janabi, H., Sutton, E. J., Horrocks, S. A., Vosper, A. J., Swancutt, D. R., & Flynn, T. N. (2012). Using qualitative methods for attribute development for discrete choice experiments: issues and recommendations. *Health economics*, *21*(6), 730-741.

Collins, J., Moore, M. & Johnson, C. (2010): Understanding the Future Energy System. Accenture report

Couture, T., & Gagnon, Y. (2010). An analysis of feed-in tariff remuneration models: Implications for renewable energy investment. *Energy policy*, *38*(2), 955-965.

Cude, B., Lawrence, F., Lyons, A., Metzger, K., LeJeune, E., Marks, L., & Machtmes, K. (2006). College students and financial literacy: What they know and what we need to learn. *Proceedings of the Eastern Family Economics and Resource Management Association*, *102*(9), 106-109.

Curtin, J., McInerney, C., & Gallachóir, B. Ó. (2017). Financial incentives to mobilise local citizens as investors in low-carbon technologies: a systematic literature review. Renewable and Sustainable Energy Reviews, 75, 534-547.

Curtin, J., McInerney, C., Gallachóir, B. Ó., & Salm, S. (2019). Energizing local communities—What motivates Irish citizens to invest in distributed renewables?. Energy Research & Social Science, 48, 177-188.

Daniel, K., Hirshleifer, D., & Teoh, S. H. (2002). Investor psychology in capital markets: Evidence and policy implications. *Journal of monetary economics*, *49*(1), 139-209.

Darling, A. H. (1973). Measuring benefits generated by urban water parks. Land economics, 49(1), 22-34.

Databank Research(2017). Africa Quarterly Strategy Report: Mid-Year Review and Outlook for 2H-2017. Available at https://www.databankgroup.com/research-quarterly-reports/

Davis, R. K. (1963). Recreation planning as an economic problem. Nat. Resources J., 3, 239.

Day, B., & Prades, J. L. P. (2010). Ordering anomalies in choice experiments. Journal of Environmental Economics and Management, 59(3), 271-285.

De Bekker-Grob, E. W., Donkers, B., Jonker, M. F., & Stolk, E. A. (2015). Sample size requirements for discrete-choice experiments in healthcare: a practical guide. The Patient-Patient-Centered Outcomes Research, 8(5), 373-384.

De Jager, D., Rathmann, M., Klessmann, C., Coenraads, R., Colamonico, C., & Buttazzoni, M. (2008). Policy instrument design to reduce financing costs in renewable energy technology projects. *PECSNL062979, International Energy Agency Implementing Agreement on Renewable Energy Technology Deployment*.

Delmas, M. A., & Montes-Sancho, M. J. (2011). US state policies for renewable energy: Context and effectiveness. *Energy Policy, 39*(5), 2273-2288.

Deloitte (2012). Deloitte on Africa. The Rise and Rise of the African Middle Class. Deloitte on Africa Collection: Issue 1. Johannesburg: Deloitte and Touche.

Derrick, A. (1998). Financing mechanisms for renewable energy. *Renewable Energy*, *15*(1-4), 211-214.

DeShazo, J. R., & Fermo, G. (2002). Designing choice sets for stated preference methods: the effects of complexity on choice consistency. Journal of Environmental Economics and management, 44(1), 123-143.

Devine-Wright, P. (2014). From backyards to places: public engagement and the emplacement of renewable energy technologies. In *Renewable Energy and the Public* (pp. 89-102). Routledge.

Dew, J. (2008). Debt change and marital satisfaction change in recently married couples. Family Relations, 57(1), 60-71

DGRV (2016) Energy cooperatives. Results of the DGRV-Survey[PowerPoint Slides] Retrieved from https://www.dgrv.de/weben.nsf/272e312c8017e736c1256e31005cedff/e7b7b885ccf6c6e8c1257e84004f9047/US$FILE/Survey_Energy_Cooperations_2015.pdf

Diamond, P. A., & Hausman, J. A. (1994). Contingent valuation: is some number better than no number?. Journal of economic perspectives, 8(4), 45-64.

Dillman, D. A., Phelps, G., Tortora, R., Swift, K., Kohrell, J., Berck, J., & Messer, B. L. (2009). Response rate and measurement differences in mixed-mode surveys using mail, telephone, interactive voice response (IVR) and the Internet. *Social science research*, *38*(1), 1-18.

Dillman, D. A., Smyth, J. D., & Christian, L. M. (2014). Internet, phone, mail, and mixed-mode surveys: the tailored design method. John Wiley & Sons.

Dimitropoulos, A., & Kontoleon, A. (2009). Assessing the determinants of local acceptability of wind-farm investment: A choice experiment in the Greek Aegean Islands. Energy policy, 37(5), 1842-1854.

Dincer, I. (2000). Renewable energy and sustainable development: a crucial review. *Renewable and sustainable energy reviews*, *4*(2), 157-175.

Dinica, V. (2006). Support systems for the diffusion of renewable energy technologies—an investor perspective. *Energy policy*, *34*(4), 461-480.

Dóci, G., & Gotchev, B. (2016). When energy policy meets community: rethinking risk perceptions of renewable energy in Germany and the Netherlands. *Energy Research & Social Science*, *22*, 26-35.

Dóci, G., & Vasileiadou, E. (2015). “Let′ s do it ourselves” Individual motivations for investing in renewables at community level. *Renewable and sustainable energy reviews*, *49*, 41-50.

Dóci, G., Vasileiadou, E., & Petersen, A. C. (2015). Exploring the transition potential of renewable energy communities. *Futures*, *66*, 85-95.

Dong, C. G. (2012). Feed-in tariff vs. renewable portfolio standard: An empirical test of their relative effectiveness in promoting wind capacity development. *Energy Policy*, *42*, 476-485.

Donovan C.W (2015). Renewable energy finance: Powering the future. Imperial College Press, London.

Drury, E., Miller, M., Macal, C. M., Graziano, D. J., Heimiller, D., Ozik, J., & Perry IV, T. D. (2012). The transformation of southern California's residential photovoltaics market through third-party ownership. *Energy Policy*, *42*, 681-690.

Duarte M, Nagarajan S, Brixiova Z. (2010) Financing of sustainable energy solutions. AfBD Committee of Ten Policy Brief, Published by AfBD-African Development Bank, Ivory Cost.

East, R. (1993). Investment decisions and the theory of planned behaviour. *Journal of Economic Psychology*, *14*(2), 337-375.

Eberhard, A., Foster, V., Briceno-Garmendia, C. Ouedraogo, F., Camos, D. and Shkaratan, M. (2008). Underpowered: The State of the Power Sector in Sub-Saharan Africa, African Infrastructure Country Diagnostic (AICD) Diagnostic Paper 6, World Bank: Washington DC

Eberhard, A., Gratwick, K., Morella, E., & Antmann, P. (2016). Independent Power Projects in Sub-Saharan Africa: Lessons from Five Key Countries. Directions in Development. Washington, DC: World Bank. doi:10.1596/978-1-4648-0800-5.

Eberhard, A., Rosnes, O., Shkaratan, M., & Vennemo, H. (2011). Africa's power infrastructure: investment, integration, efficiency. The World Bank.

Education (2nd Ed.), McGraw Hill, New York

Edwards, R., Allen, M. W., & Hayhoe, C. R. (2007). Financial attitudes and family communication about students' finances: The role of sex differences. Communication Reports, 20(2), 90-100

Elkington, J. (1998). Partnerships from cannibals with forks: The triple bottom line of 21st-century business. Environmental quality management, 8(1), 37-51.

Energy Commission (2006). Strategic national energy plan 2006-2020. *Main Report, July*.

Enzensberger, N., Fichtner, W. & Rentz, O. (2003) Evolution of local citizen participation schemes in the German wind market. International Journal of Global Energy Issues, 20, 191-207.

European Commission (2017). Identifying market and regulatory obstacles to cross border development of crowdfunding in the EU, European Union. Available at https://ec.europa.eu/info/sites/info/files/171216-crowdfunding-report_en.pdf

Ferguson, R., Wilkinson, W., and Hill, R. (2000). Electricity use and economic development. *Energy policy*, *28*(13), 923-934.

Fiebig, D. G., Keane, M. P., Louviere, J., & Wasi, N. (2010). The generalized multinomial logit model: accounting for scale and coefficient heterogeneity. *Marketing Science*, *29*(3), 393-421.

Financial Conduct Authority (FCA)(2018). Loan-based ('peer-to-peer') and investment-based crowdfunding platforms: Feedback on our post-implementation review and proposed changes to the regulatory framework. Consultation Paper. Available at https://www.fca.org.uk/publication/consultation/cp18-20.pdf

Financial Industry Regulatory Authority(FINRA)(2003) NASD Investor Literacy Research, Executive Summary. Available at https://www.finra.org/sites/default/files/InvestorDocument/p011459.pdf

Finon, D., & Perez, Y. (2007). The social efficiency of instruments of promotion of renewable energies: A transaction-cost perspective. *Ecological Economics*, *62*(1), 77-92.

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention and behavior: An introduction to theory and research*.

Fleming, C. M., & Cook, A. (2008). The recreational value of Lake McKenzie, Fraser Island: An application of the travel cost method. *Tourism Management*, *29*(6), 1197-1205.

Fonseca, R., Mullen, K. J., Zamarro, G., & Zissimopoulos, J. (2012). What explains the gender gap in financial literacy? The role of household decision making. Journal of Consumer Affairs, 46(1), 90-106.

Foster, V., & Mourato, S. (2002). Testing for consistency in contingent ranking experiments. *Journal of environmental Economics and Management*, *44*(2), 309-328.

Fowler Jr, F.J., (2013). *Survey research methods*. Sage publications.

Fraenkel, J. R., and Wallen, N. E. (1993). How to Design and Evaluate Research in

Frankfurt School-UNEP Centre/BNEF (2017). Global Trends in Renewable Energy Investment 2017, http://www.fs-unep-centre.org (Frankfurt am Main)

Fraune, C. (2015). Gender matters: Women, renewable energy, and citizen participation in Germany. Energy Research & Social Science, 7, 55-65.

Gadenne, D., Sharma, B., Kerr, D., & Smith, T. (2011). The influence of consumers' environmental beliefs and attitudes on energy saving behaviours. *Energy policy*, *39*(12), 7684-7694.

Gamel, J., Menrad, K., & Decker, T. (2016). Is it really all about the return on investment? Exploring private wind energy investors' preferences. *Energy Research & Social Science*, *14*, 22-32.

Garrod, G., & Willis, K. (1992). The Environmental economic impact of woodland: A two-stage hedonic price model of the amenity value of forestry in Britain. *Applied economics*, *24*(7), 715-728.

Gatzert, N., & Vogl, N. (2016). Evaluating investments in renewable energy under policy risks. Energy Policy, 95, 238-252.

Gerard, K., Tinelli, M., Latter, S., Smith, A., & Blenkinsopp, A. (2015). Patients' valuation of the prescribing nurse in primary care: a discrete choice experiment. Health Expectations, 18(6), 2223-2235.

Giles, E. L., Becker, F., Ternent, L., Sniehotta, F. F., McColl, E., & Adams, J. (2016). Acceptability of financial incentives for health behaviours: a discrete choice experiment. PLoS One, 11(6), e0157403.

Gracia, A., Barreiro-Hurlé, J., & y Pérez, L. P. (2012). Can renewable energy be financed with higher electricity prices? Evidence from a Spanish region. Energy Policy, 50, 784-794.

Gratwick, K. N., & Eberhard, A. (2008). An analysis of independent power projects in Africa: understanding development and investment outcomes. *Development Policy Review*, *26*(3), 309-338.

Gray, B., Sebstad, J., Cohen, M., & Stack, K. (2009). Can financial education change behavior: Lessons from Bolivia and Sri Lanka. Washington: Micro Finance Opportunities.

Greene, W. H. (2001). Fixed and random effects in nonlinear models.

Greene, W. H., & Hensher, D. A. (2010). Modeling ordered choices: A primer. Cambridge University Press.

Grimes, P. W., Rogers, K. E., & Smith, R. C. (2010). High school economic education and access to financial services. Journal of Consumer Affairs, 44(2), 317-335.

Grohmann, A. (2018). Financial literacy and financial behavior: Evidence from the emerging Asian middle class. *Pacific-Basin Finance Journal*, *48,* 129-143.

Grohmann, A., Hübler, O., Kouwenberg, R., & Menkhoff, L. (2016). Financial literacy: Thai middle class women do not lag behind.

Groves, R. M., Singer, E., & Corning, A. (2000). Leverage-saliency theory of survey participation: description and an illustration. The Public Opinion Quarterly, 64(3), 299-308.

Groves, R.M. (2002). Survey nonresponse. New York : John Wiley.

Grubb, M. (2004). Technology Innovation and Climate Change Policy: an overview of issues and options. *Keio economic studies*, *41*(2), 103.

Gujba, H., Thorne, S., Mulugetta, Y., Rai, K., and Sokona, Y. (2012). Financing low carbon energy access in Africa. *Energy Policy*, *47*, 71-78.

Gupta, K., & Kaur, J. (2014). A study of financial literacy among micro entrepreneurs in district Kangra. International Journal of Research in Business Management, 2(2), 63-70.

Gustman, A. L., Steinmeier, T. L., & Tabatabai, N. (2012). Financial knowledge and financial literacy at the household level. American Economic Review, 102(3), 309-13.

Haddak, M. M., Lefèvre, M., & Havet, N. (2016). Willingness-to-pay for road safety improvement. Transportation Research Part A: Policy and Practice, 87, 1-10.

Hammack, J., & Brown Jr, G. M. (1974). Waterfowl and Wetlands: Toward Bioeconomic Analysis. Baltimore: Resources for the Future, Inc. Hay, Michael J., and Kenneth E. McConnell. 1979."An Analysis of Participation in Nonconsumptive Wildlife Recreation.". Land Economics, 55(4), 460-71.

Hanley, N. D. (1989). Valuing rural recreation benefits: an empirical comparison of two approaches. *Journal of Agricultural Economics*, *40*(3), 361-374.

Hanley, N., MacMillan, D., Patterson, I., & Wright, R. E. (2003, May). Economics and the design of nature conservation policy: a case study of wild goose conservation in Scotland using choice experiments. In Animal Conservation forum (Vol. 6, No. 2, pp. 123-129). Cambridge University Press.

Hanley, N., Mourato, S., & Wright, R. E. (2001). Choice Modelling Approaches: A Superior Alternative for Environmental Valuation?. *Journal of economic surveys*, *15*(3), 435-462.

Hanley, N., Wright, R. E., & Adamowicz, V. (1998). Using choice experiments to value the environment. Environmental and resource economics, 11(3-4), 413-428.

Hanson, K., McPake, B., Nakamba, P., & Archard, L. (2005). Preferences for hospital quality in Zambia: results from a discrete choice experiment. *Health economics*, *14*(7), 687-701

Hastings, J., & Mitchell, O. S. (2011). How financial literacy and impatience shape retirement wealth and investment behaviors. Journal of Pension Economics & Finance, 1-20.

Hauber, A. B., González, J. M., Groothuis-Oudshoorn, C. G., Prior, T., Marshall, D. A., Cunningham, C., ... & Bridges, J. F. (2016). Statistical methods for the analysis of discrete choice experiments: a report of the ISPOR Conjoint Analysis Good Research Practices Task Force. Value in health, 19(4), 300-315.

Hausman, J. (2012). Contingent valuation: from dubious to hopeless. Journal of Economic Perspectives, 26(4), 43-56.

Hausman, J. A., & McFadden, D. (1981). Specification tests for the multinomial logit model.

Hayslett, M. M., & Wildemuth, B. M. (2004). Pixels or pencils? The relative effectiveness of Web-based versus paper surveys. *Library & Information Science Research*, *26*(1), 73-93.

Heiskanen, E., Johnson, M., Robinson, S., Vadovics, E., & Saastamoinen, M. (2010). Low-carbon communities as a context for individual behavioural change. *Energy Policy*, *38*(12), 7586-7595.

Helms, T., Salm, S., & Wüstenhagen, R. (2015). Investor-specific cost of capital and renewable energy investment decisions. In *Renewable Energy Finance: Powering the Future* (pp. 77-101).

Hensher, D. A., & Greene, W. H. (2001). The mixed logit model: The state of practice and warnings for the unwary. Institute of Transport Studies, 1-39.

Hensher, D. A., & Greene, W. H. (2003). The mixed logit model: the state of practice. *Transportation*, *30*(2), 133-176.

Hensher, D. A., Rose, J. M., & Greene, W. H. (2005). *Applied choice analysis: a primer*. Cambridge University Press.

Heras-Saizarbitoria, I., Sáez, L., Allur, E., & Morandeira, J. (2018). The emergence of renewable energy cooperatives in Spain: A review. Renewable and Sustainable Energy Reviews, 94, 1036-1043.

Herriges, J., Kling, C., Liu, C. C., & Tobias, J. (2010). What are the consequences of consequentiality? Journal of Environmental Economics and Management, 59(1), 67-81.

Herzenstein, M., Andrews, R. L., Dholakia, U. M., & Lyandres, E. (2008). The democratization of personal consumer loans? Determinants of success in online peer-to-peer lending communities. *Boston University School of Management Research Paper, 14*(6).

Hess, S., & Train, K. (2017). Correlation and scale in mixed logit models. *Journal of choice modelling*, *23*, 1-8.

Hibbert, A. M., Lawrence, E. R., & Prakash, A. J. (2013). Does knowledge of finance mitigate the gender difference in financial risk-aversion?. Global Finance Journal, 24(2), 140-152.

Hines, M. A. (1997). *The development and finance of global private power*. Greenwood Publishing Group, pp. 189–209.

Hirshleifer, D. (2001). Investor psychology and asset pricing. *The Journal of Finance*, *56*(4), 1533-1597.

Hoffman, S. D., & Duncan, G. J. (1988). Multinomial and conditional logit discrete-choice models in demography. Demography, 25(3), 415-427.

Hoffman, S. M., & High-Pippert, A. (2010). From private lives to collective action: Recruitment and participation incentives for a community energy program. *Energy Policy*, *38*(12), 7567-7574.

Holden, E., Linnerud, K., & Banister, D. (2014). Sustainable development: our common future revisited. Global environmental change, 26, 130-139.

Hole, A. R., & Kolstad, J. R. (2012). Mixed logit estimation of willingness to pay distributions: a comparison of models in preference and WTP space using data from a health-related choice experiment. *Empirical Economics*, *42*(2), 445-469.

Holmes, T. P., Adamowicz, W. L., & Carlsson, F. (2017). Choice experiments. In A primer on nonmarket valuation (pp. 133-186). Springer, Dordrecht.

Hondo, H., & Baba, K. (2010). Socio-psychological impacts of the introduction of energy technologies: change in environmental behavior of households with photovoltaic systems. *Applied Energy*, *87*(1), 229-235.

Hondo, H., Baba, K. (2004). Effects of installing residential PV systems on the households’ attitudes and behavior. In: Proceedings of the Sixth International Conference on EcoBalance, pp. 403–406.

Hoppmann, J., Huenteler, J., & Girod, B. (2014). Compulsive policy-making—The evolution of the German feed-in tariff system for solar photovoltaic power. *Research policy*, *43*(8), 1422-1441.

Hossain, I., Saqib, N. U., & Haq, M. M. (2018). Scale heterogeneity in discrete choice experiment: An application of generalized mixed logit model in air travel choice. Economics Letters, 172, 85-88.

Hoyos, D. (2010). The state of the art of environmental valuation with discrete choice experiments. Ecological economics, 69(8), 1595-1603.

Hoyos, D., & Mariel, P. (2010). Contingent valuation: Past, present and future.*Prague economic papers*, *4*(2010), 329-343.

Huber J, Zwerina K. (1996). The importance of utility balance in efficient choice designs. Journal of Marketing Research 33: 307–17.

Huijben, J. C., & Verbong, G. P. (2013). Breakthrough without subsidies? PV business model experiments in the Netherlands. *Energy Policy*, *56*, 362-370.

Hung, A., Parker, A.M. and Yoong, J.(2009). Defining and measuring financial literacy.

Hurd, M. D. (1987). Savings of the elderly and desired bequests. *The American Economic Review*, 298-312.

Huston, S. J. (2010). Measuring financial literacy. The Journal of Consumer Affairs, 44(2), 296-316

Huybrechts, B., & Mertens, S. (2014). The relevance of the cooperative model in the field of renewable energy. *Annals of Public and Cooperative Economics*, *85*(2), 193-212.

IEA (2012). Energy Technology Perspectives 2012 - Pathways to a Clean Energy System. International Energy Agency. Available at https://www.iea.org/publications/freepublications/publication/ETP2012_free.pdf

IEA (2014). Africa energy outlook. International Energy Agency. Available at https://www.iea.org/publications/freepublications/publication/WEO2014_AfricaEnergyOutlook.pdf

IEA (2018). World Energy Outlook 2018, IEA, Paris, https://doi.org/10.1787/weo-2018-en.

IEA-PVPS (2016). Review and Analysis of PV Self-Consumption Policies. IEA-PVPS, nachhaltigwirtschaften.at/resources/iea_pdf/reports/iea_pvps_task1_review_and_analysis_of_pv_self_consumption_policies_2016.pdf

Ingersoll, E., Imatteo, R., & Vysatova, R. A. (1998). Financing large-scale increases in photovoltaic production capacity through innovative risk management structures and contracts. *Special Report of Renewable Energy Policy Project (REPP), of the Center for Renewable Energy and Sustainable Technology (CREST) in the United States*.

IRENA (2011). Scenarios and Strategies for Africa. IRENA-Africa High-Level Consultations on Partnership on Accelerating Renewable Energy Uptake for Africa’s Sustainable Development.

IRENA (2012). Prospects for the African Power Sector. Working Paper. Available at https://www.irena.org/DocumentDownloads/Publications/Prospects_for_the_African_PowerSector.pdf

IRENA (2013). Renewable Energy Auctions in Developing Countries. IRENA, Abu Dhabi.

IRENA (2015). Africa 2030: Roadmap for a Renewable Energy Future. IRENA, Abu Dhabi. Accessed at www.irena.org/remap

IRENA (2016). REmap: Roadmap for a Renewable Energy Future, 2016 Edition. International Renewable Energy Agency (IRENA), Abu Dhabi, www.irena.org/remap

IRENA (2019). Global energy transformation: A roadmap to 2050 (2019 edition), International Renewable Energy Agency, Abu Dhabi.

IRENA and CEM (2015), Renewable Energy Auctions – A Guide to Design

IRENA and CPI (2018). Global Landscape of Renewable Energy Finance, 2018, International Renewable Energy Agency, Abu Dhabi

IRENA, IEA and REN21 (2018), 'Renewable Energy Policies in a Time of Transition'. IRENA, OECD/ IEA and REN21.

Jenner, S., Groba, F., & Indvik, J. (2013). Assessing the strength and effectiveness of renewable electricity feed-in tariffs in European Union countries. *Energy Policy, 52*, 385-401.

Johannesson, M., & Jönsson, B. (1991). Economic evaluation in health care: is there a role for cost-benefit analysis?. Health policy, 17(1), 1-23.

Johannesson, M., Johansson, P. O., & O'Conor, R. M. (1996). The value of private safety versus the value of public safety. *Journal of Risk and Uncertainty, 13*(3), 263-275.

Johnson, E., & Sherraden, M. S. (2007). From Financial Literacy to Financial Capability among Youth. J. Soc. & Soc. Welfare, 34, 119.

Johnson, F. R., Lancsar, E., Marshall, D., Kilambi, V., Mühlbacher, A., Regier, D. A., ... & Bridges, J. F. (2013). Constructing experimental designs for discrete-choice experiments: report of the ISPOR conjoint analysis experimental design good research practices task force. Value in Health, 16(1), 3-13.

Johnson, R., & Orme, B. (2003). Getting the most from CBC. Sequim: Sawtooth Software Research Paper Series, Sawtooth Software.

Johnston, R. J., Boyle, K. J., Adamowicz, W., Bennett, J., Brouwer, R., Cameron, T. A., ... & Tourangeau, R. (2017). Contemporary guidance for stated preference studies. Journal of the Association of Environmental and Resource Economists, 4(2), 319-405.

Jones-Lee, M. W., Loomes, G., & Philips, P. R. (1995). Valuing the prevention of non-fatal road injuries: Contingent valuation vs. standard gambles. *Oxford Economic Papers*, 676-695.

Jonubi, A., & Abad, S. (2013). The impact of financial literacy on individual saving: an exploratory study in the Malaysian context. Transformations in Business & Economics, 12(1), 41-55.

Junkus, J. C., & Berry, T. C. (2010). The demographic profile of socially responsible investors. Managerial Finance.

Julian, C. (2014). Creating local energy economies: lessons from Germany. *Respublica, London*.

Kahneman, D. (2003). A perspective on judgment and choice: mapping bounded rationality. *American psychologist*, *58*(9), 697.

Kahneman, D., & Knetsch, J. L. (1992). Valuing public goods: the purchase of moral satisfaction. Journal of environmental economics and management, 22(1), 57-70.

Kahneman, D., & Tversky, A. (2013). Choices, values, and frames. In *Handbook of the Fundamentals of Financial Decision Making: Part I* (pp. 269-278).

Kalkbrenner, B. J., & Roosen, J. (2016). Citizens' willingness to participate in local renewable energy projects: The role of community and trust in Germany. *Energy Research & Social Science*, *13*, 60-70.

Kaminker, C., & Stewart, F. (2012). The role of institutional investors in financing clean energy.

Karakezi S. and Kimani J. (2002) Status of power sector reform in Africa: impact on the poor . Energy Policy Volume 30 Issues 11-12 September 2002

Karanfil, F., & Li, Y. (2015). Electricity consumption and economic growth: exploring panel-specific differences. *Energy Policy*, *82*, 264-277.

Karekezi, S., Kimani, J., & Wangeci, J. (Eds.). (2001). *Power Sector Reform in Africa: Proceedings of a Regional Policy Seminar*. AFREPREN/FWD.

Kassie, G. T., Abdulai, A., Greene, W. H., Shiferaw, B., Abate, T., Tarekegne, A., & Sutcliffe, C. (2017). Modeling preference and willingness to pay for drought tolerance (DT) in maize in rural Zimbabwe. *World development*, *94*, 465-477.

Kharas, H. (2010). The emerging middle class in developing countries.

Kharas, H., & Gertz, G. (2010). The new global middle class: A cross-over from West to East. China's emerging middle class: Beyond economic transformation, 32-54. Retrieved from http://www.brookings.edu/~/media/Research/Files/Papers/2010/3/china middle class kharas/03_china_middle_class_kharas.pdf

Kingombe, C.K.M (2011) "Mapping the new infrastructure financing landscape". Overseas Development Institute, http://www.odi.org.uk/resources/docs/6311.pdf

Klapper, L., Lusardi, A., & Van Oudheusden, P. (2015). Financial literacy around the world. World Bank. Washington DC: World Bank.

Klöhn, L., Hornuf, L., & Schilling, T. (2016). The regulation of crowdfunding in the German small investor protection act: content, consequences, critique, suggestions. European Company Law, 13(2), 56-66.

Komendantova, N., Patt, A., Barras, L., & Battaglini, A. (2012). Perception of risks in renewable energy projects: The case of concentrated solar power in North Africa. Energy policy, 40, 103-109.

Kostakis, I., & Sardianou, E. (2012). Which factors affect the willingness of tourists to pay for renewable energy?. Renewable Energy, 38(1), 169-172.

Kouassi, H., & Pineau, P. O. (2011). Financing challenges for electricity projects in sub-saharan africa: Reviewing old models and exploring new ones. *Journal of African Business*, *12*(3), 347-367.

Kovacs, K. F., & Larson, D. M. (2008). Identifying individual discount rates and valuing public open space with stated-preference models. *Land Economics*, *84*(2), 209-224.

KPMG (2013). Taxes and incentives for renewable energy. https://assets.kpmg/content/dam/kpmg/pdf/2014/09/taxes-incentives-renewable-energy-v1.pdf. Accessed on 27 July 2019.

Krueger, R. A., & Casey, M. A. (2014). Focus groups: A practical guide for applied research. Sage publications.

Kruk, M. E., Paczkowski, M., Mbaruku, G., de Pinho, H., & Galea, S. (2009). Women's preferences for place of delivery in rural Tanzania: a population-based discrete choice experiment. *American journal of public health*, *99*(9), 1666-1672.

Ku, S. J., & Yoo, S. H. (2010). Willingness to pay for renewable energy investment in Korea: A choice experiment study. *Renewable and Sustainable Energy Reviews*, *14*(8), 2196-2201.

Kuhfeld, W. F. (2005). Experimental design, efficiency, coding, and choice designs. Marketing research methods in sas: Experimental design, choice, conjoint, and graphical techniques, 47-97.

Ladenburg, J., & Olsen, S. B. (2008). Gender-specific starting point bias in choice experiments: Evidence from an empirical study. Journal of Environmental Economics and Management, 56(3), 275-285.

Lam, P. T., & Law, A. O. (2016). Crowdfunding for renewable and sustainable energy projects: An exploratory case study approach. Renewable and Sustainable Energy Reviews, 60, 11-20.

Lancaster, K. J. (1966). A new approach to consumer theory. *The journal of political economy*, 132-157.

Lancsar, E., & Louviere, J. (2006). Deleting 'irrational'responses from discrete choice experiments: a case of investigating or imposing preferences?. Health economics, 15(8), 797-811.

Lancsar, E., & Louviere, J. (2008). Conducting discrete choice experiments to inform healthcare decision making. *Pharmacoeconomics*, *26*(8), 661-677

Lancsar, E., Louviere, J., Donaldson, C., Currie, G., & Burgess, L. (2013). Best worst discrete choice experiments in health: methods and an application. Social science & medicine, 76, 74-82.

Lee, C. K., & Mjelde, J. W. (2007). Valuation of ecotourism resources using a contingent valuation method: The case of the Korean DMZ. Ecological Economics, 63(2-3), 511-520.

Lee, C. W., & Zhong, J. (2015). Financing and risk management of renewable energy projects with a hybrid bond. Renewable Energy, 75, 779-787.

Lee, C. Y., & Heo, H. (2016). Estimating willingness to pay for renewable energy in South Korea using the contingent valuation method. Energy Policy, 94, 150-156.

Lee, S. W., Taylor, P. D., & Hong, S. K. (2008). Moderating effect of forest cover on the effect of proximity to chemical facilities on property values. *Landscape and Urban Planning*, *86*(2), 171-176.

Leisher, C. (2014). A comparison of tablet-based and paper-based survey data collection in conservation projects. Social Sciences, 3(2), 264-271.

Leke, A., S. Lund, C. Roxburgh, and A. van Wamelen (2010). What's Driving Africa's Growth. McKinsey & Company. Accessed 22 February 2019. www.mckinsey.com/global-themes/middle-east-and-africa/whats-driving-africas-growth

Liebe, U., Meyerhoff, J., & Hartje, V. (2012). Test–retest reliability of choice experiments in environmental valuation. Environmental and Resource Economics, 53(3), 389-407.

Lietz, H., Lingani, M., Sie, A., Sauerborn, R., Souares, A., & Tozan, Y. (2015). Measuring population health: costs of alternative survey approaches in the Nouna Health and Demographic Surveillance System in rural Burkina Faso. Global health action, 8(1), 28330.

Lindenberg, S., & Steg, L. (2007). Normative, gain and hedonic goal frames guiding environmental behavior. *Journal of Social issues*, *63*(1), 117-137.

Logar, I., Brouwer, R., & Paillex, A. (2019). Do the societal benefits of river restoration outweigh their costs? A cost-benefit analysis. *Journal of Environmental Management*, *232*, 1075-1085.

Loock, M. (2012). Going beyond best technology and lowest price: on renewable energy investors' preference for service-driven business models. *Energy Policy*, *40*, 21-27.

Loomis, J., Gonzalez-Caban, A., Champ, J., & Downing, J. (2011). Testing the Robustness of Contingent Valuation Estimates of WTP to Survey Mode and Treatment of Protest Responses. The International Handbook on Non-Market Environmental Valuation. Cheltenham, UK: Edward Elgar Publishing, 102-121.

Louviere, J. J. (2006). What you don't know might hurt you: some unresolved issues in the design and analysis of discrete choice experiments. Environmental and Resource Economics, 34(1), 173-188.

Louviere, J. J., & Woodworth, G. (1983). Design and analysis of simulated consumer choice or allocation experiments: an approach based on aggregate data. *Journal of marketing research*, 350-367.

Louviere, J. J., Flynn, T. N., & Marley, A. A. J. (2015). Best-worst scaling: Theory, methods and applications. Cambridge University Press.

Louviere, J. J., Hensher, D. A., & Swait, J. D. (2000). *Stated choice methods: analysis and applications*. Cambridge University Press.

Lusardi, A. and Mitchell, O.S. (2011). Financial literacy around the world: an overview. *Journal of Pension Economics & Finance*, *10*(4), pp.497-508.

Lusardi, A., & Mitchell, O. S. (2007c). The importance of financial literacy: Evidence and implications for financial education programs. Policy Brief. The Wharton School.

Lusardi, A., & Mitchell, O. S. (2008). Planning and financial literacy: How do women fare?. American Economic Review, 98(2), 413-17.

Lusardi, A., Mitchell, O. S., & Curto, V. (2010). Financial literacy among the young. Journal of consumer affairs, 44(2), 358-380.

Lusardi, A., & Mitchell, O. S. (2011). Financial literacy and retirement planning in the United States. Journal of Pension Economics and Finance, 10(4), 509-525.

Lusardi, A., & Mitchell, O. S. (2014). The economic importance of financial literacy: theory and evidence. Journal of Economic Literature, 52(1), 5-44.

Luthi, S. (2010). Effective deployment of photovoltaics in the Mediterranean countries: balancing policy risk and return. *Solar Energy*, *84*(6), 1059-1071.

Luttik, J. (2000). The value of trees, water and open space as reflected by house prices in the Netherlands. *Landscape and urban planning*, *48*(3-4), 161-167.

MacMillan, D., Hanley, N., & Lienhoop, N. (2006). Contingent valuation: Environmental polling or preference engine?. *Ecological economics*, *60*(1), 299-307.

Magnani, N., & Osti, G. (2016). Does civil society matter? Challenges and strategies of grassroots initiatives in Italy's energy transition. *Energy Research & Social Science*, *13*, 148-157.

Mahapatra, K., & Gustavsson, L. (2008). An adopter-centric approach to analyze the diffusion patterns of innovative residential heating systems in Sweden. Energy Policy, 36(2), 577-590.

Malmendier, U., & Nagel, S. (2015). Learning from inflation experiences. The Quarterly Journal of Economics, 131(1), 53-87.

Mandell, L. (2007). Financial literacy of high school students. In J.J. Xiao (Ed.), Handbook of Consumer Finance Research (pp. 163-183). New York, NY: Springer.

Mandell, L. (2008). The financial literacy of young American adults. The Jumpstart Coalition for Personal Financial Literacy.

Mangham, L. J., Hanson, K., & McPake, B. (2009). How to do (or not to do). Designing a discrete choice experiment for application in a low-income country. Health policy and planning, 24(2), 151-158.

Manley, D. K., Hines, V. A., Jordan, M. W., & Stoltz, R. E. (2013). A survey of energy policy priorities in the United States: Energy supply security, economics, and the environment. Energy Policy, 60, 687-696.

Mansfield, C., Pattanayak, S. K., McDow, W., McDonald, R., & Halpin, P. (2005). Shades of green: measuring the value of urban forests in the housing market. *Journal of forest economics*, *11*(3), 177-199.

Manski, C. F. (1977). The structure of random utility models. Theory and decision, 8(3), 229-254.

Markowitz, H. (1952). Portfolio selection. *The journal of finance*, *7*(1), 77-91.

Marsden, P. V., & Wright, J. D. (Eds.). (2010). Handbook of survey research. Emerald Group Publishing.

Marshall, D., Bridges, J. F., Hauber, B., Cameron, R., Donnalley, L., Fyie, K., & Johnson, F. R. (2010). Conjoint analysis applications in health—how are studies being designed and reported?. The Patient: Patient-Centered Outcomes Research, 3(4), 249-256.

Masini, A., & Menichetti, E. (2012). The impact of behavioural factors in the renewable energy investment decision making process: Conceptual framework and empirical findings. *Energy Policy*, *40*, 28-38.

Matějka, F. and McKay, A.(2015). Rational inattention to discrete choices: A new foundation for the multinomial logit model. *American Economic Review*, *105*(1), pp.272-98.

Mawdsley, E. (2004). India's middle classes and the environment. *Development and Change*, *35*(1), 79-103.

McFadden, D. (1974). The measurement of urban travel demand. Journal of public economics, 3(4), 303-328.lanning, 24(2), 151-158.

McFadden, D., & Train, K. (2000). Mixed MNL models for discrete response. Journal of applied Econometrics, 15(5), 447-470.

McIntosh, E., & Ryan, M. (2002). Using discrete choice experiments to derive welfare estimates for the provision of elective surgery: implications of discontinuous preferences. Journal of Economic Psychology, 23(3), 367-382.

McNulty, J. J., Yeh, T. D., Schulze, W. S., & Lubatkin, M. H. (2002). What’s your real cost of capital. *Harvard Business Review*, *80*(10), 114-121.

McPeake, J., Bateson, M., & O'Neill, A. (2014). Electronic surveys: how to maximise success. *Nurse Researcher (2014+)*, *21*(3), 24.

Menanteau, P., Finon, D., & Lamy, M. L. (2003). Prices versus quantities: choosing policies for promoting the development of renewable energy. *Energy policy*, *31*(8), 799-812.

Merrett, S. (2002). Deconstructing households' willingness-to-pay for water in low-income countries. *Water policy*, *4*(2), 157-172.

Meyerhoff, J., & Liebe, U. (2009). Status quo effect in choice experiments: empirical evidence on attitudes and choice task complexity. Land Economics, 85(3), 515-528.

Michelsen, C. C., & Madlener, R. (2012). Homeowners' preferences for adopting innovative residential heating systems: a discrete choice analysis for Germany. Energy Economics, 34(5), 1271-1283.

Mignon, I., & Bergek, A. (2016). Investments in renewable electricity production: The importance of policy revisited. *Renewable Energy*, *88*, 307-316.

Miller, M., Godfrey, N., Levesque, B. and Stark, E. (2009). The Case for Financial Literacy in Developing Countries: Promoting Access to Finance by Empowering Consumers. World Bank, DFID, OECD, and CGAP joint note, Washington, DC: World Bank.

Mills, B., & Schleich, J. (2010). What's driving energy efficient appliance label awareness and purchase propensity?. Energy Policy, 38(2), 814-825.

Mills, B., & Schleich, J. (2012). Residential energy-efficient technology adoption, energy conservation, knowledge, and attitudes: An analysis of European countries. Energy Policy, 49, 616-628.

Mills, S. J., & Taylor, M. (1994). Project finance for renewable energy. *Renewable energy*, *5*(1-4), 700-708.

Ministry of Energy(2010). National Energy Policy (NEP) 2010. http://www.ecowrex.org/system/files/repository/2010_national-energy-policy_ministry-of-energy.pdf(Accessed 19 June 2018).

Mitchell, O. S., & Lusardi, A. (2015). Financial literacy and economic outcomes: Evidence and policy implications. The journal of retirement, 3(1), 107-114.

Mitchell, R. C., & Carson, R. T. (1989). *Using surveys to value public goods: the contingent valuation method*. Resources for the Future.

Monticone, C. (2010). How much does wealth matter in the acquisition of financial literacy? The Journal of Consumer Affairs, 44(2), 403- 422

Moore, B., & Wüstenhagen, R. (2004). Innovative and sustainable energy technologies: the role of venture capital. *Business Strategy and the Environment*, *13*(4), 235-245.

Morales, D. J. (1980). The contribution of trees to residential property value. Journal of Arboriculture, 6(11), 305-308.

Munro, A., & Hanley, N. D. (2001). Information, uncertainty, and contingent valuation. *Valuing Environmental Preferences: Theory and Practice of the Contingent Valuation Method in the US, EU, and Developing Countries. Oxford University Press, Oxford*, 258-274.

Murakami, K., Ida, T., Tanaka, M., & Friedman, L. (2015). Consumers' willingness to pay for renewable and nuclear energy: A comparative analysis between the US and Japan. *Energy Economics*, *50*, 178-189.

Murphy, A. J. (2005). Money, money, money: An exploratory study on the financial literacy of black college students. College Student Journal, 39(3), 478-489.

Murphy, L. M., & Edwards, P. L. (2003). *Bridging the valley of death: Transitioning from public to private sector financing*. Golden, CO: National Renewable Energy Laboratory.

Nagy, R. A., & Obenberger, R. W. (1994). Factors influencing individual investor behavior. *Financial Analysts Journal*, *50*(4), 63-68.

National Energy Policy (2014). Ministry of Energy and Petroleum, Republic of Kenya. Accessed from https://www.greengrowthknowledge.org/sites/default/files/downloads/policydatabase/KENYA%29%20National%20Energy%20Policy%2C%202014.pdf

National Renewable Energy and Energy Efficiency Policy (NREEEP) (2015). Ministry of Power, Federal Republic of Nigeria. Accessed from http://www.power.gov.ng/download/NREEE%20POLICY%202015%20FEC%20APPROVED%20COPY.pdf

Nilsson, J. (2008). Investment with a conscience: Examining the impact of pro-social attitudes and perceived financial performance on socially responsible investment behavior. Journal of business ethics, 83(2), 307-325.

Noblet, C. L., Teisl, M. F., Evans, K., Anderson, M. W., McCoy, S., & Cervone, E. (2015). Public preferences for investments in renewable energy production and energy efficiency. *Energy Policy*, *87*, 177-186.

Noll, D., Dawes, C., & Rai, V. (2014). Solar community organizations and active peer effects in the adoption of residential PV. *Energy Policy*, *67*, 330-343.

Noothout, P., de Jager, D., Tesnière, L., van Rooijen, S., Karypidis, N., Brückmann, R., ... & Konstantinavičiūtė, I. (2016). The impact of risks in renewable energy investments and the role of smart policies. DiaCore report.

NREL (National Renewable Energy Laboratory) (2016a), Feed-in Tariffs: Good Practices and Design Considerations, NREL, Golden, CO, www.nrel.gov/docs/fy16osti/65503.pdf

NREL (National Renewable Energy Laboratory) (2016b), Financial incentives to enable clean energy Deployment, NREL, Golden, CO, www.nrel.gov/docs/fy16osti/65541.pdf

Obeng-Darko, N. A. (2019). Why Ghana will not achieve its renewable energy target for electricity. Policy, legal and regulatory implications. *Energy Policy*, *128*, 75-83.

Odean, T. (1998). Are investors reluctant to realize their losses? *The Journal of finance*, *53*(5), 1775-1798.

Odean, T. (1999). Do investors trade too much? *American economic review*, *89*(5), 1279-1298.

OECD, INFE. (2015). "National strategies for financial education."

Oerlemans, L. A., Chan, K. Y., & Volschenk, J. (2016). Willingness to pay for green electricity: A review of the contingent valuation literature and its sources of error. Renewable and Sustainable Energy Reviews, 66, 875-885.

OFGEM (Office of Gas and Electricity Markets) (2017), “Electricity storage under the Renewables Obligation”, blog, 13 September, OFGEM, London, www.ofgem.gov.uk/newsblog/our-blog/electricity-storage-under-renewables-obligation (accessed 21 January 2018)

Organization for Economic Co-Operation and Development (2013). Financial literacy and inclusion: Results of OECD/INFE survey across countries and by gender. OECD Centre, Paris, France

Organization for Economic Co-Operation and Development (2013). Women and Financial Education: Evidence, Policy Responses and Guidance, OECD Publishing.

Organization for Economic Co-Operation and Development (2018). G20/OECD INFE Policy Guidance on Digitalisation and Financial Literacy

Organization for Economic Co-Operation and Development (2019). Under Pressure: The Squeezed Middle Class, OECD Publishing, Paris, https://doi.org/10.1787/689afed1-en.

Organization for Economic Co-Operation and Development(2005). Improving Financial Literacy: Analysis of Issues and Policies.

Orme, B. (1998). Sample size issues for conjoint analysis studies. Sawthooth Software Research paper Series Squim, WA, USA: Sawthooth Software Inc.

Orme, B. (2010). Sample Size Issues for Conjoint Analysis Studies. Sawtooth Software Research

Ostrom, E. (2003). Toward a behavioral theory linking trust, reciprocity, and reputation. Trust and reciprocity: Interdisciplinary lessons from experimental research, 6, 19-79.

Owen, A. D. (2006). Renewable energy: Externality costs as market barriers. *Energy policy*, *34*(5), 632-642.

Pacifico, D., & Yoo, H. I. (2013). lclogit: A Stata command for fitting latent-class conditional logit models via the expectation-maximization algorithm. The Stata Journal, 13(3), 625-639.

Painuly, J. P. (2001). Barriers to renewable energy penetration; a framework for analysis. *Renewable energy*, *24*(1), 73-89.

Pandian, P. M. (2001). A study on equity investor awareness.

Patterson, W. (1999). Transforming Electricity, London, Earthscan

Portney, P. R. (1994). The contingent valuation debate: why economists should care. *The Journal of Economic Perspectives*, *8*(4), 3-17.

Potrich, A. C. G., Vieira, K. M., & Kirch, G. (2015). Determinants of financial literacy: Analysis of the influence of socioeconomic and demographic variables. Revista Contabilidade & Finanças, 26(69), 362-377.

Powe, N. A., & Bateman, I. J. (2003). Ordering effects in nested ‘top-down’and ‘bottom-up’contingent valuation designs. Ecological economics, 45(2), 255-270.

President: Executive Summary.

President’s Advisory Committee on Financial Literacy (PACFL)(2008). Annual Report to the

Puckett, S. M., & Hensher, D. A. (2009). Revealing the extent of process heterogeneity in choice analysis: An empirical assessment. Transportation Research Part A: Policy and Practice, 43(2), 117-126.

Pueyo, A. (2018). What constrains renewable energy investment in Sub-Saharan Africa? A comparison of Kenya and Ghana. *World Development*, *109*, 85-100.

Ratcliffe, J., & Longworth, L. (2002). Investigating the structural reliability of a discrete choice experiment within health technology assessment. *International journal of technology assessment in health care*, *18*(01), 139-144.

Ravallion, M. (2009). The developing world's bulging (but vulnerable)" middle class". The World Bank.

Read, D. L., Brown, R. F., Thorsteinsson, E. B., Morgan, M., & Price, I. (2013). The theory of planned behaviour as a model for predicting public opposition to wind farm developments. *Journal of Environmental Psychology*, *36*, 70-76.

Remund, D. L. (2010). Financial literacy explicated: the case for a clearer definition in an increasingly complex economy. The Journal of Consumer Affairs, 44(2), 276-295

REN21 (2017) Renewable Energy Policy Framework for the 21st Century, Renewables 2017. Global Status Report

RESCOOP (2018). *What is a REScoop?* Retrieved from https://www.rescoop.eu/the-rescoop-model

Ridker, R. G., & Henning, J. A. (1967). The determinants of residential property values with special reference to air pollution. The Review of Economics and Statistics, 246-257.

Ritchie, H., & Roser, M. (2017). CO_2 and Greenhouse Gas Emissions. *Our world in data*. Retrieved from: 'https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions' [Online Resource]

Rizzi, L. I., & de Dios Ortúzar, J. (2003). Stated preference in the valuation of interurban road safety. *Accident Analysis & Prevention*, *35*(1), 9-22.

Robb, C. A., Babiarz, P., & Woodyard, A. (2012). The demand for financial professionals' advice: the role of financial knowledge, satisfaction, and confidence. Financial Services Review, 21(4), 291-305

Roberts, J, Bodman, F and Rybski, R (2014). Community Power: Model Legal Frameworks for Citizen-owned Renewable Energy. (ClientEarth: London)

Rogers, J. C., Simmons, E. A., Convery, I., & Weatherall, A. (2008). Public perceptions of opportunities for community-based renewable energy projects. *Energy Policy*, *36*(11), 4217-4226.

Rolfe, J., & Brouwer, R. (2012). Design effects in a meta-analysis of river health choice experiments in Australia. *Journal of Choice Modelling*, *5*(2), 81-97.

Rommel, J., Sagebiel, J., & Müller, J. R. (2016). Quality uncertainty and the market for renewable energy: Evidence from German consumers. Renewable energy, 94, 106-113.

Rose, J. M., & Bliemer, M. C. (2009). Constructing efficient stated choice experimental designs. Transport Reviews, 29(5), 587-617.

Ryan, M. (1999). A role for conjoint analysis in technology assessment in health care?. *International journal of technology assessment in health care*,*15*(03), 443-457.

Rydin, Y. J., Turcu, C., Chmutina, K., Devine-Wright, P., Goodier, C., Guy, S., ... and Wiersma, B. (2012). Urban energy initiatives: the implications of new urban energy pathways for the UK. Network Industries Quarterly, 14(2 & 3), 20-23.

Ryu, E., Couper, M. P., & Marans, R. W. (2005). Survey incentives: Cash vs. in-kind; face-to-face vs. mail; response rate vs. nonresponse error. International Journal of Public Opinion Research, 18(1), 89-106.

Sakah, M., Diawuo, F. A., Katzenbach, R., & Gyamfi, S. (2017). Towards a sustainable electrification in Ghana: A review of renewable energy deployment policies. *Renewable and Sustainable Energy Reviews*, *79*, 544-557.

Salm, S. (2018). The investor-specific price of renewable energy project risk–A choice experiment with incumbent utilities and institutional investors. Renewable and Sustainable Energy Reviews, 82, 1364-1375.

Salm, S., Hille, S. L., & Wüstenhagen, R. (2016). What are retail investors' risk-return preferences towards renewable energy projects? A choice experiment in Germany. *Energy Policy*, *97*, 310-320.

Samuelson, P. A. (1954). The pure theory of public expenditure. The review of economics and statistics, 387-389.

Samuelson, P. A. (1989). The Judgement Of Economic Science On Rational Portfolio Man. Journal of portfolio Management, 16(1), 4.

Samuelson, P. A. (1994). The long-term case for equities. Journal of Portfolio Management, 21(1), 15.

Sardianou, E., & Genoudi, P. (2013). Which factors affect the willingness of consumers to adopt renewable energies?. Renewable energy, 57, 1-4.

Sarpong-Danquah, B., Gyimah, P., Poku, K., & Osei-Poku, B. (2018). Financial Literacy Assessment on Tertiary Students in Sub-Saharan Africa: A Ghanaian Perspective. *International Journal of Accounting and Financial Reporting*, *8*(2), 76-91.

Sathye, M. (1999). Adoption of Internet banking by Australian consumers: an empirical investigation. *International Journal of bank marketing*, *17*(7), 324-334.

Sauter, R., & Watson, J. (2007). Strategies for the deployment of micro-generation: Implications for social acceptance. *Energy Policy*, *35*(5), 2770-2779.

Sax, L. J., Gilmartin, S. K., & Bryant, A. N. (2003). Assessing response rates and nonresponse bias in web and paper surveys. Research in higher education, 44(4), 409-432.

Scarpa, R., & Willis, K. (2010). Willingness-to-pay for renewable energy: Primary and discretionary choice of British households' for micro-generation technologies. *Energy Economics*, *32*(1), 129-136.

Scarpa, R., Ferrini, S. and Willis, K.G. (2005). Performance of error component models for status-quo effects in choice experiments, Ch13, in Scarpa, R. and Alberini, A. (eds), Applications of Simulation Methods in Environmental and Resource Economics, pp. 247–274. Springer,Publisher, Dordrecht, The Netherlands

Scarpa, R., Thiene, M. & Train, K. (2006). Utility in WTP space: a tool to address confounding random scale effects in destination choice to the Alps. (Department of Economics Working Paper Series, Number 15/06). Hamilton, New Zealand: University of Waikato.

Scarpa, R., Thiene, M., & Train, K. (2008). Utility in willingness to pay space: a tool to address confounding random scale effects in destination choice to the Alps. *American Journal of Agricultural Economics*, *90*(4), 994-1010.

Scheresberg, C. B. (2013). Financial literacy and financial behavior among young adults: evidence and implications. Numeracy, 6(2)

Schreuer, A. (2016). The establishment of citizen power plants in Austria: A process of empowerment? *Energy Research & Social Science*, *13*, 126-135.

Schreuer, A., & Weismeier-Sammer, D. (2010). Energy cooperatives and local ownership in the field of renewable energy technologies: A literature review.

Schwerhoff, G., and Sy, M. (2017). Financing renewable energy in Africa–Key challenge of the sustainable development goals. *Renewable and Sustainable Energy Reviews*, *75*, 393-401.

Scott, A. (2002). Identifying and analysing dominant preferences in discrete choice experiments: an application in health care. Journal of economic Psychology, 23(3), 383-398.

Segerson, K. (2017). Valuing environmental goods and services: an economic perspective. In A primer on nonmarket valuation (pp. 1-25). Springer, Dordrecht.

Servon, L. J., & Kaestner, R. (2008). Consumer financial literacy and the impact of online banking on the financial behavior of lower-income bank customers. Journal of Consumer Affairs, 42(2), 271-305.

Seyfang, G., Park, J. J., & Smith, A. (2013). A thousand flowers blooming? An examination of community energy in the UK. *Energy Policy*, *61*, 977-989.

Shefrin, H. (2001) 'Do investors expect higher returns from safer stocks than from riskier stocks?' The Journal of Psychology and Financial Markets, 2, 176–181.

Shefrin, H. (2002). *Beyond greed and fear: Understanding behavioral finance and the psychology of investing*. Oxford University Press on Demand.

Shih, T. H., & Fan, X. (2009). Comparing response rates in e-mail and paper surveys: A meta-analysis. *Educational research review*, *4*(1), 26-40.

Shiller, R. J. (1999). Human behavior and the efficiency of the financial system. *Handbook of macroeconomics*, *1*, 1305-1340.

Shleifer, A. (2000). *Inefficient markets: An introduction to behavioural finance*. OUP Oxford.

Shogren, J. F., & Taylor, L. O. (2008). On behavioral-environmental economics. Review of Environmental Economics and Policy, 2(1), 26-44.

Shogren, J. F., & Taylor, L. O. (2008). On behavioral-environmental economics. Review of Environmental Economics and Policy, 2, 26–44.

Simon, H. (1990). *Reason in human affairs*. Stanford University Press.

Simon, H. A. (1955). A behavioral model of rational choice. *The quarterly journal of economics*, *69*(1), 99-118.

Simon, H. A. (1959). Theories of decision-making in economics and behavioral science. The American economic review, 49(3), 253-283.

Singer, E., & Ye, C. (2013). The use and effects of incentives in surveys. The ANNALS of the American Academy of Political and Social Science, 645(1), 112-141.

Singer, E., Groves, R. M., & Corning, A. D. (1999). Differential incentives: Beliefs about practices, perceptions of equity, and effects on survey participation. *The Public Opinion Quarterly*, *63*(2), 251-260.

Sippel, R. (1997). An experiment on the pure theory of consumer's behaviour. The Economic Journal, 107(444), 1431-1444.

Smith, J. P. (1999). Healthy bodies and thick wallets: the dual relation between health and economic status. *Journal of Economic perspectives*, *13*(2), 145-166.

Söderholm, P., Ek, K., & Pettersson, M. (2007). Wind power development in Sweden: Global policies and local obstacles. *Renewable and sustainable energy reviews*, *11*(3), 365-400.

Soler, I. P., Gemar, G., Correia, M. B., & Serra, F. (2019). Algarve hotel price determinants: A hedonic pricing model. Tourism Management, 70, 311-321.

Stenzel, T., & Frenzel, A. (2008). Regulating technological change—The strategic reactions of utility companies towards subsidy policies in the German, Spanish and UK electricity markets. *Energy policy*, *36*(7), 2645-2657.

Stiglitz, J. E. (2002). Participation and development: Perspectives from the comprehensive development paradigm. *Review of development economics*,*6*(2), 163-182.

Street D.J, Burgess A, Louviere J.J. (2005). Quick and easy choice sets: Constructing optimal and nearly optimal stated choice experiments. International Journal of Research in Marketing 22: 459–70.

Su, W., Liu, M., Zeng, S., Štreimikienė, D., Baležentis, T., & Movsumova-Šeškienė, I. (2018). Valuating renewable microgeneration technologies in Lithuanian households: A study on willingness to pay. *Journal of Cleaner Production*, *191*, 318-329.

Sudman, S., & Bradburn, N. M. (1983). Asking questions: a practical guide to questionnaire design.

Terris-Prestholt, F., Hanson, K., MacPhail, C., Vickerman, P., Rees, H., & Watts, C. (2013). How much demand for new HIV prevention technologies can we really expect? Results from a discrete choice experiment in South Africa. *PloS one*, *8*(12), e83193.

Thaler, R. H. (2013). Financial literacy, beyond the classroom. The New York Times.

Thurstone, L. L. (1927). A law of comparative judgment. Psychological review, 34(4), 273.

Tietenberg, T. H., & Lewis, L. (2012). Environmental and natural resource economics. Pearson.

Train, K. E. (2009). Discrete choice methods with simulation. Cambridge university press.

Train, K., & Weeks, M. (2005). Discrete choice models in preference space and willingness-to-pay space. In *Applications of simulation methods in environmental and resource economics* (pp. 1-16). Springer, Dordrecht.

Tschirley, D., Reardon, T., Dolislager, M., & Snyder, J. (2015). The rise of a middle class in East and Southern Africa: Implications for food system transformation. *Journal of International Development*, *27*(5), 628-646.

Tu, G., Abildtrup, J., & Garcia, S. (2016). Preferences for urban green spaces and peri-urban forests: An analysis of stated residential choices. *Landscape and Urban Planning*, *148*, 120-131.

Tversky, A. (1972a). Elimination by aspects: A theory of choice. Psychological review, 79(4), 281.

Tversky, A. (1972b). Choice by elimination. Journal of mathematical psychology, 9(4), 341-367.

Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases. *science*, *185*(4157), 1124-1131.

Tversky, A., & Kahneman, D. (1986). Rational choice and the framing of decisions. *Journal of business*, S251-S278.

Twidell, J., & Weir, T. (2015). Renewable energy resources. Routledge.

Tyrväinen, L. (1997). The amenity value of the urban forest: an application of the hedonic pricing method. *Landscape and Urban planning*, *37*(3-4), 211-222.

Unruh, G. C. (2000). Understanding carbon lock-in. *Energy policy*, *28*(12), 817-830.

Unruh, G. C. (2002). Escaping Carbon Lock-in. *Energy Policy*, *30*(4), 317-325.

Vagliasindi, M. (2013). *Revisiting Public-Private Partnerships in the Power Sector*. World Bank Publications

Van Der Schoor, T., & Scholtens, B. (2015). Power to the people: Local community initiatives and the transition to sustainable energy. *Renewable and Sustainable Energy Reviews*, *43*, 666-675.

Van Der Schoor, T., Van Lente, H., Scholtens, B., & Peine, A. (2016). Challenging obduracy: How local communities transform the energy system. *Energy Research & Social Science*, *13*, 94-105.

Van Rooij, M. C. J., Lusardi, A., & Alessie, R. J. M. (2011). Financial literacy and retirement planning in the Netherlands. Journal of Economic Psychology, 32(4), 593-608

Van Rooij, M., Lusardi, A., & Alessie, R. (2007). Financial literacy and stock market participation.NBER Working Paper No. 13565. Cambridge, MA:National Bureau of Economic Research

Vecchiato, D., & Tempesta, T. (2015). Public preferences for electricity contracts including renewable energy: A marketing analysis with choice experiments. *Energy*, *88*, 168-179.

Venkatachalam, L. (2004). The contingent valuation method: a review. *Environmental impact assessment review*, *24*(1), 89-124.

Viotto da Cruz, J. (2015). Competition and regulation of crowdfunding platforms: A two-sided market approach. Communications & Strategies, 99, 33-50.

Volpe, R. P., Chen, H., & Pavlicko, J. J. (1996). Personal investment literacy among college students: A survey. Financial Practice and Education, 6(2), 86-94.

Volta River Authority(VRA)(2015). Ghana’s Power Outlook.

Vossler, C. A., Doyon, M., & Rondeau, D. (2012). Truth in consequentiality: theory and field evidence on discrete choice experiments. *American Economic Journal: Microeconomics*, *4*(4), 145-71.

Wagner, O., & Berlo, K. (2015). The wave of remunicipalisation of energy networks and supply in Germany: the establishment of 72 new municipal power utilities. In First fuel now: ECEEE 2015 Summer Study; 1-6 June 2015, Toulon/Hyères, France; proceedings. Stockholm: Europ. Council for an Energy Efficient Economy.

Waissbein, O., Glemarec, Y., Bayraktar, H., & Schmidt, T.S., (2013). Derisking Renewable Energy Investment. A Framework to Support Policymakers in Selecting Public Instruments to Promote Renewable Energy Investment in Developing Countries. New York, NY: United Nations Development Programme

Walker, G. (2008). What are the barriers and incentives for community-owned means of energy production and use?. *Energy Policy*, *36*(12), 4401-4405.

Walker, G., & Devine-Wright, P. (2008). Community renewable energy: What should it mean. *Energy policy*, *36*(2), 497-500.

Walker, G., Devine-Wright, P., Hunter, S., High, H., & Evans, B. (2010). Trust and community: Exploring the meanings, contexts and dynamics of community renewable energy. *Energy Policy, 38*(6), 2655-2663.

Watts, M. (1994). Development II: the privatization of everything?. *Progress in Human Geography*, *18*(3), 371-384.

Weiqi, C., Huasheng, H. O. N. G., Yan, L., Zhang, L., Xiaofeng, H. O. U., & Raymond, M. (2004). Recreation demand and economic value: An application of travel cost method for Xiamen Island. China Economic Review, 15(4), 398-406.

Wen, C. H., & Lai, S. C. (2010). Latent class models of international air carrier choice. Transportation Research Part E: Logistics and Transportation Review, 46(2), 211-221.

Whittington, D. (1998). Administering contingent valuation surveys in developing countries. *World development*, *26*(1), 21-30.

Williamson, O. E. (1994). The institutions and governance of economic development and reform. *The World Bank Economic Review*, *8*(suppl 1), 171-197.

Willis, K. G., & Garrod, G. D. (1991). An individual travel-cost method of evaluating forest recreation. *Journal of agricultural Economics*, *42*(1), 33-42.

Wolde-Rufael, Y. (2009). Energy consumption and economic growth: the experience of African countries revisited. *Energy Economics*, *31*(2), 217-224.

World Bank(2011). State and Trends of the Carbon Market. Available at: http://siteresources.worldbank.org/INTCARBONFINANCE/Resources/StateAndTrend_LowRes.pdf

World Bank(2014). Financial education programs and strategies : approaches and available resources (English). Washington, D.C. : World Bank Group. http://documents.worldbank.org/curated/en/901211472719528753/Financial-education-programs-and-strategies-approaches-and-available-resources

Wurpts, I. C., & Geiser, C. (2014). Is adding more indicators to a latent class analysis beneficial or detrimental? Results of a Monte-Carlo study. *Frontiers in psychology*, *5*, 920.

Wüstenhagen, R., & Menichetti, E. (2012). Strategic choices for renewable energy investment: Conceptual framework and opportunities for further research. *Energy Policy*, *40*, 1-10.

Wüstenhagen, R., & Teppo, T. (2006). Do venture capitalists really invest in good industries? Risk-return perceptions and path dependence in the emerging European energy VC market. *International Journal of Technology Management*, *34*(1/2), 63-87.

Yildiz, Ö. (2014). Financing renewable energy infrastructures via financial citizen participation–The case of Germany. *Renewable Energy*, *68*, 677-685.

Yildiz, Ö., Rommel, J., Debor, S., Holstenkamp, L., Mey, F., Müller, J. R., ... & Rognli, J. (2015). Renewable energy cooperatives as gatekeepers or facilitators? Recent developments in Germany and a multidisciplinary research agenda. *Energy Research & Social Science*, *6*, 59-73.

Yoo, S. H. (2005). Electricity consumption and economic growth: evidence from Korea. Energy Policy, 33(12), 1627-1632.

Zanoli, R., Scarpa, R., Napolitano, F., Piasentier, E., Naspetti, S., & Bruschi, V. (2013). Organic label as an identifier of environmentally related quality: A consumer choice experiment on beef in Italy. Renewable Agriculture and Food Systems, 28(1), 70-79.

Zarnikau, J. (2003). Consumer demand for ‘green power’and energy efficiency. Energy policy, 31(15), 1661-1672.

Zetzsche, D., & Preiner, C. (2018). Cross-Border Crowdfunding: Towards a Single Crowdlending and Crowdinvesting Market for Europe. *European Business Organization Law Review*, *19*(2), 217-251.

Zhan, M., Anderson, S. G., & Scott, J. (2006). Financial knowledge of the low-income population: Effects of a financial education program. J. Soc. & Soc. Welfare, 33, 53.

Zhang, F., Wang, X. H., Nunes, P. A., & Ma, C. (2015). The recreational value of gold coast beaches, Australia: An application of the travel cost method. *Ecosystem Services*, *11*, 106-114.

Zhu, N. (2002). The local bias of individual investors.

Zinaman, O., Aznar,A., Linvill,C., Darghouth,N., Dubbeling,T., and Bianco, E.(2017), Grid-Connected Distributed Generation: Compensation Mechanism Basics, NREL, Golden, CO, https://www.nrel.gov/docs/fy18osti/68469.pdf

Zott, C., Amit, R., & Massa, L. (2011). The business model: recent developments and future research. *Journal of management*, *37*(4), 1019-1042.

APPENDICES

Appendix A: Choice Survey Questionnaire

UNIVERSITY OF DUNDEE

CENTRE FOR ENERGY PETROLEUM AND MINERAL LAW AND POLICY

INVESTOR PREFERENCES FOR RENEWABLE ENERGY INVESTMENTS IN GHANA

A SURVEY OF OPINIONS

SEPTEMBER 2017

INTRODUCTION

For many countries in Sub-Saharan Africa, reliability of electricity supply is a recurring challenge. Ghana is no different and has experienced its own share of unreliable power supply which was dubbed "*dumsor*". Ensuring reliability of power supply for a growing population in most countries in the sub-region requires investment in power generation infrastructure which in most cases has been inadequate.

The increasing attention being paid globally to securing supply in a clean and sustainable manner has made renewable energy a key part of providing power for the now and for the future. Renewable energy sources like solar, wind, hydro, tidal and wave power and household and agricultural waste are being harnessed all over the world through the investment in renewable energy technologies.

Investing in local renewable energy has many benefits. These include the use of abundant natural resources, reducing the reliance of fossil fuel imports and the creation of jobs.

In Ghana, government has committed to improving the share of renewable energy in the mix to 10% (300 MW) of current electricity mix. This will require an all-hands- on- deck approach to investment in renewable energy and private investment by citizens individually or as part of a group is a trend observed in some developed countries.

This survey aims to find out the conditions and factors under which citizens would like to invest in small-scale grid connected renewable energy projects in Ghana. More specifically, this study will investigate the factors that will shape citizen decision-making regarding investment in a **small-scale grid connected solar project** in Ghana. The results of this study will shape discussions and policymaking regarding citizen investment in renewable energy in Ghana and in the African sub-region.

INFORMED CONSENT

We would like to ask you to participate in this survey of the preferences of citizens/households for renewable energy investments.

The objective of this research is to gain a better understanding of the preferences of households as regards renewable energy investing.

Participation in this study is entirely voluntary. Survey completion takes 15 minutes. Your name or any other personal identifying information will not be collected.

The information gained from this survey will only be used for the above objectives, will not be used for any other purpose and will not be recorded in excess of what is required for the research. There are no known or anticipated risks to you as a participant in this study.

If you have any questions regarding this study or would like additional information please contact Bridget Okyerebea Menyeh, University of Dundee, PhD Candidate and Principal Investigator, at b.o.menyeh@dundee.ac.uk

By filling in this survey you indicate that you understand its purpose and consent to the use of the data as indicated above.

Thank you for your cooperation

Bridget O. Menyeh, PhD Candidate

University of Dundee

* I agree with the use of my responses for research purposes in the project as outlined above.

- ☐ Yes
- ☐ No

Thank you for consenting. Please proceed to the next page and answer as accurately as you can.

BEGINNING QUESTIONS (1)

This first section is to help us understand the level of experience and knowledge you have about investing. This is to provide information about respondent's style and nature of investing and how it fits into the Ghanaian population of investors. Thank you.

* Who makes direct investment decisions for your household?

A. Myself
B. Other person in household
C. Joint with spouse or partner
D. Decline to answer
E. Other (please specify)

* Which of the following words describes your investing style (choose all descriptions that apply):

A. Novice
B. Experienced
C. Rare
D. Occasional
E. Often
F. High risk
G. Balanced risk
H. Low risk
I. Only Returns matter
J. Recreational investor (Invest as a hobby)
K. Socially responsible (care about the impact social impact of investment)
L. Others (please specify)

BEGINNING QUESTIONS (2)

*Suppose you had **GH¢**1000 in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow?

F. More than GH¢1020
G. Exactly GH¢ 1020
H. Less than GH¢1020
I. Do not know
J. Decline to answer

* Which is the riskier asset to invest in?

F. A single company share
G. A portfolio of different company shares
H. The risk is the same
I. Do not know
J. Decline to answer

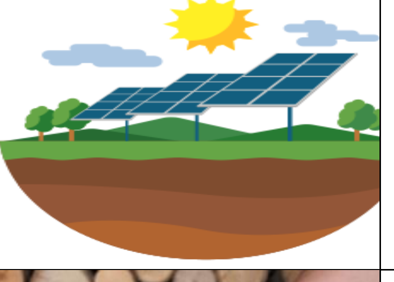
*Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, how much would you be able to buy with the money in this account?

F. More than today
G. Exactly the same
H. Less than today
I. Do not know
J. Decline to answer

BEGINNING QUESTIONS (3) – TECHNOLOGY TYPE

Please rank the following technologies from 1 to 4 according to **your preference** with 1 being the most desired and 4 being the least desired technology.

Please rank the following technologies from 1 to 4 according to **your preference** with 1 being the most desired and 4 being the least desired technology.

Technology	Image	Rank
Hydro		
Wind power		
Solar		
Biomass		

INVESTMENT CHARACTERISTICS UNDER STUDY IN THIS SURVEY

This survey looks at six characteristics that have been known to influence investment decision making regarding renewable energy investments. These are

1. Return on investment
2. Track record of project developer
3. Origin of project developer
4. Cost of Investment
5. Project Viability
6. Holding Period

What Do These Characteristics Mean?

Return on Investment: This is a measure of how profitable the investment is. A high return denotes high reward and vice versa for a low return.

Track record of developer: This captures the experience or achievements of the developer in delivering similar projects in the past. This is a subset of the overall reputation of the developer

Origin of project developer: This refers to where the firm developing the power plant originates from. In this study, the options under consideration are domestic (local) or foreign (international). This is also a subset of the developer reputation characteristic.

Price of Investment: This is the minimum amount required to partake or own a share in the investment.

*Project Viability***:** This is a measure of how a project will survive, remain profitable and grow. For power projects, certain rights and guarantees enhance the viability of a project and the more of these guarantees exist for a project, the greater the likelihood of it surviving and remaining profitable. These include the **right to grid access**, **a guaranteed feed-in-tariff (FiT)**, **investment subsidies** and a **long-term contract (ltc).**

Holding Period: This is the time between purchasing of the investment and when it can be sold.

STEPS IN A CHOICE SURVEY

The remainder of this survey consists of a **three step** Choice Experiment.

Step One: On the following page we are going to present a **SCENARIO** where you have money to invest.

Step Two: We are then going to describe different types of financial investments you could make with that money.

Step Three: After that you will be presented with **EIGHT** choice cards. On each choice card you will be asked to indicate which investment you would most want to make. Also, you will be asked to indicate which of the investments you consider the least desirable.

By combining your answers with all the other answers given by people taking this survey we are able to develop an understanding of what characteristics of investments are most valuable or important to the people who have responded.

THE SCENARIO AND OPTIONS

Please imagine you have GH¢1000 to invest in a **grid connected solar photovoltaic power project** or use to buy 91 day treasury bills. The GH¢1000 is money you have saved from your salary with an intention to invest it.

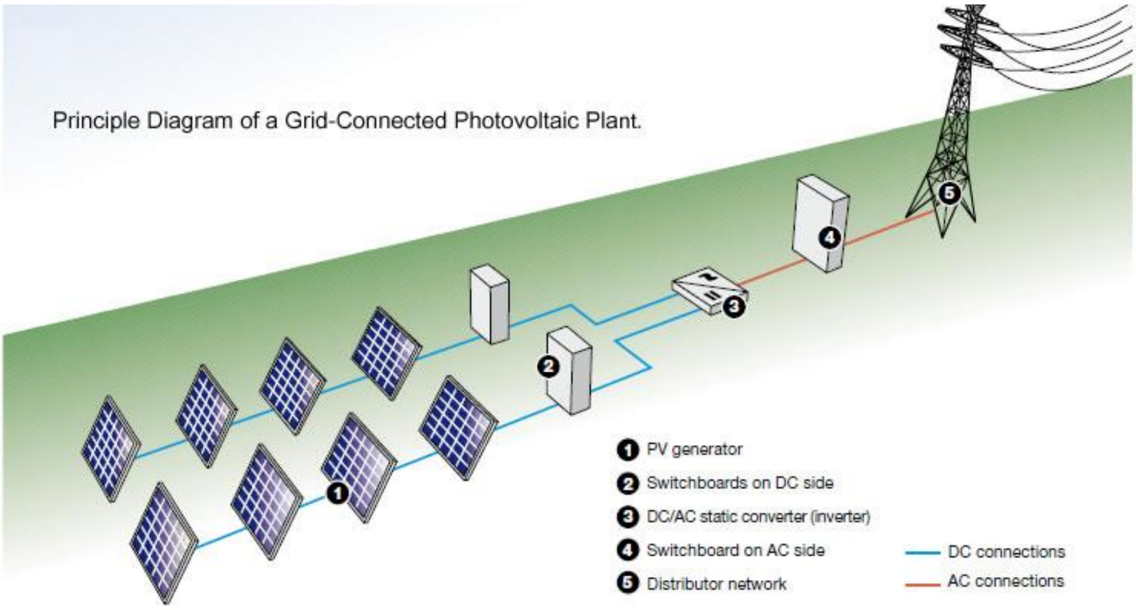


Fig 1: Diagram of a grid connected photovoltaic plant (Clean energy brands, 2017)

You are required to indicate how you would invest this money from the selection of investment options provided with the assumption that you can make at **least one potential investment**. Later on in this survey, you will come across several different choice cards and be asked how you choose to invest this money. On each choice card you have the option to invest in the power project (o*ption or B*) or in a *91-day government treasury* bill or *None.*

The investment options differ by the **return on investment, developer reputation (track record and origin of developer), cost of investment, project viability and holding period** as explained above. The characteristics have varying levels associated with them which can be found in the table below.

INVESTMENT CHARACTERISTICS AND LEVELS

1. Return on investment

5% p.a.	**8% p.a.**	**11% p.a.**	**14% p.a.**	**17% p.a.**

2. Developer Reputation

a) Track record

None *This is the first project being undertaken	**Some** *Executed five similar projects in the past	**Lots** * Executed more than 5 similar projects in the past

b) Origin of developer

Domestic (Ghanaian)	**International** (Foreign)

3. Cost of investment

350 GH¢	**500 GH¢**	**650 GH¢**

4. Project Viability

Low (Right to grid access)	**Moderate** (Grid access + FiT)	**High** (Grid access+ FiT +Investment subsidies)	**Very high** (Grid access + FiT Investment subsidies + long term contract)

5. Holding Period

9 months	**18 months**	**27 months**	**36 months**

RANKING OF CHARACTERISTICS

Having been informed of the characteristics and their meanings under this study, please rank the characteristics from 1 to 5 based on their **importance to you** in making an investment decision: 1 being the most important and 5 being the least important.

Characteristics	Rank
Track record of developer	
Cost of investment	
Return on investment	
Project viability	
Origin of project developer	
Hold time	

THE CHOICE EXPERIMENT

On this and each of the following pages you will be given a Choice Card with the investment characteristics and associated levels. You are required to choose the option that you are **most** and **least** likely to invest in. Thank you!

CHOICE CARD BLUE

Characteristics	**Option A**	**Option B**	**Option C**	**Option D**
Track record of developer	None	Some	Invest in Treasury bills at 12% for 91 days	None
Origin of developer	Domestic	International		
Cost of Investment	500GH¢	500GH¢		
Return on Investment	17%	14%		
Viability	Low	Low		
Hold Time	18 months	9 months		

In which option would you **most likely** invest**?**

- ☐ A
- ☐ B
- ☐ C
- ☐ None
- ☐ Decline to Answer

In which option would you be **least likely** to invest**?**

- ☐ A
- ☐ B
- ☐ C
- ☐ None
- ☐ Decline to Answer

CHOICE CARD YELLOW

Characteristics	Option A	Option B	Option C	Option D
Track record of developer	Lots	Some	Invest in Treasury bills at 12% for 91 days	None
Origin of developer	Domestic	Domestic		
Cost of Investment	500GH¢	350GH¢		
Return on Investment	14%	17%		
Viability	Low	Moderate		
Hold Time	36 months	36 months		

In which option would you **most likely** invest**?**

- ☐ A
- ☐ B
- ☐ C
- ☐ None
- ☐ Decline to Answer

In which option would you be **least likely** to invest**?**

- ☐ A
- ☐ B
- ☐ C
- ☐ None
- ☐ Decline to Answer

CHOICE CARD GREEN

Characteristics	**Option A**	**Option B**	**Option C**	**Option D**
Track record of developer	Lots	Lots	Invest in Treasury bills at 12% for 91 days	None
Origin of developer	Domestic	International		
Cost of Investment	500GH¢	350GH¢		
Return on Investment	8%	5%		
Viability	High	Moderate		
Hold Time	9 months	18 months		

In which option would you **most likely** invest**?**

- ☐ A
- ☐ B
- ☐ C
- ☐ None
- ☐ Decline to Answer

In which option would you be **least likely** to invest**?**

- ☐ A
- ☐ B
- ☐ C
- ☐ None
- ☐ Decline to Answer

CHOICE CARD RED

Characteristics	Option A	Option B	Option C	Option D
Track record of developer	Lots	Some	Invest in Treasury bills at 12% for 91 days	None
Origin of developer	Domestic	International		
Cost of Investment	350GH¢	350GH¢		
Return on Investment	11%	11%		
Viability	Very High	Low		
Hold Time	9 months	9 months		

In which option would you **most likely** invest**?**

- ☐ A
- ☐ B
- ☐ C
- ☐ None
- ☐ Decline to Answer

In which option would you be **least likely** to invest**?**

- ☐ A
- ☐ B
- ☐ C
- ☐ None
- ☐ Decline to Answer

CHOICE CARD ORANGE

Characteristics	Option A	Option B	Option C	Option D
Track record of developer	None	None	Invest in Treasury bills at 12% for 91 days	None
Origin of developer	International	International		
Cost of Investment	500GH¢	350GH¢		
Return on Investment	8%	14%		
Viability	Moderate	High		
Hold Time	9 months	18 months		

In which option would you **most likely** invest**?**

- ☐ A
- ☐ B
- ☐ C
- ☐ None
- ☐ Decline to Answer

In which option would you be **least likely** to invest**?**

- ☐ A
- ☐ B
- ☐ C
- ☐ None
- ☐ Decline to Answer

CHOICE CARD PURPLE

Characteristics	Option A	Option B	Option C	Option D
Track record of developer	Some	Some	Invest in Treasury bills at 12% for 91 days	None
Origin of developer	Domestic	International		
Cost of Investment	650GH¢	350GH¢		
Return on Investment	8%	8%		
Viability	Very High	Low		
Hold Time	18 months	27 months		

In which option would you **most likely** invest**?**

- ☐ A
- ☐ B
- ☐ C
- ☐ None
- ☐ Decline to Answer

In which option would you be **least likely** to invest**?**

- ☐ A
- ☐ B
- ☐ C
- ☐ None
- ☐ Decline to Answer

CHOICE CARD BROWN

Characteristics	**Option A**	**Option B**	**Option C**	**Option D**
Track record of developer	Some	None	Invest in Treasury bills at 12% for 91 days	None
Origin of developer	International	Domestic		
Cost of Investment	500GH¢	350GH¢		
Return on Investment	5%	8%		
Viability	Very High	Low		
Hold Time	36 months	36 months		

In which option would you **most likely** invest**?**

- ☐ A
- ☐ B
- ☐ C
- ☐ None
- ☐ Decline to Answer

In which option would you be **least likely** to invest**?**

- ☐ A
- ☐ B
- ☐ C
- ☐ None
- ☐ Decline to Answer

CHOICE CARD GREY

Attributes	**Option A**	**Option B**	**Option C**	**Option D**
Track record of developer	None	Some	Invest in Treasury bills at 12% for 91 days	None
Origin of developer	Domestic	Domestic		
Cost of Investment	350GH¢	500GH¢		
Return on Investment	5%	11%		
Viability	Low	Low		
Hold Time	9 months	18 months		

In which option would you **most likely** invest**?**

- ☐ A
- ☐ B
- ☐ C
- ☐ None
- ☐ Decline to Answer

In which option would you be **least likely** to invest**?**

- ☐ A
- ☐ B
- ☐ C
- ☐ None
- ☐ Decline to Answer

THANK YOU… ALMOST DONE!

DEMOGRAPHIC INFORMATION

Just a few simple questions about you. We assure you that information provided will be anonymised, so it cannot be traced to one individual.

Providing this information will really help us better understand and interpret this research properly as well as capture the variety of individuals or groups that have participated.

What is your gender?

A. Female
B. Male
C. Prefer not to say

What is your job or occupation? Please choose from the groupings provided.

A. Managers/Legislators
B. Professionals
C. Technicians and associate professionals
D. Clerical support workers
E. Service/Sale workers
F. Skilled agricultural and fishery workers
G. Craft and related trade works
H. Plant machine operators and assemblers
I. Elementary occupations
J. Prefer not to say
K. Other occupations

What is your age?

A. 18 to 24 years
B. 25 to 34 years
C. 35 to 44 years
D. 45 to 54 years
E. 55 to 64 years
F. Age 65 or older
G. Prefer not to say

*What is your highest level of education attained?

A. Below University Degree/Diploma
B. University Degree/Diploma
C. Master’s Degree
D. Above Master’s Degree
E. Prefer not to say

*What is your average household income level per year? Here is a scale of incomes. We would like to know in what group your household is, counting all wages, pensions and other incomes that come in. Just give the letter of the group your household falls into, before taxes and other deductions.

A. Less than 15,000 GH¢ **[Band excluded in survey]**
B. 15,001 to 25000 GH¢.
C. 25,001 to 35,000 GH¢.
D. 35001 to 45000 GH¢.
E. 45,001 to 55,000 GH¢.
F. 55,001 to 65,000 GH¢.
G. 65001 to 75,000 GH¢.
H. 75001 to 85,000 GH¢.
I. More than 85,000 GH¢.
J. Prefer not to say

THANK YOU FOR COMPLETING THIS SURVEY

****

Appendix B: Focus Group Materials

A. Focus Group Questionnaire

Introduction

In order to create a comfortable, positive and welcoming atmosphere, a series of actions will be taken. These are as follows:

Welcome participants with tea and biscuits.

Filling out consent forms and demographic survey

Introduction of focus group team that is, Moderator and assistant

Purpose of focus group

Establishment of ground rules

a) Everyone is encouraged to participate fully (we want to hear everyone's view)
b) There is no right and wrong answer
c) Respect for views and opinions of others
d) Session will be tape recorded. Any views or opinions expressed during the focus group will be confidential and anonymised.

Introduction of participants and setting up of name tents.

Ice – breaker

"If you had a limitless budget, what two things would you do"?

1. **Engagement questions: introduce participants to and make them comfortable with the topic of discussion.**

What do you think about Dumsor (erratic power supply)? In what ways has it affected you?

What initiatives have you or others taken to reduce the impact?

How do you think citizens, or you can help with the power situation?

2. **Exploration questions**

Attributes that affect renewable energy investments

What types of renewable energy do you know about? Get names and get clarification on what they mean. This will be done in the group and answers written on a flipchart.

What I want you to think about is what characteristics of each type of energy are either good or bad.

I want you to imagine if you had a budget of GH100 - what energy types would you invest your money in? What characteristics do you like about these technologies?

If you were offered an opportunity to invest small amounts of your saving in a renewable energy power plant whose power will be put into the grid, what would you typically consider before you investment.

Potential responses:

- *Risk*
- *Return*
- *Investment model*
- *Technology type/ source of renewable energy*
- *Developer reputation*
- *Phase of project (associated with different risks including regulatory risks, administrative risk, grid access risk, market design and regulatory risk, sudden policy change risk i.e., retroactive or sudden change in support schemes)*
- *Project duration*
- *Developer reputation*

How do you invest your savings now?

What are some of the initiatives or projects you or others had to bring money together for? How was this money collected?

Have you heard of crowdfunding? *If participants have not, explain what it is and how it works*. Does that sound like something you might use and be engaged in?

If participants have, What do you know about it? Good? Bad?

Do you know anyone who has used this method? What was their experience? Have you considered using it? Please explain.

How would you find it if the contributions were collected online through a payment platform on the internet? Why?

3. **Exit question: check to see if anything was missed in the Discussion**

Let's summarize some of the key points from our discussion. Is there anything else?

Do you have any questions?

Thank you for your time.

B. Focus Group Demographics Form

Please note: ALL INFORMATION IS ANONYMOUS. NO IDENTIFYING INFORMATION IS BEING COLLECTED. THIS INFORMATION IS VITAL TO THE RESEARCH ON INVESTMENT PREFERENCES. No meaningful results can be found without knowing these characteristics of households and investment decision makers.

❖ What is your gender?

☐ Male
☐ Female
☐ No answer

What is your job/occupation?

☐ No answer

☐ Job/occupation

❖ What year where you born?

☐ No answer

☐ Year

❖ What is your level of education?

☐ Below tertiary

☐ Tertiary/University degree

☐ Master’s Degree

☐ Above Masters

☐ No answer

❖ What is your average monthly income per household?

☐ Less than GHS4000

☐ 4000 -- 6000 GHS

☐ 6000 – 8000 GHS

☐ More than 10,000 GHS

☐ No answer

THANK YOU FOR COMPLETING THIS SURVEY

C. Participant Information Sheet – Focus Group

Achieving Universal Electricity Access in Sub-Saharan Africa: The Role of Crowdfunding by Households in Bridging the Investment Gap

Dear Sir/Madam,

You are invited to participate in an academic research project conducted by Ms. Bridget Menyeh, a PhD candidate of the University of Dundee, under the supervision of Dr. Ariel Bergmann, also of the University of Dundee. The research aims to understand the preferences of individuals for renewable energy investments through crowdfunding. The focus group aims to elicit citizen perception, attitudes and beliefs when faced with an opportunity to make small investments into renewable energy power projects in the country using an online platform. Simply put, what factors or attributes will make them invest or otherwise in such a project. The information learned in this would be used to design a choice survey for the main study that would include a greater number of Ghanaians.

The study is timely and important as the country is often plagued with electricity supply shortages and citizen owned power projects have proven beneficial in other countries in adding to supply capacity and greater involvement of citizenry in energy policy.

Your participation in this study is entirely voluntary. If you do agree to take part in the study, the researcher will conduct a group interview (focus group) with you and about six to nine others. The session will last about 1hour 30minutes. With your permission, the focus group sessions will be audio recorded only and transcribed. If you feel at any point like stopping either the group interview, please feel free to do so.

There are no right or wrong answers to the focus group questions. We want to hear many different viewpoints and would like to hear from everyone. We hope you can be honest even when your responses may not be in agreement with the rest of the group. In respect for each other, we ask that only one individual speak at a time in the group.

The information you provide is confidential. Only anonymised information will be used in the PhD thesis, and in any other reports or publications. Your name or any other personal identifying information will not appear in any publications resulting from this study; neither will there be anything to identify your place of work or the projects you are involved in. The information gained from this survey will only be used for the above objectives, will not be used for any other purpose, and will not be recorded in excess of what is required for the research. Even though the study findings may be published in the PhD dissertation, international conferences and journals, only the researcher and the PhD supervisor, will have access to the interview data itself. We will both be bound by the principles outlined above. All the study data will be appropriately held securely on the researcher's University issued laptop, and will be deleted at the end of the researcher's PhD studies. There are no known or anticipated risks to you as a participant in this study.

Funding for this research is being provided by the Ghana Education Trust Fund and the study has been reviewed and approved by the University of Dundee Research Ethics Committee.If you have any questions regarding this study or would like additional information please contact Ms. Bridget Okyerebea Menyeh, PhD candidate and principle investigator for this project, University of Dundee, at b.o.menyeh@dundee.ac.uk.

Please sign the consent form attached to this letter to indicate that you have read and understood the information contained in this letter, and that you agree to participate in the study.

Thank you for your kind cooperation.

Ms. Bridget Okyerebea Menyeh

D. Consent Form

Achieving Universal Electricity Access in Sub-Saharan Africa: The Role of Crowdfunding by Households in Bridging the Investment Gap

This focus group study aims to look at what citizens would consider if they were offered an opportunity to make small investments into renewable energy power projects in the country using crowdfunding. Simply put, what factors or attributes will make them invest or otherwise in such a project. The information learned in this study would be used to design a choice survey for the main study that would include a greater number of Ghanaians.

By signing below you are indicating that you have read and understood the Participant Information Sheet and that you agree to take part in this research study. Any information you provide is confidential; and only anonymised information will be used in the PhD thesis, and in any other reports or publications.

Please also indicate whether or not you:

Agree to the audio recording of the interview YES ☐ NO ☐

Agree to the use of anonymous extracts from your interview in conference papers and academic publications YES ☐ NO ☐

______________________________ ________________

Participant’s signature Date

Participant's name

Signature of person obtaining consent

Date

Name of person obtaining consent

Appendix C: Report of Focus Group Discussions in Ghana

BY: BRIDGET OKYEREBEA MENYEH

PhD CANDIDATE

MAY 2017

1. INTRODUCTION

This report details the outcome of focus group discussions aimed at investigating the preferences of citizens for renewable energy power investments through crowdfunding in Ghana. Ghana has in times past been faced with security of supply shortages due to a growing demand coupled with a lagging of additional supply capacity. In developed countries, there is an increasing wave of citizen involvement in the power sector especially in the investment in power generation activities for a low carbon transition. In the similar vein, this thesis would like to investigate the role citizens can play in contributing to renewable energy power investments through crowdfunding. At the heart of that is understanding the preferences and motivation of citizens and focus groups are known to produce rich, context specific information to complement research design and outcome.

The report is divided into two major sections: a detailed description of the methodology, and an explanation of key findings. This is interspersed with excerpts and quotes form the focus group interviews to reflect participant thought and provide the needed context. The methodology section outlines the rational and design of the focus group interviews as well as some background knowledge on participants and the questions asked.

The findings are grouped under 3 main headings. In this report, the first part sought to obtain information on how participant see and manage the recurrent power crisis, the second seeks to glean obtain participant knowledge on renewable energy technology and how their preferences for renewable energy investments. The third session sought to assess participant knowledge on crowdfunding as well as their perceptions about online financial transactions.

2. METHODOLOGY

This section explains the method that was used to elicit participant responses and why this was done. In the development of a choice survey, one of the most important step is the identification attributes and the assignment of levels. This step done right ensures that the results are valid and relevant to the study. Attributes as themes concerning the subject or study can be gathered using interviews, group discussions, expert opinions or a literature review (Coast and Horrocks, 2007). The choice of which combination to use depends on the context and aim of the study being undertaken (Louviere *et al.* 2000). According to Coast *et al.* (2012), attributes obtained from literature alone, though easy may not be exhaustive or relevant to the context of the study. He reckons that to refine and have the relevant attributes for the study, the target population whose preferences will be sought in the final experiment must be consulted on what attributes are plausible and best reflects their local perspectives. In this study, focus groups were used to draw out themes related to participant's attitudes and motivations towards the financing of renewable energy projects through crowdfunding.

According to Krueger and Casey (2014), focus groups afford the researcher an opportunity to uncover people's attitudes, experiences and biases and this is important for interpreting some trends in survey data which often do not say why. The interaction between participants allow the researcher to zoom in on things he otherwise had not thought about relating to the study.

3. PARTICIPANTS AND PROCEDURES

Focus groups were held in January 2017. A total of three focus groups were conducted. Groups consisted of 6 to 7 persons and each focus group lasted an average of 60 – 75 minutes. Purpose sampling was used to recruit participants making sure that they satisfied the income requirements. In the recruitment, participants were either met face to face or a preliminary telephone call was used to assess interest. This was in all cases followed by an email containing all the relevant materials concerning the study. A few days before the focus groups, participants were sent a reminder email and telephoned to reconfirm attendance. Usually about nine to ten people are invited. There was in all cases about a 30% drop out rate before the day of the event.

Using an open-ended interview protocol, the group discussion was led by the facilitator (lead researcher) with the assistance of a graduate student of the University of Ghana who took notes. Interview questions was developed by the researcher with input from Supervisor and the University of Dundee Research Ethics Committee.

Informed consent was highlighted in the all communications preceding the focus groups and later explained at the beginning of each of the focus group and consent forms (see Appendix) distributed for signature. All focus groups were tape recorded with the permission of participants. Participants were also assured of confidentiality in the report of focus group results and all future reports generated form this study.

4. DATA ANALYSIS

Focus group interview tape-recordings were transcribed using Nvivo and subjected through phases of coding and analysis. A general analysis was done to get a sense of what the data was saying and later analysis was done to bring out the necessary themes bearing in mind the objectives and aim of the study. Key findings represent the main topics that emerged after analysis of the three main segments of the interview.

5. KEY FINDINGS

Analysis of focus group interview transcripts revealed several key findings regarding the preferences of citizens in investing in renewable energy power projects through crowdfunding. These finding include:

The findings are elaborated below. A description of the major themes is interspersed with participant narratives about their perception and experiences to provide context and enhance understanding. It is noteworthy to mention that when a quote is used, it has been chosen purposefully and not randomly to paint a clear picture of the finding.

5.1 THOUGHTS ABOUT 'DUMSOR' (ERRATIC POWER SUPPLY) AND MEASURES TO IMPROVE IT

- Overall perception that erratic power supply has negative impacts on personal and societal living
- Necessitated measures by citizens to adapt in more ways than one.
- Energy efficiency was mentioned by most participants as a way citizens can help
- Government leadership was considered important in reversing the situation

Focus group participants were first asked to talk about what they thought of the erratic power situation in the country popularly known as "dumsor" which translates into on-off. All participants described "dumsor" as a *negative phenomenon* that should not have happened and must not be allowed to persist.

In participant narratives of how they perceived dumsor, some described it as "*unacceptable", "terrible" and …. "more of a hell".* Narratives about how participants' perceived dumsor was usually accompanied by personal experiences of how it affected their daily lives and interactions. In addition to that, majority bemoaned the effect of business citing increased operational costs as well as an increase in unemployment as a result. Two participants however had some more to add to demonstrate that the situation inured to some benefit for a group of people. One believed the phenomenon was "*politically motivated*" to ensure people make money off the sale of generators which is government funded. The other suggested that the situation improved family interaction as members are forced to talk and interact with each other in the absence of a powered television and other gadgets that competed.

Most participants discussed their experiences by incorporating initiatives they undertook to adapt to the situation. This included the proper planning for when power was available, buying of diesel generators, instalment of solar system or the use of solar lamps. In one of the focus group sessions, the participant showed others a phone he had bought to ensure he stays connected during the power crisis. He mentions that "…..*On a personal level, I had to buy this phone. You charge it once a month if you don't use the radio or lamp and just receive and make calls, it could last a month. So you get your important calls…..so we made adjustments"*

In discussing what citizens could do to help the power situation in the country as the many understood it to a problem of increasing electricity demand and lagging supply, majority of participants mentioned the need to *conserve power* by changing consumer behaviour and the use of energy efficient gadgets. This outcome is consistent with some studies that have sought to understand the choice of citizens between investing in renewable energy and energy efficiency measures. For example, this was seen in Zarnikau (2003) who found that energy efficiency was prioritised over renewable energy support when electric utilities in Texas conducted a poll.

One of the participants in the sessions however did not think changing consumer behaviour by putting some gadgets off when not in use can help the situation significantly. She blames electricity theft through *illegal connection* in some suburbs and the inability of authorities to ensure checks and so the right thing. She explained:

"*Seriously I do not believe that all of us trying to put one bulb or the other off will solve* *the problem. I don't know why but I don't believe it. I think it is rather structures and those in authority who are not doing the right thing. For example, if there could be a whole community like Nima and those areas. They can't even go there to collect their monies or even arrest them because the whole of the community has connected illegally. So how you say that one bulb or two bulb one fridge that is not off……..*"

Other participants within the group agreed fully adding their own narratives. One added that "*….the leakages, I can tell you I know people, not just in Nima but East Legon. I have a neighbour who has AC on every evening but does not pay electricity in East legon. He uses AC, me I can't use AC. But the guy uses AC every evening today today. Because he can't afford. With the current electricity bill he can't afford."* By adding this, he sought to explain that electricity theft was not restricted to zongo or slum areas (Nima) but also areas where the elite and middle class are perceived to reside (East Legon). Another participant added that "*What I think we need to focus on which you can help are the people who are stealing the power. That one is about 12%. Are you getting it? If let's say you and I report such people and we are able to collect such monies."* The 12% he mentions refer to commercial or distribution losses which if tackled can help the power situation.

Consistent with the viewed expressed above was the need for Government and its agencies to show leadership and take control. One participant explained that Governments over time are to blame for the recurring predicament. He states:

> "*As for the government institutions I know the kind of waste that goes on. People want the cleaners to switch on air conditioners before they, the workers get to the office. So if the cleaner comes at 6 am and works starts at 8:30am, it means the air conditioner will be on for two and half hrs. Looking at this waste, it is money and government is the biggest client the energy sector has and they owe them the largest amount. They are the ones that even put us into this problem because of their debt to these companies in the energy sector*."

Another participant who works with a non- governmental organisation with renewable energy project activities, stated

"*I think it is more of governance problem than we the citizens directly maybe various* *agencies can help here and there. Energy Commission was trying to pilot a programme where people have their own solar panels and feed into the grid so my organisation actually keyed into that. So far, I don't see much happening on that scale but it could have been a good thing. So from the part of Energy Commission they could actually manage this thing well. We did our part but what next. Some of these policies or interventions start but dont move forward".*

Another added that:

"*.... I think that as citizens we can do much but the government must give leadership. When the dumsor crisis was ongoing, I think I read something about Morocco investing in solar...very expensive. Probably government will say I don't have money to do that but we must start from somewhere. And you can float shares for citizens to buy... the little money that this person gives and that person gives can do something*".

Two other participants also thought that citizens can invest in low carbon technologies with support and subsidies from government further echoing the role of government in facilitating this transition. In other session, two participants encouraged the generation of power by citizens citing some working example they have been told about in some private estates in Ghana. They narrate that the estate developer generates power and bills residents for it. They reckon it is a model that can work with proper regulation and monitoring.

5.2 RENEWABLE ENERGY TECHNOLOGY AND INVESTMENT CHOICES

<u>Solar PV is the most known and trusted among participants</u>
<u>Return, Cost of Investment and Developer Reputation are the top 3 factors considered by investors</u>
<u>Environmental concerns featured poorly in investment decision</u>
<u>Treasury bills and investing in land is considered good investment with good returns</u>

Day to day living is full of choices and more so when it has to do with finite resources like money. Investment choices by investors whether objective and/or subjective are based on the attribute of the investment product. For renewable energy investments, the type of renewable energy is usually is documented by many studies as affecting consumer willingness to pay or invest. See Bergmann *et al.* (2006), Borchers *et al.* (2007) and Noblet *et al.* (2015).

Choice of Renewable Technology

Considering the connection between the type of renewable energy technology and the willingness to invest, focus group participants were asked about their knowledge and sentiments about the renewable energy technologies they know about.

Participants in each focus group were asked to mention some renewable energy technologies and the answers were written on a flipchart by the moderator. Technologies mentioned include solar, wind, biomass, hydro and geothermal. **Majority of participants across all focus groups were most conversant with solar with some already owning the technology in form of small installation and lamps.** In one of the focus groups, the conversation led to participants being asked to choose their best three (3). All participants mentioned **solar and biomass** as part of their choices. The others mentioned were mini-hydro and wind. Wind is known as being a renewable energy resource but appeared unfamiliar to some participants. One participant gave this reason to explain why wind does not make it in her top three renewable technologies for Ghana. She said:

"I don't see any wind that blows in Ghana... to be frank! The weather is still in my house"

To investigate their interests further, participants were asked what technologies they would invest a sum of 100GH cedis (25 dollars) in if they had to choose. Participants had difficulty understanding this as many thought this amount was small to make any impact in funding any of these technologies. The moderator explained that the amount was to gauge their affinity for the technologies further and not to skew their interests from one they liked to another based on the fact that the amount could not finance that technology. It was further explained that the projects will most likely be crowd financed and that all options were on the table.

With this understanding, participants proceeded to make their choice. **Here also, majority of the participants chose solar PV technology as where they would invest**

their money. Two participants opted for a combination of solar, wind and mini-hydro, splitting their investment among all three. A combination of biomass and wind as well as biomass only was also recorded amongst the choices. **This exercise supports the hypothesis that participants allocate their resources based on their a priori knowledge and experiences about renewable technology type and this affects their investment decisions.**

Attributes to considered before making an investment

Going further and to the main point of the study which seeks to understand the key attributes, potential investor would consider before investing in a grid connected renewable energy projects, focus group participants were asked to individually write down the factors they would consider before choosing to invest in such a project. They are as follows:

The **rate of return** was the most mentioned attribute in all focus groups. From an investor's point of view, the main goal of investing is to maximise the return considering the risk. This outcome was not surprising as it is well documented.

The next most cited was the **cost of investment**. Further probing to ascertain what participants meant by that answers included "How much will it cost me overall to be part of that", "How much you are supposed to put in... like the value per share", "*How much I am getting and how much will it cost me to start*". In investment, upfront costs are usually the reference point for assessing profitability and returns and this is quite a rational outcome. According to Walker, (2008) high cost of investment are often obstacles in investing in renewable energy projects.

Developer reputation was also mentioned by participants as a key factor in shaping their willingness to invest. This was explained further by statements like *"Those behind the project. If they are credible. If they are not some DKM people"*. DKM is a microfinance company involved in a financial scandal in Ghana at the moment. This scandal has attracted the attention of the central bank and the main political parties in the country ("My gov't will probe DKM scandal – Akufo-Addo", 2016).

The issue of trust and truth worthiness is usually discussed with developer reputation and is a key concept in civic engagement and collaboration. Ostrom (2003) describes trust as a necessary ingredient for building strong and cohesive communities. Walker *et al.* (2010) also underscore the need for trust in community renewable energy projects. Last but not least, Kalkbrenner and Roosen (2016) in investigating the motivation behind community renewable energy project find that interpersonal trust features prominently in the non –financial motivations for participation.

Project feasibility placed highly after developer reputation in what participants would consider. This was rephrased as some participants as the viability of the project. How it was captured include:

"*The feasibility of running the project. You should know whether it will survive in the long term or how sustainable it will be in the long term*."

"Viability of the project. If I say viability… is it going to provide what we claim it is going to do?"

"What are the some of the things they have put in place to make sure the project materialises and lives overtime."

In one of the focus groups, this was written as proof of concept.

Environmental benefit/effect ranked after project feasibility in the factors participants would consider before investing in the project. However, it must be noted that this observation comes in at this spot due to its importance in one of the focus group sessions. Environmental effect as part of the decision to invest featured very poorly in the other two focus groups. In fact, it was not mentioned by the respondents in one session at all. The focus group session with majority of participants citing this factor in their investment decision had present or prior work engagements in the clean energy sector. Without this group, environmental effects would feature quite poorly in the decision making hierarchy. As explained in Brown (2001) and Hester (2001), this is usually not a key factor for consumers who are less informed about the externalities of conventional energy.

Government policy was mentioned in two of the focus group sessions. One of the participant explained that support and policy from government would influence his willingness to invest. He said "*All that they have said boils down to the policy commitment by government. We are talking about renewable energy here. The technology expertise we don't have in -country and we are not spearheading it. Has the country signed up to renewable energy conventions. Are they supporting households?"*

Government policy as well as the political environment is well documented in literature as either being a support or hindrance to local energy projects as well as renewable energy development (Bomberg and McEwen, 2012). According to Painuly (2001) and van Rooijen & van Wees, (2006), governments can provide information, institutional capacity and develop the necessary environment that fosters investment.

Payback period market demand and information/education provided featured least**.**

For payback period, the participant explained that he would want to know when he could get his money back in case he needed it for other things.

The participant who included **market demand** as part of his list explained it in these terms:

"Is there a need for it? Like we started with "dumsor", that means we have a challenge in the system. So it means it is something I can consider and invest in."

On the issue of education and information provided, the participant intimated that with available information on its structure, set up and operations is most likely to attract here investment. This is captured in a fragment of her explanation ..... *"we should know the whole system in and out".*

In one of the focus group sessions, one participant stated that he had no interest in such a project at all. Explaining why, he states that

"Not interested at all because the national system does not work... I will not get my money back .... I will not make such an investment"

How Savings are Invested Currently

Considering that citizen investment in grid connected renewable energy power project was something unfamiliar to most of the participants, they were asked about how the invest their savings at the moment to get a sense of their appetites for risk as well as what they considered to be a good return.

In all three focus groups, the most popular investment vehicle was treasury bills and land or real estate. Participants who were advocates of treasury bills alluded that it was basically risk free with returns between 18- 25% per annum. One participant had this to say about what he considered an attractive and worthwhile investment:

"Normally what Ghanaians will say is that anything at par or above T-bill rates is good for them. Any investment I do must be above T-BILL rates. Because with T-Bills there are no real risks because I give the money to government I am assured in 3 months or 6 months I will get this amount but yours there are risks to it so it must be more"

Another participant clearly stated that he considered himself "highly risk averse" and added that a return above treasury bill rate was not necessarily attractive to him considering the rate of inflation in the country. He was of the view that inflation can erase all the gains of an investment and this is well – documented in economic literature. He says "*…..so the simplest thing I do, is open a dollar account and put my money in a dollar savings account"* or farming. The view of the dollar as a safe haven in maintaining the purchasing power of one's savings was a trend recognised by the Central government of Ghana in times past and an *ad-hoc* measure devised to discourage it as it was creating more demand for the dollar and depreciating the cedi further. Another participant agreed to the attractiveness of dollar savings but adds that sometimes the authorities can "*hold it*" so no gains are made. Furthermore he add that the perception of dollar is more stable currency is making consumers consider dollar investments with dollar returns.

Other participants stated that they invest in land and real estate. One participant stated that land was the only investment he considered worthwhile because it appreciates over time. In his own words he explains:

"*If I look around, I invest in land and properties. That's what I do, that is the only thing that appreciates over time. You can buy land today and in the following month, you can* *sell for higher. So I don't invest in any... I have never even bought a treasury bill … no no no*"

The only problem evident in investment in land which is common knowledge and admitted by one of the participants is the issue of litigation which is a risk. The participant further add that once due diligence to reduce the risk of litigation happens and one has a land, the value can double every year.

Others also thought investment in fixed deposits and mutual funds was also attractive though it appeared that was more of a short term investment vehicle as can be seen from this statement "…. In *short terms savings, I do mutual funds*". Another said:

"*I did fixed deposit initially because he (bank staff) explained to me that anytime I need my money I just have to tell him and within 12 hours I get my money*"

Common Group Initiatives

Going further, participants were asked questions to map out whether contributing funds in a group for a common cause was something they do often and to explore the financial channels they explored. Most participants mentioned ways in which they had either contributed for security in their area or estate, as a family for a family project or a project by a school alumni group. The channels for collecting these monies was usually by mobile money, direct deposit or in person.

5.3 CROWDFUNDING AND PERCEPTIONS ABOUT ONLINE FINANCIAL TRANSACTIONS

<u>Trust and security are key in promoting the use of online financial transaction</u>
<u>Testimonial and reviews can help in certain instances</u>
<u>Mobile Money is a trusted and convenient method for online transaction in Ghana</u>

With many community energy projects crowdfunded by many people, questions were asked to assess the degree of crowdfunding knowledge. First of all participants were asked if they had ever heard of crowdfunding and whether they had used it before.

Majority of participants in all three focus groups had never heard of the term. The few that that thought they had were not sure if they really knew. In all three cases, the moderator had to explain what the concept of crowdfunding was and how it usually works.

When asked if it would be something they would engage in, participants generally resorted to two approaches.

a) The first suggested that a known avenue be exploited rather than an avenue the very “crowd” was unaware of.

Participants were keen to suggest mobile money as the avenue because they believed it was common and almost everyone owned a mobile money account. A count showed that all participants had a functioning mobile money account. Participants explained were confident with the application and shared instances when they have used their mobile money accounts. Additional evidence to suggest that the mobile money application was indeed entrenched is the the service is provided by almost every bank as attested by participants and bank services boards. It is undisputable that mobile money has become hard to ignore and now seen as a viable financial tool. They had this to say.

“*I pay things with it. When i buy something and my money is not enough I can use my mobile money to pay the rest and they receive it there and then*”

“I pay my seamstress through mobile money. It is really convenient.”

“*All the banks have now subscribed to mobile money*”.

“Now mobile money is giving interest on the amount in your wallet”

“Even insurance”

With the very positive vibe about mobile money, participants were asked if there were any downsides. “*Of course, systems sometimes go down*” was the answer given and there was consent from other participants.

b) Others suggested that it was something they were willing to consider however the discussion became an issue about online financial transactions which is key in discussing crowdfunding anyway.

Majority of participants asserted that the key issue in online financial transaction is the issue of trust and security. This was shown in statements such as: "*……That is the issue here... the trust. The fact that people know that if I am bringing my money out ... are they going to put it to good use".* Another participant said *"…Security, security that's the main thing, for me also security because I am very conservative".* Another added…*and then reliability of the source... if I am going to use a card I will have to be cautious"*

One participant expressed that he had little issues using crowdfunding or online platform for social giving but definitely not for investment saying: "*I will have a lot of hesitation for investment. For social if it is appealing I will just throw some money into it*. Throwing more light, the participant said that most Ghanaians even in the middle class struggle for some basic needs and thus are very cautious as to how they invest their savings. According to him, you will be investing your next rent or children's school fees and this is money one uses for taking "*funny risks*".

Apart from the issues of security, a few participant hinted issue of ease of use. He stated that

"*My challenge has always been the ease of use of such platforms. You want to donate now but if it is complicated to tend to just give up. So that's just the thing for me... but I have a few and you know if the platform is easy and I just do it and I am off or the end means must really motivate me to want to do it*"

Furthermore, he added that trusted platforms like PayPal also do not work in Ghana as he had challenges signing up though a friend asked him to.

Another participant added that aside the issue of security and credibility, one key problem is the confidence in the banking system. He explains that:

"*I think if you are not looking at what your money has been used for but you are* *concerned about the platform and security, what boosts confidence is just good laws in the banking system. If the banking system has assured me that if my account is hacked, there is evidence that it was hacked then the bank will refund my money to me, then I don't care I can do business on the internet. I mean people elsewhere put money in the bank because up to a certain amount you are secured*."

Other participants agreed adding that little glitches such as an faulty bank ATM transaction that is, no money dispensed but amount taking out of your account can take days and sometimes weeks to rectify. These frequent occurrences makes online banking more unattractive as banks will not take liability.
Key Recommendation from Participants include:

Assurance: Participants underscored the need for assurance from the platform owner. One said:

"So the only way to go about it is to get the platform owner to assure potential contributors that look, for this platform anybody that we are going to give your money to, this is what we are going to put in place. This is key in Ghana. And that platform owner must be credible".

a) *Avenue for face to face interaction:* A large majority of participants endorsed the need for face – face interaction in the allaying of fears associated with credibility. Heading nodding and verbal agreement was observed with this input.

"Personally, I would love some face to face"

Of course (face to face)

"This feedback please listen to it. It is key. Ghanaians love face to face"

b) *Education*: Some participants agreed that education on measures that have been put in place will do well to boost credibility and trust.

“*I think there will be a lot of hesitation... maybe a lot of education needs to be thrown in there. A lot of understanding needs to go into the modalities.*

How the tracking and monitoring is done.
How continual feedback is given.
How to know if a company is going out of business.
What is the insurance for your investment?”

c) *Reviews and Testimonials:* Participants in their discussion also added that testimonial or reviews from people -- better people you trust can be of immense help. One participant had this to say:

“*But I think one of the things that has helped me with the few places I have been to testimonials ... on the same page that someone comes and says this is reliable, this is super its gives a certain ..... But even that one we are still cautious.”*

Mobile Money: The endorsement of mobile money as a good avenue was endorsed by most participants in all sessions. It appears it has earned consumer points on security, ease of use and its integration into the current banking framework.

Appendix D: Other Statistical Information

Appendix D- 1 Mean annual household and per capita expenditure by quintile group

Quintile group	Mean annual household expenditure (GH₵)	Mean annual per capita expenditure (GH₵)	Mean household size	Percentage share of total expenditure
First (Lowest)	3,924	664	6.1	5.6
Second	5,833	1,194	5.0	10.0
Third	7,444	1,761	4.4	14.6
Fourth	9,238	2,656	3.6	21.9
Fifth (Highest)	14,665	6,337	2.6	47.9
Ghana	**9,317**	**3,117**	**4.0**	**100.0**

Source: Ghana Living Standards Survey (GLSSS 6)(2014, page 135).

Appendix D-2 Mean annual household income by quintile by region

	Quintile							
Region	1	2	3	4	5	All	Mean annual household income (GH₵)	Mean annual per capita income (GH₵)
Western	11.6	16.4	17.9	25.2	28.9	100.0	22,599.1	7,730.7
Central	10.1	19.8	23.6	21.4	25.1	100.0	12,004.0	3,975.7
Greater Accra	3.0	5.7	11.9	23.2	56.2	100.0	16,580.8	5,428.5
Volta	19.0	21.4	18.0	20.8	20.8	100.0	15,451.1	4,382.2
Eastern	11.7	18.8	23.0	24.4	22.1	100.0	13,074.3	3,919.1
Ashanti	7.1	15.0	19.1	25.3	33.6	100.0	23,119.5	8,205.4
Brong Ahafo	16.4	20.0	21.9	20.9	20.7	100.0	14,167.8	3,949.1
Northern	34.2	22.7	18.7	14.2	10.2	100.0	12,281.4	3,023.5
Upper East	32.5	21.3	17.7	15.9	12.7	100.0	7,240.5	1,801.9
Upper West	56.1	16.6	10.5	6.3	10.6	100.0	11,977.5	3,015.7
Ghana	**13.3**	**16.1**	**18.4**	**22.1**	**30.1**	**100.0**	**16,644.6**	**5,346.9**

Source: Ghana Living Standards Survey (GLSSS 6)(2014, page 155).

Appendix D- 3 Main occupation of persons aged 15 and over and their average monthly earnings

Main occupation	Average monthly total earnings (cash and in-kind) by all paid employees			Average monthly cash earnings by those receiving cash			Average monthly In-kind earnings by those receiving payments in-kind		
	Both sexes	Male	Female	Both sexes	Male	Female	Both sexes	Male	Female
Total	898.65	1,011.13	715.22	883.42	993.06	704.50	140.85	171.13	96.14
Managers	1,378.76	1,305.61	1,533.40	1,371.42	1,294.79	1,533.40	180.49	180.49	0.00
Professionals	1,017.31	1,122.90	905.59	1,010.40	1,110.31	904.68	108.07	171.47	16.83
Technicians and associate professionals	1,201.19	1,427.13	658.86	1,140.14	1,360.05	612.29	261.65	229.26	511.43
Clerical support workers	1,163.24	1,328.63	985.82	1,112.31	1,239.47	975.89	262.73	550.36	43.54
Service and sales workers	499.96	590.62	380.74	483.66	580.89	355.82	119.64	97.90	135.03
Skilled agricultural, forestry and fishery workers	525.04	658.48	259.40	520.41	651.97	258.53	28.11	32.01	10.00
Craft and related trades workers	1,071.77	1,327.07	409.64	1,062.36	1,321.76	383.61	77.06	42.70	123.59
Plant and machine operators, and assemblers	714.71	732.62	348.82	709.02	726.66	348.82	114.49	114.49	0.00
Elementary occupations	504.99	684.42	276.01	502.85	683.78	271.95	20.13	7.76	29.73
Other occupations	1,162.50	1,162.50	0.00	1,162.50	1,162.50	0.00	0.00	0.00	0.00

Source: Ghana Labour Force Report (2017, page 44).