PERCEIVED VALUES IN CONSUMPTION OF SOLAR PV ENERGY:

A CASE OF HOUSEHOLDS IN NAIROBI, KENYA.

BY
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Name Dr Joseph Onjala

Signed ………………………………………………….

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DEDICATION

To my dear son Lionel.

ACKNOWLEDGEMENT

I would like 'to first give thanks to God for having taken me through this course successfully.

Secondly, I would like to acknowledge my dissertation supervisor for having the patience to guide me and push me through this work. Thank you, Dr Onjala, for your time, your advice and most importantly, your patience. I sure needed it especially since this project came to me at a time when I was expectant and then spilt over into new motherhood. The work that I had to do initially was a lot, but with a baby, it was triple. Somehow, you managed to push me still to finish this work without being too punitive.

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ABSTRACT

Renewable energy has proven to be one of the solutions that scholars and researchers have proposed as a tenable measure in the management of climate change while promoting development. Efforts have, therefore, been put forth to make sure that these energy sources are viable. Solar PV energy has been no different. Over the past decades, these renewable energy sources have been on a steady innovation path that has seen them achieve viability status.

Kenya is celebrated as one of the countries that have recorded some of the highest levels of renewable energy consumption in Africa. Solar PV energy is one of those that have seen a doubled consumption rate in the last decade. Despite this, a lot of what is driving this consumption is yet to be known. Empirical evidence of the consumption of solar PV in Kenya is still scarce.

This study looks to build on this knowledge by analyzing the characteristics of those who consume solar PV energy, the level of consumption of solar PV energy and the perceptions that consumers have that may influence them to buy solar PV products. The author used a sample of 166 respondents from all socio-economic backgrounds in Nairobi County, and the results used to make this analysis. Rogers's diffusion of innovation theory and the unified theory of acceptance and use of technology were theories from which the study borrowed its theoretical background.

Findings showed that 36% of respondents owned some form of solar PV units. Most of these used their Pico units such as torches and phone charging devices. These are used occasionally for when power fails. It could be associated with the fact that many of them they were found to live close to power lines had to have had access to mains electricity. Only 0.2% had solar systems that were used consistently for their energy needs, and these had larger solar home systems. The most significant perception that households in Nairobi considered in buying solar PV products conditional value. It had a score of 84%. It was followed by novelty value at 80%, then environmental concern measure at 76%. Functional value came in fourth at 72%, then the emotional value at 67% and finally, social value at 46%.

From the study findings, it is recommended that the government works with players in the solar PV industry to make sure that conditions that help the adoption of solar PV are improved to boost consumption. Manufacturers and innovators of solar PV are also encouraged to keep up with the innovation to maintain superior productivity for lower prices as consumers were found to be sensitive to the pricing on the units. They are also encouraged to market their products through other forms of communication such as media advertisement as most consumers learnt of their products by observation of the installation of their neighbours.

CHAPTER ONE

1. INTRODUCTION

1.1 Background

Climate change is a multifaceted and multidisciplinary problem (Bill, 2012) that has received the attention of governments, and innovators because of the complex approach that is required to tackle it (Urry, 2010). It has mostly been ascribed to the emission of greenhouse gases (GHGs) (Abolhosseini & Heshmati, 2014), most of which have been attributed to the combustion of fossil fuels for energy production (Chandel et al., 2018; Kondoh, 2009; Moriarty & Honnery, 2014). It is not surprising; therefore, that reduction in these emissions has been proposed as one of the solutions to climate change (Sarzynski et al., 2012).

One of the main methods proposed in combating the climate change menace has been a change from fossil to renewable energy solutions (International Renewable Energy Agency, 2012). Renewable energy solutions involve many aspects, including electricity generation, otherwise referred to as green energy (Brennan, 2013). Green energy is electricity that is generated using renewable energy sources (Wüstenhagen & Bilharz, 2006). It includes innovations such as biomass projects, geothermal productions, photovoltaic solar panels, and wind farms (Siegel, Jeff; Nelder, Chris; Hodge, 2008). Other scholars have gone ahead to also include hydroelectricity, wave and tidal energy as well. Green energy has been a long-term solution, given that it involves zero-emission of GHGs (Kostakis & Sardianou, 2012).

Governments and states have committed to encouraging private adoption and consumption of green energy through the introduction of incentives such as feed-in-tariffs (Abolhosseini & Heshmati, 2014), adjustment of policy and institutional constraints (Yahya et al., 2013) and tax incentives (Sangroya & Nayak, 2017). (Marques & Fuinhas, 2011); in a study in 24 countries in Europe; found that consumption of renewable energy was not driven by the market instead through incentives, further justifying the need for incentives in the promotion of consumption of renewable energy.

These incentive programs are observable in the United States, Canada and Europe in the form of legislation. In East Asia, countries have been seen to make efforts to embrace renewable through adjustment of their legislation (Japan), promotion of research and innovation for renewable energy products(China), promoting energy efficiency(Indonesia) and encouraging renewable energy projects with feed-in-tariff schemes(Malasia) (Siva Raman et al., 2018). Results have, however, been varying from country to country. In China, for example, even after years of promoting research in renewable energies and through legislative means, there still remains high levels of dependency on fossil fuels (Siva Raman et al., 2018). These examples show that regulation and legislation alone are not enough in promoting the consumption of green energy products. Other factors, such as consumer acceptance and social acceptance (Upham et al., 2015) also must be considered by policymakers.

In the UK, for example, a study undertaken between 2006 and 2009 on the application of an offshore wind power project found that two of every three wind energy project applications were rejected owing to a 'not in my backyard' notion that the society had (Thøgersen & Noblet, 2012). No one was willing to accept the inconvenience of having transmission lines taken through their spaces. Similarly, in the US, resistance was organized against the Cape Wind project in Massachusetts. This resulted in years of delay in the start of the project (Sangroya & Nayak, 2017).

The above examples show the importance of product and project acceptability in promoting renewable energy consumption. This, according to (Hartmann & Apaolaza-Ibáñez, 2012) is achievable if government regulation and legislation and consumer environmental consciousness and values are combined in the marketing of renewable energy. This means that values that consumers attach to their energy consumption should be coordinated with government policy and regulation if long term adoption and consumption of green energy is to be achieved.

This paper intends to interrogate the values that solar PV consumers attach to their products and how that has influenced their choice in the adoption (or non-adoption) in the use of this energy alternative. The paper will interrogate perceived values in terms of social value, functional value, emotional value, novelty value and conditional value.

1.2 Renewable Energy Trends

Renewable energy has been strongly advocated as one of the solutions to achieving sustainable economic growth and dealing with poverty (Keho, 2016). This is the kind of energy that on a human timescale, is seen to be replenishable. It is sourced from processes that arise from the earth's natural cycles (Energy Information Administration, 2018)and is used mostly in transportation, electricity generation, off-grid energy needs and heating/cooling of air and water (Renewable Energy Agency, 2019; Trainer, 2007).

Globally, renewable energy is still secondary to fossil fuel energy. The former contributes about 13% in energy supply while the later supplies 60% of energy needs (IEA. 2017). Due to pressing sustainability needs, renewable energy has continued to be developed, although its growth has been remarkably slow at 2% per annum since 1990. Of this, solar PV has the fastest growth rate that currently stands at 37.2%, followed by wind energy at 23.6% (IEA. 2017). Renewable energy is also contributing significantly to electricity generation.

Africa is seen to have an immense renewable energy potential having a primary supply capacity of about 49%, the highest in comparison to other regions. It is also characterized by having a high percentage of its renewable energy supply from charcoal and biomass. Other primary sources of renewable energy remain untapped due to challenges that the continent is facing. These challenges include but not limited to technological advancement in renewable energy solutions, epidemic poverty levels and low commercial use of available renewable energy.

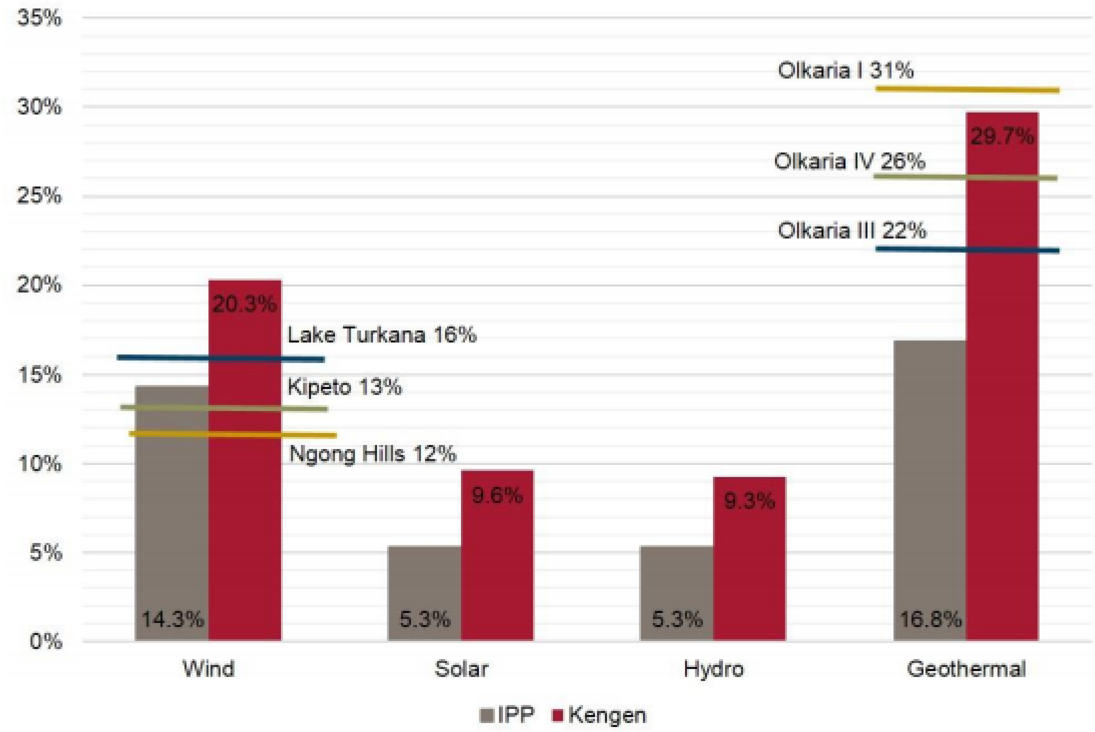
Renewable energy in Kenya satisfies a sizable portion in electricity generation, given that it contributes 70% of all electricity generated (Government of Kenya, 2016). Investment in the renewable energy sector has also continued to grow steadily with a notable 65% of total private investments in energy being directed to geothermal, wind and solar (Cedrick & Long, 2017). Not only has investments grown within the renewable energy sector, but also, they have performed well enough to place Kenya as a model country (Ondraczek, 2013). This success has been attributable to certain favourable conditions that include consumer attitude towards RE use, availability of local demand and local innovation and manufacturing for RE technologies (Sergi et al., 2018)

The Kenyan government strongly supports renewable energy efforts (Akinsola & Odhiambo, 2017; Hoka Osiolo et al., 2017), and this is shown by the percentage of installed renewable capacity and private investment. Majority of the electric energy produced in Kenya is sourced from renewables. 64% of her installed capacity; and 29% if excluding large hydro; is renewable (Hussain, 2013).

Renewable energy investments in Kenya have done remarkably well compared to other regions in Africa. They have been regarded as some of the most viable RE investments by various scholars, including (Eberhard et al., 2017; Mutua et al., 2012; Ondraczek, 2013; Pueyo, 2018). This success has made Kenya stand out to be a model country in RE consumption and use. Some of the unique structures that have helped Kenya to attain this have been argued to include consumer attitude towards RE use, availability of local demand and local innovation and manufacturing for RE technologies (Ondraczek, 2013).

The competitiveness of these renewable energy options is apparent when analyzed from a rate of return-on-investment perspective. (Pueyo et al., 2016) found that of all renewable technologies in Kenya, solar, wind and geothermal energy sources were the most viable primary sources of renewable energy in Kenya. Geothermal energy was leading at a rate of 30% nominal return on equity, followed by the wind from 14-20% and solar at 9.6%. The productivity of solar PV, from, this discussion is therefore not in question.

Figure 1: Equity rates of return of Kenyan RE generation technologies 2015



Source: (Pueyo et al., 2016)

(Ondraczek, 2013; Sergi et al., 2018) found solar PV to be a competitive renewable energy source, especially for off-grid applications compared to other countries in Africa with the exception of South Africa. The sector is also expected to grow owing to reducing the cost of solar PV products (about 10% per annum overall), tax exemption, growing credit financing (Kenya Climate Innovation Centre, n.d.) and growing commercial use (Hille & Franz, 2011).

Despite the superior performance of the sector, there still exist various investment challenges, especially for the most profitable ventures, Solar PV, wind, and geothermal energy respectively (Ondraczek, 2014; Pueyo & DeMartino, 2018). According to (Pueyo, 2018), these are revealed in the form of risks. The unique risks for investors have been system costs, social risk, regulatory risks, and governance risks.

Systems costs here refer to issues such as inadequate or unavailable transmission and distribution infrastructure, low demand because of prevalent poverty levels and low “productive uses” and technological inefficiencies. The model of power transmission and distribution is a challenge since Kenya, like most SSA governments, prefers to use a hybrid power transmission and distribution system despite its proven inefficiencies (International Energy Agency, 2015 (b), 2017). The hybrid system is a system where the government controls a centralized power system and allows independent power suppliers to fill in the gaps both in power supply and financing for energy development (Pueyo & DeMartino, 2018).

Regulatory risks are general risks that exist from a policy perspective. These are considered low in Kenya in comparison to the rest of SSA. Governance risks are associated with issues such as corruption and bureaucracy, which are still rampant for many projects.

Social risks are those that are manifested in the number of conflicts that investors face with host communities. These, she argues, are because of "lack of clarity regarding land property rights and consultation procedures, as well as the unbalanced distribution of costs and benefits between investors and communities."

Earlier research has found that there is also a need for financing and credit schemes that are tailor-made in order to attract sustainable long term local and international capital. Entrepreneurs may view this challenge in three primary forms which are a) financing for industrialists who do not meet the local threshold for credit access, b) financing for a business that is less understood or accepted by its potential market (Kardooni et al., 2016) and c) "finance and local investor interest and risk averseness to business start-ups and ventures in developing countries" (Wüstenhagen et al., 2007).

1.3 Problem Statement

Kenya is one of many countries that are actively trying to implement the renewable energy model in order to achieve economic growth (Government of Kenya, 2016). This is fuelled by the fact that it is a developing country with a significant segment of its population being classified as poor. It is also still significantly dependent on fossil fuels such as oil and wood fuel to meet its energy needs. Electricity demand has also been strong and growing (IEA, 2014). Overall, however, Kenya's energy supply has not been able to match energy demand owing to constraints from various quotas such as infrastructural limitations and policy gaps (Pueyo, 2017), among others.

(Mutua et al., 2012) found that of all renewable technologies in Kenya, solar, wind and geothermal energy sources were the most viable primary sources of renewable energy in Kenya. Geothermal energy was leading at a rate of 30% minimal return on equity, followed by the wind from 14-20% and solar at 9.6%. (Sergi et al., 2018) & (Ondraczek, 2013) found solar PV to be a competitive renewable energy source, especially for off-grid applications compared to other countries in Africa with the exception of South Africa (Ondraczek, 2014). The sector is also expected to grow owing to reducing the cost of solar PV products (about 10% per annum overall), tax exemption, growing credit financing (KCIC, 2018) and growing commercial use (Hille & Franz, 2011).

Kenya's solar insolation ranges between 4-6KWHr/m^2 (Energy Regulatory Commission, n.d.-a; Steurer et al., 2016) although its real potential is yet to be well understood. In technical terms, however, this means that there is a workable amount of solar resource (Theuri, 2008)..

Consumption of solar electricity in Kenya does not reflect in relation to its solar potential. (Ondraczek, 2014) argued that theoretically, "solar energy alone could contribute almost 100 times as much energy as Kenya currently consumes in electricity". The uptake in terms of consumption of solar PV in Kenya is still low compared to other countries such as China and South Africa.

Many organizations, such as the government and non-governmental organizations, have endeavoured to promote the use of green energy all over the world; in Kenya, it is no different. The efforts have resulted in more awareness of the benefits of using solar PV energy, such as environmental conservation and societal responsibility. It is this awareness that has even driven the growth and sustainability of solar energy systems to a level that can only be admirable to other African nations (Hansen et al., 2015).

Consumption patterns for solar products in Kenya are skewed and biased towards domestic and residential usage. If the (KCIC, 2016) report on solar markets is anything to go by, more than 60% of all solar products are consumed by individuals for non-commercial purposes. The (IEA, 2017) comes to the same conclusion as well. This highlights the significance of which household consumption of solar energy is. Despite being the biggest consumers of solar products in Kenya, little is known empirically about the factors that influence household consumption decisions and patterns of solar PV energy. This could be attributed to the informality and individualist patterns for which these products are obtained and consumed.

The knowledge and research gap that is noticed poses a problem for policymakers as they are unable to empirically know household consumption patterns and trends and how policy can be formulated to suit various segments of the Kenyan population in line with development goals. This paper looks to show some of the factors; that contribute to the consumption patterns of solar PV for electricity generation; held by households in different economic categorizations. These factors are in the form of perceived green consumer values. They will be analyzed to the extent to which they influence the decision by households to invest/adopt (or otherwise) in a solar power system.

1.4 Research Questions

This study's central research question is what values do households in Nairobi County consider in making investments in solar PV installations for their homes? The specific research questions are:

i. What is the status of investment in solar PV for electricity generation for households in Nairobi County?

ii. What are the characteristics of households that own and use solar PV products?

iii. What perceived values do households consider that influence their investment in solar PV installations for electricity generation in Nairobi County?

1.5 Research Objectives

This study looks to analyze perceived values that households in Nairobi County hold towards the installation of solar PV energy for their homes. Specific research goals are:

i. To find out what is the status of investment in solar PV energy by Nairobi County households.

ii. To find out the characteristics of households that own and use solar PV products

iii. To find out what perceived values households in Nairobi County hold towards solar PV.

iv. To analyze how these perceived values have influenced Nairobi County households in investing in solar PV energy.

1.6 Research gap

Consumption of solar products in Kenya is affected by many factors. (Keho, 2016)in his study on factors that drive energy consumption in developing countries finds that Kenya is affected by "population, urbanization, imports, GDP per capita, industrial output, foreign direct investment and credit to the private sector". While these are important influences, they are not the only ones. Consumer attitude is equally important in influencing how, what, where and when consumers make purchases (Holbrook, 1999; Hur et al., 2013).

Globally, most studies about renewable energy and solar in specific have been in the form of market reports that report mostly on the trend of energy demand and supply in the world (Asali, 2002; Benjamin & Mbaye, 2012; *IEA - IEA Renewables 2018-IEA (2018)*, n.d.; IEA, 2014, 2015; International Energy Agency, 2017a, 2017b; International Renewable Energy Agency, 2016; Park, n.d.). Those that have endeavoured to give more information on consumption patterns have focused on larger industries that are highly generalized such as manufacturing, industry, and transport, which can be vague if more specific segments of the industry are to be analyzed. The gap that still remains to be seen pertains to who is consuming what energy and why. This is the breach that this study seeks to fill but on a much smaller scale.

At the Kenyan level, studies have focused on energy resource distribution (Francis Oloo et al., 2016; Theuri, 2008), product distribution (Kenya Climate Innovation Centre, n.d.; Pueyo & DeMartino, 2018), solar home systems (K. Lee et al., 2016) and cost analysis (Hoka Osiolo et al., 2017). (Hansen et al., 2015; Kenya Climate Innovation Centre, n.d.; KIPRA, 2010) assessed the solar PV market in Kenya. They focused on the policy status as well as the challenges faced in the industry by different market players. These studies did not analyze the sectoral segmentation of solar PV customers; instead, they focused on the institutional distribution of the market based on supplier points of sale. (Magambo, 2010) focused on consumption in households while (KIPRA, 2010) focused on the overall consumption patterns in the entire energy sector. This review illustrates that large segments of the market have been left un-researched in Kenya. The household has been the leading market segment, and yet empirical data about it still is difficult to access. This paper will look to add knowledge about consumption by households, with a particular focus on how perceived values influence solar PV adoption in this market segment.

1.7 Purpose and aim of the study

This study aims to show the status of the use of solar PV for electricity generation by Kenyan households. It also looks to see what values these units hold that can be used to promote the viability of renewable energy products and specifically solar PV in Kenya in order to promote sustainable economic growth.

The study will also contribute to the overall study concerning green consumer perceived values. This is because, there has been a limited amount of empirical research on green consumer perceived values, most of which have focused on the nature and determinants of consumer discontent.

1.8 Justification for Study

Energy is a crucial element in development. It has a co-causative relationship with development, specifically economic growth. Many studies have been carried out to attest to this. It may lead to growth and vice-versa. This paper will focus on how perceived values can be re-directed to promote the use of solar PV as a critical method to drive economic growth in Kenya.

Perceived consumer values are intrinsic factors that determine the adaptability of technology. Without these, it is difficult to make policies that are relevant to the population - be it from a government planning perspective or a business marketing perspective. In the case of this study, it would be interesting to know what functional value, conditional value, emotional value, novelty value and social value, Kenyan households have towards solar PV and how that has affected their decision to adopt the technology. Even more interesting will be to look at how different socio-economic households prioritize these values.

1.9 Organization of Study

This study is organized into five sections organized by chapters. This chapter is the first, and it plays the function of giving the background of the study, introducing the research questions and the justifications for this study. It is followed by a literature review which is in the second chapter. This chapter is separated into three main sections. The first section deals with the theoretical literature review. Here, theoretical justifications of the study are set up through analysis. The empirical literature is also analyzed. This then will inform the development of a conceptual framework which details the dependent and other variables that are used in the study. Research design and methodology makes the third chapter. Here, the respondents are identified, and a means of collecting data from them is devised. Methods to analyze data are also established here. Chapter four presents the study findings and also has a discussion of these findings. Chapter five is the final chapter, and it is comprised of a summary of the study and makes recommendations going forward regarding solar PV energy in Kenya. This is followed by the appendices that are comprised of references and the data collection questionnaire instrument that was used in this study.

CHAPTER TWO

2. LITERATURE REVIEW

2.1 THEORETICAL LITERATURE REVIEW

2.1.1 Theories of technology adoption

The perceptions that technology adopters hold are significant determinants of the level of adoption of that technology and the rate at which it is absorbed (Lai, 2017). This is even stronger than the personal characteristics of those individuals, as was illustrated by (Ostlund, 1974). This section will investigate the theoretical background of how innovations such as solar PV get accepted and used within populations and the role of perception in the diffusion of innovation.

One early technology adoption theory is the Technology Acceptance Model (TAM). This theory was developed by Davis in 1986 and sought to model the acceptance of information technology systems and systems. It tested 'perceived usefulness and perceived ease of use' of computer usage and behaviour. (Dinodia, 2018) defined 'perceived usefulness' as the potential user's subjective probability that the use of an individual system (e.g., single platform E-payment System) will advance his/her action and 'perceived ease of use' as the gradation to which the possible user anticipates the target system to be unproblematic (Davis, 1989). The confidence of the person towards a system may be influenced by other factors referred to as external variables in the Technology Acceptance Model.

(Davis et al., 1989) analyzed both the Technology Acceptance Model and Theory of Reasonable Action theories and combined both of these to produce Theory of Planned Behaviour (TPB). This was arrived at after it became plain that TAM did not consider social norms which was an important determinant of behaviour. The TPB was further developed to include other human and social factors that also affected the adoption of technology. This was done by (Mathieson, 1991) and (Yi et al., 2006). Social norms became an area of further study and (Viswanath Venkatesh & Bala, 2008) found that social norms had a significant effect on behaviour in circumstances where the adoption was mandatory. Where situations are voluntary, it was found not to be significant. (Yi et al., 2006) had similar conclusions. These modifications continued to be made and adjusted until eventually; they came up with the unified theory of acceptance and use of technology.

(Rogers, 1995) sought to theorize how innovation was adopted socially by examining 508 diffusion patterns. He ended up with the Diffusion of Innovation Theory (DIT) which argued that over time, innovation would get communicated and be eventually adopted by communities. Unlike TAM and TRA, the DIT is more accommodative of many more variables, including social norms.

It is for this purpose that this dissertation will adopt it as its leading theory. It is also more foundational and covers all the requisite areas of study. It will be deliberated in further detail later in this chapter. The unified theory of acceptance will be the secondary theory that will be used to name specific, measurable variables that the primary theory does not provide.

2.1.2 Rogers diffusion of innovation theory (DIT)

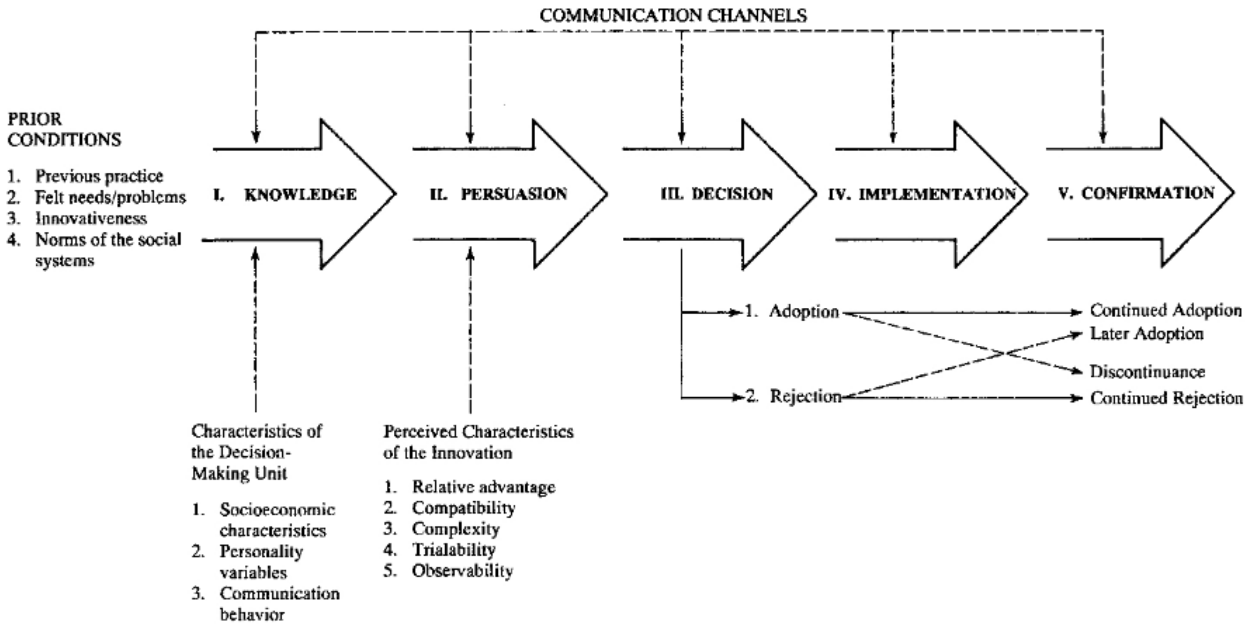
(Gatignon & Robertson, 2012) and (Rogers, 2003) theoretical proposal on the diffusion of innovation argues that a potential innovation adopter passes through various stages before accepting or rejecting an innovation. Rogers proposes that the diffusion of innovation in society is the process by which new innovative technology is communicated over time through various channels. It assumes that this process only starts after some level of exposure or knowledge by (an) individual(s) in society about an innovation, from which persuasion happens before an individual can decide whether to adopt a technology.

The theory proposes five stages of innovation diffusion. They are argued to be factors that determine the rate at which the adoption happens and are a) the relative advantage that the innovation offers, b) its compatibility with existing systems, norms and values, c) its complexity while in use, d) how easy it is to try out the innovation and e) its visibility to others in terms of visual performance and results. These factors are dependent on the perception and values that are held by individuals and groups (Straub, 2009). They are also applicable to technologies (Masood Qureshi et al., 2018), which explains why it is a theory that has been applied in much research.

It is vital that these stages are re-categorized in terms of environmentally oriented technologies for purposes of analyzing green perceived. This was done by (Vasseur & Kemp, 2015) who discussed the determinants of adoption and non-adoption in terms of environmental and green-oriented technologies by categorizing them into three main elements: “(1) the system of information transfer, (2) the characteristics of the technology (economic and technical) and (3) the characteristics of the adopter environment”. These are the lenses through which this study will view how perceived values affect the adoption of solar PV in households in Kenya. The study will also limit itself to the ‘decision’ stage rather than the whole adoption cycle. This is because it requires time for it to be tested through the whole cycle, an aspect to which the study was limited.

These determinants apply to this study in that; the system of information transfer relates to how solar PV adopters are socialized, and how solar PV products are marketed and distributed. This has a direct bearing on social and emotional value for which adopters hold. The characteristics of the technology determine the functionality, price, and performance of solar PV technology which relates to the functional value that potential adopters perceive. Finally, characteristics of the adopter environment, on the other hand, impact heavily on conditional value and to some extent, social and emotional values.

Figure 1: Rogers Diffusion of Innovation Flow Chart



Source: (Rogers, 2015)

Prior conditions are factors that determine the experience of the user. In our case, it applies to what solar PV users have experienced. As earlier said, solar PV technology has been growing, and this has been seen in its development as it tried to resolve its issues to improve productivity, lower costs and be maintainable (Hoka Osiolo et al., 2017). Users have had the experience of getting unreliable energy at a high price (Hoka Osiolo et al., 2017). This forced its developers to become more innovative as it has been seen with the inclusion of such technologies as lithium batteries instead of car batteries, among others. Solar panels are also now known to have an output that is higher per unit area as compared to earlier technologies. It is therefore expected that these technological developments will lead to a higher adoptability rate for solar PV systems among users owing to better experience with the technology.

A significant variable that this theory will inform in this study is that of knowledge. According to this theory, knowledge is the first stage in the diffusion process. It is influenced by user demographics, their communication behaviour, their prior experiences and conditions and personality variables. An interesting aspect of knowledge that will be studied will be the impact of knowledge on the adoption. According to this theory, the mode of transmission of knowledge is what majorly determines whether an innovation will be adopted. This is because knowledge alone is not the only factor that determines adoption.

The study will also analyze the persuasion aspect by looking at the perceptions that users have about the performance of the technology itself. Solar PV systems since their start have improved tremendously and are now as good if not better than the traditional grid electricity supply. This means that they are competitive and have gained a reasonable level of competitive advantage. According to this theory, this means that they are expected to be adaptable, not only because they have now become competitive, but also because they have been tried and have been found over time to be getting more reliable and cheaper.

The same theory also argues that the simplicity of technology determines adoption. Solar PV systems are known to be complicated and highly specialized technologies (Hoka Osiolo et al., 2017). This theory predicts that this will be a reason for non-adoption. The same would be said about its compatibility with the existing grid electricity. Solar PV is very disruptive to the electricity supply market. While it brings independence from reliance on grid electricity, it also requires many components to be installed in order to make it useful with existing electrical gadgets.

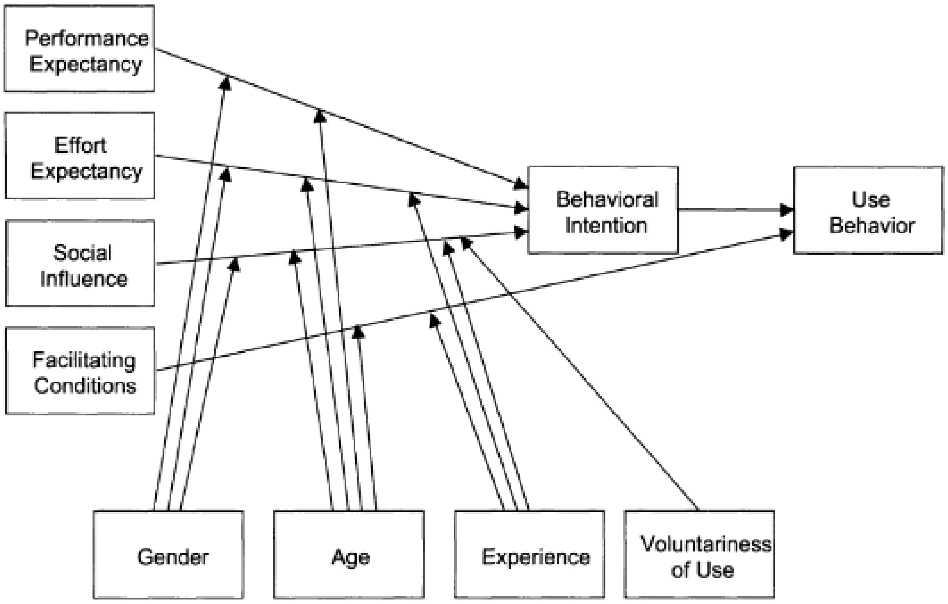
Like all theories, Roger's diffusion of innovation theory makes some assumptions which this study will adopt as well. First, it bears a preadoption bias where if an adoption does not occur, it will be considered a failure of adoption rather than a process that might result in adoption eventually. Secondly, it assumes that individuals and groups are predisposed to adopt the solar PV technology owing to influence from their environment and the technology itself (Wood & Swait, 2002). These individuals/groups are also assumed to be capable of learning not just from their experiences but also from the experiences of others (Bandura, 1997). It also assumes that the adoption has already been running over a reasonable period, sufficient for the (non)adoption process to have occurred (Lai, 2017). Finally, it assumes that time has an effect of dividing the population into socio-economic groups, which explains why the study will be done across different socio-economic groups.

This theory's main strength and weakness stem from the fact that it is a general theory. It is therefore applicable to the study of most technologies available. Its generality, therefore, means that it does not prescribe specific, measurable variables. This is where the unified theory of acceptance comes in.

2.1.3 Unified Theory of Acceptance and Use of Technology

(Viswanath Venkatesh et al., 2003) established the unified theory of acceptance and use of technology (UTAUT). It is based on (Ajzen 1996) and Fischbein's (1980) theory of reasoned action that postulated that the acceptance of technology by populations does not merely depend on the extrinsic factors but also on the intrinsic perception factors. It is an improvement of the earlier technology adoption model (TAM) that was developed by (Davis, 1986) since it unifies eight models that had earlier been studied into one. The eight that were reviewed were: the technology acceptance model, a model combining the technology, theory of reasoned action, the motivational model, the theory of planned behaviour, acceptance model and the theory of planned behaviour, the model of PC utilization, the innovation diffusion theory, and the social cognitive theory. It also introduces moderating factors such as age, gender, experience and the perception of voluntariness of change.

Figure 2: Model of the Unified Theory of Acceptance and Use of Technology



Source: (Viswanath Venkatesh et al., 2003)

This theory argues that there are three determinant of technological adoption - performance expectancy[1], effort expectancy[2], facilitating conditions[3] and social influence[4] . These are argued to be quantified to measure behavioural intention, which in turn could predict usage behaviour for technology. In (Viswanath; Venkatesh et al., 2016), the theory is developed to include new moderating factors. It introduces more demographic variables which include individual differences, such as income and level/type of education.

In this study, the theory will be used secondarily to determine measurable variables. This is because the primary theory (Rogers's diffusion of innovation theory) is general and needs to be

[1] The degree to which an individual believes that a technology will assist them in performing job duties, this is influenced by previous constructs of perceived ease of use (F. Davis, 1989)
[2] The degree to which an individual perceives a particular technology to be easy to use (F. Davis, 1989)
[3] The degree to which an individual believes that his or her organization is supporting the change
[4] The degree to which an individual feels social pressure to use a particular information technology, based on the construct of subjective norm from the theory of reasoned action (Ajzen & Fishbein, 1980)

tailored to be usable for this study. It will also be used secondarily because its original form is tailor-made for formal settings to help managers determine how well the introduction of technology will be accepted in organizations. This makes it inappropriate for application in the study of households as these are more informal in nature. The theory is also complicated as it is a combination of eight earlier theories and if used without modification, will make this study more complicated for the scope that is achievable.

2.2 EMPIRICAL LITERATURE REVIEW

This section will review the literature about the concept of perceived consumer values and the state of solar PV in Kenya. It will look at the challenges that have been faced, how they have been dealt with and how knowledge of perceived values is relevant in trying to deal with these issues through policy. It will also set out the variables under study that is, the dependent variables, moderating variables, intervening variables and independent variables. Finally, it will set out the conceptual framework relevant to this study.

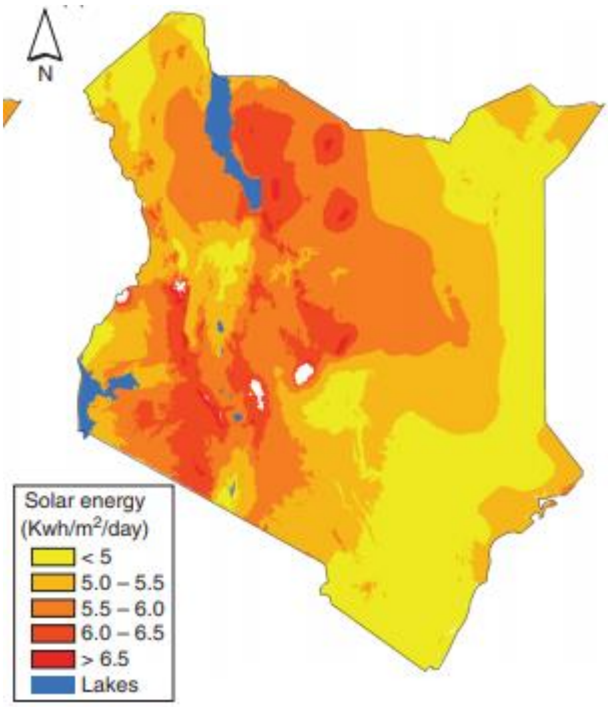
2.2.1 Solar PV in Kenya

The energy sector in Kenya is a crucial development driver given that it contributes to economic growth (Narayan Sarkar & Kundu, 2017; Odhiambo et al., 2018) which literally fuels socio-economic development by powering industry, transport, commerce and agriculture (Institute of Economic Affairs, 2013). It is critical in the attainment of Kenya's development agenda that is Vision 2030 (GoK Ministry of Energy and Petroleum, n.d.; Institute of Economic Affairs, 2013).

Access to electric power in Kenya has been growing at an impressive 8% since 2000 and currently stands at about 65% (Pueyo, 2018). This is relatively high in comparison to the regional sub-Saharan Africa access rate of 42% (International Energy Agency, 2017a). Furthermore, Kenyan firms are more concerned by issues like informality, corruption, and political instability (Hussain, 2013; The World Bank, 2013) rather than the electricity supply in order to run their businesses smoothly. This, however, does not automatically reflect a superior quality of electricity supply. In any case, the quality of the electricity provided and distributed in the main grid by government parastatals and institutions is still poor. "The system is minimal, with just 2404MW for a 50 million population and consumption levels are very low" (Pueyo, 2018).

The chief source of energy in Kenya is that of petroleum products which are used mostly for electricity generation and transportation (Kenya National Bureau of Statistics, 2018). It also has investments in renewable energy sources for electricity production, commanding a supply of about 70% of total electrical power demand in 2015 (Hoka Osiolo et al., 2017).

Figure 3: Classified average solar energy potential for Kenya in kWh/m2/day



Source:(Francis Oloo et al., 2016)

Kenya is among countries of the world that receives high daily insolation (4-6kWh/m^2) (Energy Regulatory Commission, n.d.-b) owing to its equatorial location. This insolation is not constant and varies seasonally and geographically. Solar power in Kenya is mostly used for photovoltaic (PV) systems, water heating, and drying. Other applications are water pumping and irrigation, telecommunication, cathodic protection of pipelines and lighting (Hille & Franz, 2011).

(Hansen et al., 2015) find two emerging trends in the solar industry in Kenya: "a changeover from small-scale, off-grid systems in the direction of mini-grids and large-scale, grid-connected solar power plants; and a program from the donor and government-based funding to market-driven distribution of solar PV". This in Kenya has been facilitated by the waning in world market prices for PV modules; the lengthy support from international donors; and conducive framework conditions postulated by national governments. Other factors that make Kenya's market to stand out include "a growing middle-class; geographical settings; local sub-component dealers; local campaigners; and favourable business culture".

2.2.2 Institutional and Regulatory Framework

The government has been making efforts that include setting up of regulatory and institutional frameworks to promote the use of solar energy. In the past, these frameworks focused on petroleum and electricity subsectors. Sessional Paper No. 10 of 1965 dealt with the Electric Power Act (CAP 314); Sessional Paper No. 1 of 1986 called for the establishment of the Department of Price and Monopoly Control (DPMC) to monitor action in restraint of trade and to enforce pricing in the various sectors; National Oil Corporation of Kenya Limited was set up in 1981 to coordinate oil exploration (upstream) activities and from 1988, to furnish 30% of the country's crude oil needs that would, in turn, be vended to oil marketing companies for refining and straight on sale to consumers; Electric Power Act No. 11 of 1997 set up the Kenya Power and Lighting Company (KPLC) that was to perform transmission and distribution functions, the Electricity Regulatory Board (ERB) to regulate the power sector in 1998 and KenGen was to perform the generation purpose. The Act aimed at easing private sector participation in the provisions of electricity services. It also allowed Independent Power Producers (IPPs) to enter into Power Purchase Agreements (PPAs) with KPLC to add more power to the grid.

The most recent regulatory frameworks include the energy policy through Sessional Paper No. 4 of 2004, renewable energy regulations, government-driven strategies, and plans and private sector strategies. These are further extrapolated below

Table 1:Existing policy and regulatory framework for renewable energy in Kenya

POLICY TOOL	PURPOSE
Sessional Paper No. 4 of 2004	• Laid the policy framework from 2004 - 2023. • Laid out the agenda for action including the enactment of a new and robust Energy Act (Energy Act 2006) and create a standard energy sector regulator, the Energy Regulatory Commission • Provided quality energy amenities for development. • Used energy as a tool to hasten economic emancipation for development. • Advanced access to reasonable energy amenities. • Provided a permitting environment for the delivery of energy services. • Enhanced the security of supply. • Promoted the development of original energy resources. • Encouraged energy efficiency and conservation as well as sensible environmental, health and safety practices
Renewable Energy Regulations	• The Energy (Solar Photovoltaic Systems) Regulations, 2012 • Designation of Energy Users Gazettement • The Energy (Energy Management) Regulations, 2012 • The Energy (Solar Water Heating) Regulations, 2012
Government driven strategies and plans	• Kenya Vision 2030 • Kenya's 5000 MW Power Plan (2013-2016) • Kenya's Last Mile Connectivity Project (2015-2017) • Least Cost Power Development Plan (2013-2033) • Scaling-up Renewable Energy Program (SREP) • Investment Plan for Kenya Rural Electrification Master Plan • Kenya National Climate Change Response Strategy • National Electrification Program Prospectus [Rural Electrification Authority (REA) Prospectus] developed by REA with support from the Norwegian Agency for Development Cooperation (NORAD) July 2014. • Feed-in tariff s for Renewable Energy (2012) • Net Metering- the draft national Energy Policy 2015 contains provisions on net metering

POLICY TOOL	PURPOSE
Private sector strategies	• Kenya National Domestic Biogas Program (KEDBIP) • Kenya Country Action Plan – Cook-stoves • Lighting Africa Program

Source: Author generated from Kenya government publications

The Ministry of Energy and Petroleum has, however, remained the most prominent and most robust institution for coordinating government policies in the energy sector. It works in conjunction with other stakeholders such as NGOs and private sector players to make sure that polices are streamlined and adequately implemented.

2.2.3 Consumption of Solar PV Energy in Kenya

There has emerged a vibrant solar energy market in Kenya that is characterized by off-grid units (Hille & Franz, 2011) located in rural (57%) and peri-urban (35%) areas where grid electricity is limited (Pueyo & DeMartino, 2018). This has been facilitated by feed-in-tariffs, tax exemptions and standardized power-purchasing agreements (Kenya Climate Innovation Centre, n.d.). Solar energy is used in these areas mostly by institutions and households to supply electricity and for medium temperature water heating for domestic and commercial purposes.

Kenya's solar PV market can be categorized either as commercial and non-commercial (KIPRA, 2010) or into various segments, as shown below. It is essential to categorize them since the products vary in capacity, installation costs, longevity, and other technological differences (Hansen et al., 2015). The consumption seems to increase with smaller units. Small pico-systems are the most consumed solar units, while grid systems are merely getting introduced in the market (Hansen et al., 2015).

Table 2: Solar PV market segmentation in Kenya

Market segment	Solar product	Market Characteristics	Installed Capacity	Owners & Buyers
Small pico-systems	Solar lanterns LED lamps Solar chargers Torches	Lighting & charging of batteries and mobile phones in mainly non-electrified areas Products are prone to failure and short lifespan Assume the most considerable portion of the market	1-10Wp	Private (over the counter) consumer devices Residential SHS (private households), ESCOs Government/municipal
Micro-solar home systems	Semi-portable systems associated with a portable solar panel and the battery that power 1-4 lights,	Lighting & charging of batteries and mobile phones in non-electrified areas	5-10Wp	Private (over the counter) consumer devices Residential

Market segment	Solar product	Market Characteristics	Installed Capacity	Owners & Buyers
	radio and mobile phone	Products are prone to failure and short lifespan Assume the largest part of the market		SHS (private households), ESCOs Government/municipal
Solar home systems (SHS)	Systems associated with a permanent solar panel and wet batteries that power lighting television, and radios as well as mobile phone charging.	Off-grid electricity need in homes in dispersed & scattered settlements, in smaller non-electrified villages and on the outskirts of electrified towns and villages far from existing distribution lines The oldest segment of the market	10-100Wp	Residential SHS (private households), ESCOs
Stand-alone Institutional PV Systems	Stand-alone PV systems are diffused through government plans and projections and implemented by private technicians	Governmental initiatives under REA electrification program to schools and hospitals without a grid Institutions situated in villages without grid or mini-grid, or on the outskirts of grid-electrified villages	500Wp-2kWp	Government/municipal purchasing for public institutions (schools, hospitals, health clinics)
Telecommunication, Tourism, Street and Market Lighting		Driven by private companies installing telecommunication networks in remote areas Driving telecom base receiver stations (BTS), link sites, and remote telecentres, and primary electricity supply (lighting) for rural lodges and hotels	0.2kWp-15kWp	Purchase by commercial companies in the telecom and tourism sectors (e.g., telecom service providers, hotel owners, etc.)
Mini-grids	hybrid-PV-diesel	Villages and towns located far from the existing grid	5kWp-1MWp	Utilities, cooperatives (community-based), ESCOs (village electrification projects)
Grid Connect (Small and Large=-03Scale)	Large-scale and small-scale grid-connected PV systems	Expansion of production capacity in existing grid-connected driven by IPP and currently installed under the FiT policy of 2012 Interest is growing amongst private actors – shopping malls, institutions, and private limited companies	0.5MWp – 3MWp, 4MWp – 40MWp	Utilities, IPPs (including foreign investors)

Source: Author modification from (Hansen et al., 2015; Kenya Climate Innovation Centre, n.d.; KIPRA, 2010)

The market has been expanding rapidly. For example, distribution channels for pico-systems for ''D.-light'' grew by 2500% between 2011 and 2013 (Kenya Climate Innovation Centre, n.d.) while the solar home system market doubled between 2010 and 2014 (International Renewable Energy Agency, 2016). This is indicative of a consumer preference that is skewed towards household application rather than commercial use. (Ondraczek, 2014) attributes this to a perception that has been perpetuated by various scholars that there is a high cost of electricity generation from solar PV, which makes it an uneconomical investment.

2.3 PERCEIVED CONSUMER VALUES

The concept of perceived consumer value is grounded in economic theory where consumer value is considered as a critical determinant in sales and marketing (Holbrook, 1999). The importance of perceived consumer value cannot be underestimated if successful marketing of a product or service is to be achieved (Hargreaves, 2011). (Hartnett & Gelman, 1998) noted that when retailers gratify people-based needs, they are delivering value, which puts them in a much sturdier position in the long run. This was a conclusion from a retailing perspective. (Karimi et al., 2014) commented that successful retailers increasingly target their offers towards two consumer categories: those with an emphasis on value and those for whom trust is the key. This does not in any way discharge the role of incentives in the promotion of consumption of solar PV products. Instead, it is putting emphasis that incentives alone are not enough in achieving long term (sustainable) consumption if consumer values are ignored (Nordlund & Garvill, 2002). In (Hur et al., 2013), consumer values have significant effects on customer satisfaction that, in turn, results in customer allegiance and lowered price awareness.

Perceived customer value has been a pivotal element in forecasting how attractive a product or service will be to a potential consumer (Lindgreen et al., 2012). (KIPRA, 2010) found that renewable energy had the highest consumer satisfaction index at a 74% score as compared to conventional energy. The perception of value was the most significant factor in renewable energy consumption as compared to perceived quality, customer allegiance and customer expectation.

Green perceived value is a concept that was presented by (Chen & Chang, 2012) in the green and environmental marketing literature. They defined it as a purchaser's overall appraisal of the take-home benefit of a product or service between what is given and what is received based on the consumer's environmental wishes, sustainable prospects, and green desires which emphasizes the association as unidimensional. This definition is, however, inadequate as it does not consider the complexity of perceptions and values attached to them (Holbrook, 1999; Sweeney & Soutar, 2001). This paper will therefore adopt an analytical model for determining the multidimensional nature of the perceived customer value based on measurable constructs as developed by (Sweeney & Soutar, 2001). This concept will be relevant to green energy as it will focus on solar PV as the energy and households in Nairobi as the consumers.

Dimensions that will be measured will be in terms of social value, functional value, conditional value, novelty value and emotional value. These scopes have been chosen based on the multidimensional nature of perceived conceived value as elaborated by various authors. The table below shows various dimensions that have been studied previously.

Table 3: Dimensions of perceived consumer value

Author	**Dimensions of perceived consumer value**
(Sheth et al., 1991)	Functional, Emotional, Social
(Sánchez et al., 2006)	Functional value (of the travel agency installations, professionalism & quality, price) Emotional value and Social value.
(Sweeney & Soutar, 2001)	Social, Emotional, Quality/Performance and Price/Value for Money
(Williams & Soutar, 2009)	Value-for-money, Emotional value, and Novelty value
(Sangroya & Nayak, 2017)	Functional, Social, Emotional &. Conditional values
(Hur et al., 2013)	Social, Emotional and Functional Values

Source: Author

2.3.1 Conditional value

This dimension has been defined by several authors. (Sheth et al., 1991, p. 162) defined it as the perceived usefulness acquired by a substitute as the result of the specific state or set of circumstances facing the choice maker. (Sánchez-Fernández & Iniesta-Bonillo, 2007) defined it as the contingent upon various physical, economic, social or environmental situations which may enhance the product's social and functional value". While (Biswas & Roy, 2015) defined it as "the utility derived in a specific situation". What creates conditions consists of contexts and situations that result in specific environments. These conditions may enable or confine pro-environment behaviour (Hargreaves, 2011; Nordlund & Garvill, 2002).

Conditions are made up of such situations such as consumer work environments, (Salmela & Varho, 2006) government incentives & subsidies (Kanevce et al., 2016; Munoz et al., 2009;

Sovacool & Lakshmi Ratan, 2012), rules, laws & regulations (Bergek & Mignon, 2017; Zhou & Haas, 1999), availability and accessibility of green products (Masood Qureshi et al., 2018), environmental concerns (Bashiri & Alizadeh, 2017), etc. Discounts, grants, incentives, subsidies, and other incentives motivate customers to invest in energy-efficient projects. (Caird et al., 2008). (Bandura, 1997) states that most behaviour is the product of multiple determinants operating in concert'. The nature and strength of coexisting determinants will vary for different activities, different individuals and different circumstances (Bandura, 1999a). For example, as (Bandura, 1999b) highlights, if situational conditions are weak, personal factors will have more influence. From this discussion, it is clear that conditional value forms a major aspect of perceived values.

Incentivizing the purchase of green energy is considered to be a short-term strategy in the promotion of adoption of renewable energy. It has, however, been advised by (Herbes & Ramme, 2014) that it should not be considered a lasting solution. Instead, he argues for the establishment of sustainable green energy businesses. The way to go about this was by promoting the willingness for consumers to accept, purchase and use green energy (Hartmann & Apaolaza-Ibáñez, 2012). Their perception of value towards green energy must, therefore, be enhanced (Kaenzig & Wüstenhagen, 2008).

2.3.2 Novelty Value

The novelty value has often been equated to epistemic value (Williams & Soutar, 2009). It is defined as the value created when a product arouses curiosity and provides a desire for knowledge (Sheth et al., 1991). It is what fuels the desire for one to be on the lookout for new products and find out as much evidence as they can before finally deciding to make a purchase. Novelty concerns technological development from older to current competing innovations (Amara et al., 2016; Koc & Bozdag, 2017; Svennevik et al., 2020). Since not all innovations are the same, they are often categorized into typologies as a way of naming their innovative characteristics and degree of novelty (Garcia & Calantone, 2002).

Solar PV products are technology and innovation products (Ahuja & Lampert, 2001; Schoenmakers & Duysters, 2010). They have also witnessed a tremendous journey as they sought to upgrade technologically (Energy Information Administration, 2018). It is for this reason that their consumers are expected to have a degree of novelty before making purchases (Koc & Bozdag, 2017). Novelty is such an essential value that (Danneels & Kleinschmidtb, 2001; Duhamel & Santi, 2012; Kleinschmidt & Cooper, 1991) determined it to be a factor that could determine the success or failure of an innovation commercially.

(Amara et al., 2016; Danneels & Kleinschmidtb, 2001) also suggest in their prior research, that the degree of novelty is significant and requires a better understanding of academic circles and organizational policy management to avoid risk and carry out a good innovation process. This is because it brings in risk, which if not effectively managed, can lead to unnecessary negative repercussions.

Despite having received a fair amount of research on it, this area still is significantly unresearched, particularly in the expanses of technology and innovation (Koc & Bozdag, 2017) in Kenya. This paper will, therefore build on this knowledge by measuring novelty among residents of Nairobi.

2.3.3 Functional Value

Functional value has been the most reviewed value that is acceptable and whose measurement method is almost agreed by all the authors. (Sheth et al., 1991) defines it as "the perceived utility acquired from an alternative's capacity for functional, utilitarian or physical performance". (Hur et al., 2013) describes it as "value (that) is related to the practical or technical benefits consumers can obtain by using a product or service." It is arrived at when consumers seek to maximize their value for money. A study by Long et al. (2014) on the energy-saving character of consumers found that consumers were most sensitive to price. (Hur et al., 2013) however, finds that this sensitivity is variable depending on the (other) values that a consumer derives from the product.

Solar PV energy products not only offer benefits that are like the advantages offered by conventional energy products, but also provide added functional benefits, such as saving on electricity bills (Kenya Climate Innovation Centre, n.d.; Pueyo & DeMartino, 2018), and reducing the generation of harmful waste and pollution in the long term (Tyagi et al., n.d.). It is therefore clear that functional value is a crucial aspect of consumer perceived value.

In Kenya, this value has been theorized to be one of the most limiting among challenges facing the adoption of solar PV. The main culprit has often been pricing in the sense that the price is high and most of it must be paid upfront. (Karekezi et al., 2008) found that the upfront cost of installing solar products was limiting for most property developers in Kenya. Not only is the price high, but the quality that those who have installed them receive is low (Hoka Osiolo et al., 2017), further jeopardizing the value derived from their investments.

Access to finance to ease the purchase of solar PV has also been found to be a significant obstacle (Eberhard et al., 2017). This could be attributed to the kind of financing that is available. It comes in the form of public finance, development finance, climate finance, and commercial finance. While the government receives many funds in support of the development of solar PV and other renewable energy sources, only little financing (10%) is provided to commercial banks. The bulk of it stays with the government where it is used for such issues as creating conducive markets and forming policy (Abolhosseini & Heshmati, 2014).

Other economic related challenges that households face include difficulty to access finance, the low purchasing power of consumers and rising counterfeit products that further trouble consumers to distinguish (Kenya Climate Innovation Centre, n.d.).

2.3.4 Emotional value

Emotional value is a perceived value that is driven by strong feelings that are usually derived from something or someone. It regards the convention of mental or psychological needs of product or service users (Sweeney & Soutar, 2001). It is the “perceived utility attained from an alternative’s ability to arouse curiosity, provide novelty, and fulfil a desire for knowledge” (Sheth et al., 1991, p. 161). As a perceived value, it relates to the feelings and emotions that a buyer experiences while buying a product. (Jackson, 2004) analyzed several cognitive factors and concluded that consumer purchases are influenced by emotions beside other socio-cultural and political factors.

According to (Hartmann & Apaolaza-Ibáñez, 2012), the effect of emotional value could be so much stronger than that of functional value when a consumer is purchasing green products. In the case of using environmentally friendly products, consumers feel a sense of warm well-being due to the moral satisfaction gained by contributing to the environment (Nunes & Schokkaert, 2003). (Wüstenhagen & Bilharz, 2006) supported this assertion by empirical research on existing green energy consumers and concluded that the only reason for buying green electricity at a premium is to feel better with themselves.

Although societies as a whole gain from green electricity, customers’ experience added emotional benefits by contributing to energy independence and climate change (Hartmann & Apaolaza-Ibáñez, 2012; Menges et al., 2005). Thus, (Hartmann & Apaolaza-Ibáñez, 2012) further emphasized the overall psychological benefits of green energy and suggested that green energy marketing campaigns should focus on psychological benefits such as warm glow, nature experiences and self-expressive benefits. Several other studies have also, in different contexts, proved a relationship between emotional benefits and green electricity usage (Hansla, 2011; Hansla et al., 2008a, 2008b). It is crucial that emotional value is assessed as an aspect with varied effects on consumer adoption (Wiedmann & Hennigs, 2014). The discussion above sets up emotional value as a significant dimension of green perceived value.

2.3.5 Social value

Social value is a perceived value that is gained when users get the sensation that they are associated with others in their circles by using a service or a product (Sweeney & Soutar, 2001).

(Smith & Colgate, 2007) defined it as “the perceived utility of an alternative resulting from its look and symbolism in association or disassociation with the demographics, socio-economic and cultural-ethnic referent groups”. For example, consumers could find social value by riding a bicycle rather than driving. In this case, they prove to their society that they are socially responsible and are contributing to their respective communities by taking environmental responsibility. Social value denotes that individual perception about what civilization would think or how it would look if a purchase were made by the person. In (Ek & Matti, 2014), communities were found to have positive attitudes towards their members who made investments in renewable energy, a factor that enhanced individual self-image positively.

Consumer behaviour is fashioned by the picture produced about a product or service in societal groups in which an individual belongs (Merton, 1968). Consumers make purchases also to satisfy the need to have social status and to create and retain social relationships (Bergesen et al., 2006). Thus, it is vital for policymakers to understand the factors that affect social norms and responses and anticipate communal changes in people's behaviour towards energy (Shove et al., 2015; Shove & Walker, 2014).

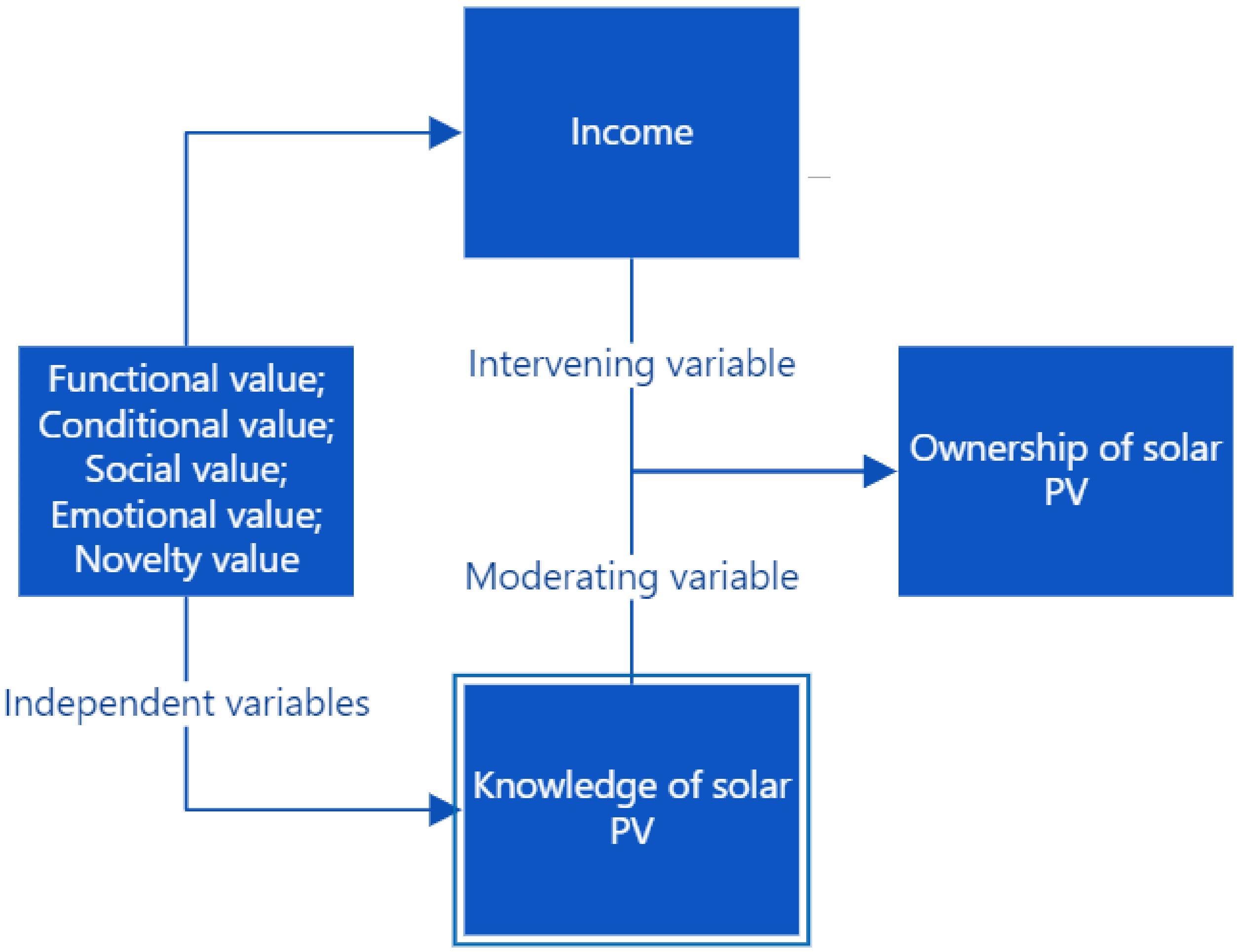
Social norms also significantly encourage consumers to capitalize on activities geared towards environmental conservation and protection (Ek & Matti, 2014) for which solar invest is included. The embracing of renewable energy is not exclusively dependent on their functional qualities (Pueyo & DeMartino, 2018). People, however, are encouraged to embrace them because of what they symbolize (Smith & Colgate, 2007). Positive symbolic attributes are attributes that shape a positive image of consumers in society when they purchase and display products (Johnstone & Hooper, 2016; Sangroya & Nayak, 2017). For example, designer cars and watches indicate class and wealth, and their acquisition signals good taste. Symbolic characteristics may encourage the adoption of sustainable goods because they enable a person to show their status and identity (Anand, 2016). The adoption of sustainable products; in this case; gives an indication that one is conscious of the environment and cares for it.

In the context of energy-efficient-products (Holbrook, 1999; Johnstone & Hooper, 2016) noted a definite positive impact of several societal factors on adoption by consumers. According to (Boström & Klintman, 2008), the pressure from peer groups revealed forced investors to re-direct their investments towards renewable energy technologies. (Anand, 2016) revealed that the intention to use electricity from renewable sources was most intensely affected by the endorsement of green electricity by family and other close social contacts. Governments' influence on green consumer behaviour could only be seen through policy and regulatory framework (Yahya et al., 2013). The discussion above lays bare the argument that social value is a vital dimension of green consumer perceived value.

2.4 CONCEPTUAL FRAMEWORK

The dependent variable in this study is the ownership of solar PV that was measured against the socio-economic status of various households. Knowledge of solar PV and Income was the secondary dependent variables. Knowledge of solar PV was measured qualitatively based on five questions to which respondents gave scores about their familiarity with solar PV on a scale of one to ten: one being 'ignorant/unfamiliar 'and ten being 'very knowledgeable.' Income was based on the score of their monthly expenditure on essential goods that is, housing, clothing, food, transport, and entertainment.

Figure 2: Conceptual Framework



Source: Author

2.4.1 Knowledge of Solar PV

Knowledge is acquired when an individual (or another decision-making unit) learns of an innovation's existence and gains some understanding of how it functions. (Rogers, 2015). Those that are ignorant of the technology are less likely to adopt it. However, this is not the only factor. The exposure and mode of coming to the knowledge of a technology or innovation also determine whether an individual will adopt the technology (Larsen, 2011). This was also found by (Rogers, 2015; Straub, 2009) who argued that individuals only predisposed themselves to the knowledge that was consistent with their beliefs and stayed away from the knowledge that was conflicting.

(Kaplan, 1999), had an interesting finding on the role of knowledge in affecting the adoption of solar PV among utility company managers. He undertook a national survey of company managers of companies that distributed solar PV and found that only 2.5% had adopted solar PV technology. He found that even though most power company managers had a superior level of technical knowledge about PVs, they were not adopting the technology. One reason he gave for this disparity was that photovoltaics was a misfit: *"PVs are decentralized, modular, and easily disconnected from the utility grid. Power company managers should adopt photovoltaics, but they do not. These potential adopters have the knowledge, but not the experience, with this disruptive technology; ('disruptive' in the sense that it is radically different from the usual operations of power companies)."* This drove the conclusion that: the more fundamental and disruptive an innovation is, the slower its rate of adoption (Bower & Christensen, 1995; Linton & Walsh, 2000).

Knowledge is critical in determining whether a technology will be adopted. (Zainudin et al., 2014) found that knowing that energy was green did not encourage consumers to buy it. Energy suppliers also rely on knowledge for them to make reasonable predictions on what their markets need (Lin & Lee, 2005). It shows interestingly that knowledge alone is not the only consideration. Most people do not evaluate an innovation exclusively or at all based on its performance as judged by scientific research (Mohammed Wazed et al., 2018). Instead, they decide whether to adopt based on the subjective assessments of the innovations suggested to them by others like themselves (Hirsh & Dolderman, 2007). They also make these decisions factoring how easy it would be to use technology as was found by (Hua & Wang, 2019).

In this study, we will seek to know the influence that knowledge has had on the adoption/non-adoption of solar technology among Nairobi residents. It will even be interesting to see how knowledge interacts with the other variables in determining whether a household will use a solar PV system.

2.4.2 Income and Solar PV

Income is an investment factor that is linked to the affordability of the technology in question. According to (Hoka Osiolo et al., 2017), it is indirectly proportional to the cost of solar PV. This means that the higher the cost of the system, the less likely it is to get bought. Reason for this is that most Kenyans, and indeed residents of Nairobi County (65%), are poor and would prioritise other more pressing consumption needs. The level of income also determines the type of solar PV system that is likely to be adopted. Households with more income are likely to install more effective solar PV systems such as solar home systems, while households with less income will most likely invest in a small system or none. (Sadorsky, 2009) found that a 1% increase in real income per capita rises the utilization of renewable energy per capita in unindustrialized economies by approximately 3.5%.

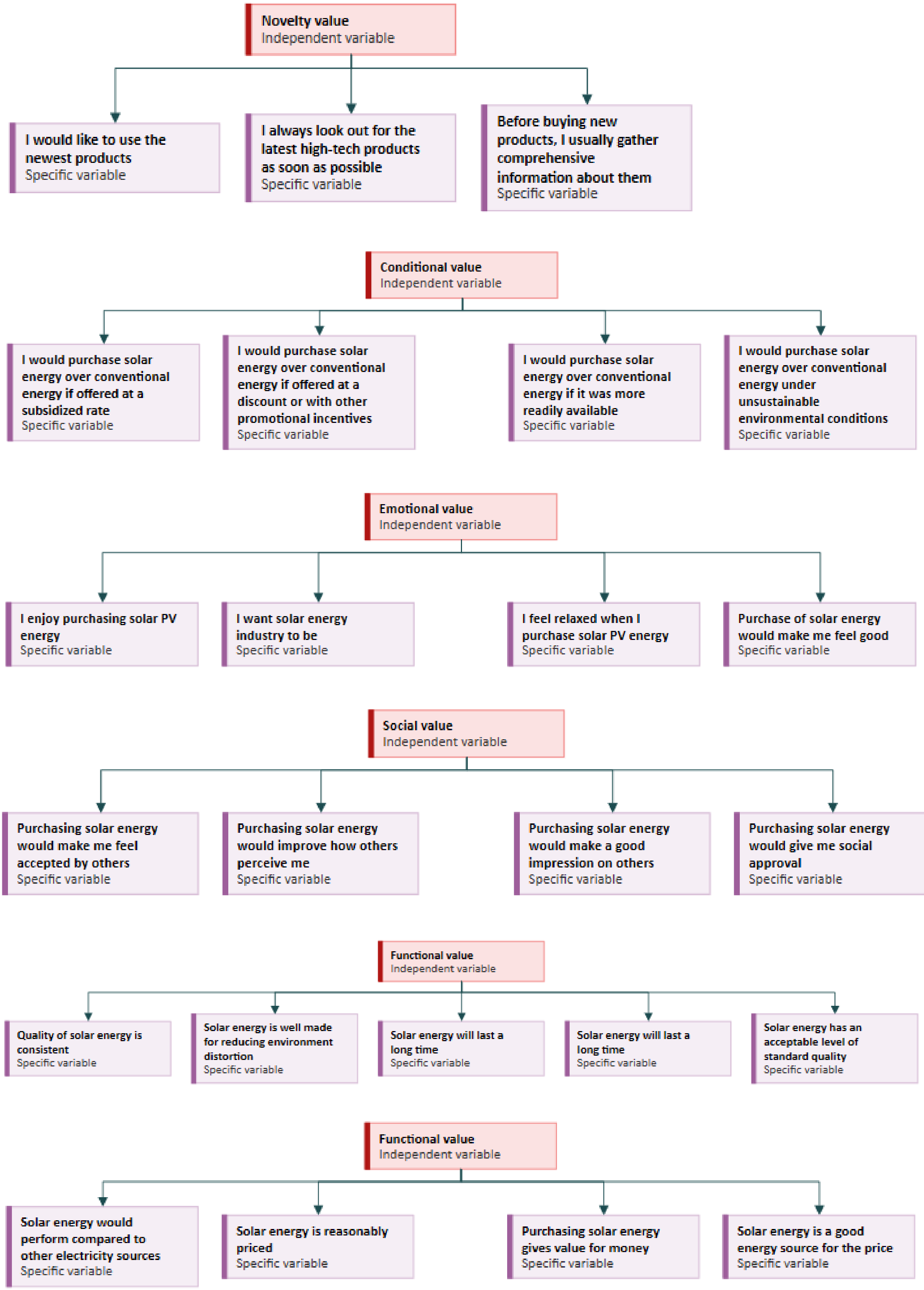
Studies involving the relationship between income and electricity are rich in the scientific literature. (Akinlo et al., 2008; Brewer & Chen, 2007; Chontanawat et al., 2008; C. C. Lee, 2005; Mahadevan et al., 2007; Narayan et al., 2009; Wolde-Rufael, 2008; Yoo & S.-H., 2006). It, however, gets scanty on renewable energy and further with solar PV in specific. The design of renewable energy policy requires sound knowledge on the relationship between per capita income and energy consumption. This is because relatively large long-run income elasticities show that minor changes in real per capita income have a proportionally higher impact on per capita renewable energy consumption. This suggests that relatively small increases in per capita income are likely to lead to large increases in renewable per capita energy consumption (Sadorsky, 2009).

Income also has been found to affect technology adoption through influencing household tolerance levels for risk-taking. (Hua & Wang, 2019) found that farmers that had larger farms earned more from their farms and were more likely to adopt technologies that were likely to give them even higher yields. Other studies found this to have a negative effect, that is, those with larger farms were less likely to adopt recent technologies as that meant taking a more significant risk and standing to lose more (Rogers, 2015). Income as a factor affecting adoption has been found to have a myriad of effects. This study will pursue to add to knowledge about this relationship regarding solar PV.

2.4.3 Independent variables

The indicators of socio-economic status were those identified as critical indicators by the unified theory of acceptance of innovation and were income, level of education, age, head of household (male/female) and social associations. Independent variables were questions which the respondents scored on a scale of one to ten. They are as below.

Figure 3: Flow charts of independent variables



Source: Author

CHAPTER THREE

3. RESEARCH DESIGN & METHODOLOGY

3.1 Introduction

This section will expound in detail the respondent characteristics and design methods of data collection and analysis that were used by the researcher before arriving at her findings. This methodology is designed to achieve the following objectives:

i. To find out what is the status of investment in solar PV energy by Nairobi County households.

ii. To find out the characteristics of households that own and use solar PV products

iii. To find out what perceived values households in Nairobi County hold towards solar PV.

iv. To analyse how these perceived values have influenced Nairobi County households in investing in solar PV energy.

The first question was answered through the establishment of the number of respondents that owned any form of solar PV from small lighting devices and phone chargers to sizeable solar PV systems – specifically the Solar Home System. The second question was analysed by getting the demographical data of respondents. The third objective was achieved by tabulating the scores that the respondents gave regarding their perceptions. Other analyses that were carried out aimed to find out the influence of perceived values and other variables such as knowledge and environmental concern on the adoption of solar PV products.

3.2 Research Design

A research design is a framework within which social research carried out (Bryman, 2012). There are several types of research design, and these are based on the type of study (Lewis-Beck et al., 2004)(experimental, case study etc.) and the time allowable for the study (e.g., social survey, longitudinal surveys etc.). This dissertation will adopt a cross-sectional study design which 'involves observation of a sample of a population at one point in time' (Babbie, 2010). This is because perceptions are variables that can change over time for individual respondents and society by extension. This study was limited by time which makes the cross-sectional study ideal.

Original studies that have looked at perceived values have also taken the cross-sectional approach, as illustrated in Table 4 below. There also exist original studies, most of which are developing frameworks for which to measure perceived values. These adopt a longitudinal research design that analyses existing literature and frameworks. They employ exploratory and confirmatory tools of data analysis. Other than these original works, cross-sectional surveys have been used. This is explained through the limited literature in this field. The concept of perceived value is reasonably new and is still getting developed. In the course of time, as more research in the area is done, other research designs may be employed.

Table 4: Methodology applied in the study of perceived values

Study	Methodology	Data Analysis
(Williams & Soutar, 2009)	An empirical cross-sectional survey of value, satisfaction and behavioural intentions	Confirmatory factor analysis of each value
(Chen & Chang, 2012)	Application of original green concepts to an integral model to enhance green purchase intentions	Structural equational modelling
(Sweeney & Soutar, 2001)	A longitudinal survey of measurement of perceived values (PERVAL)	Exploratory & confirmatory analysis of values
(Sánchez et al., 2006)	A cross-sectional survey of tourists perceived values.	Multi-dimension regression of perceived values
(Hansla, 2011)	Survey of environmental values and corresponding awareness-of-consequences	Co-relation and co-variance analysis
(Hur et al., 2013)	A cross-sectional survey of consumers of hybrid cars in the USA.	Structural equational modelling and multiple-item scale analysis

Source: Author analysis of literature

3.2.1 Population

The target population for this dissertation was households of different socioeconomic status in Nairobi County. According to the national census of 2019, there are 1,494,676 households in Nairobi County. Of these, only 0.2% (3073) of them used solar PV for lighting (Kenya National Bureau of Statistics, 2019b). These are distributed as below.

Table 5: Distribution of households in Nairobi Sub-counties with solar PV lighting

SUB-COUNTY	TOT. POPULATION	% WITH SOLAR LIGHTING
DAGORETTI	154,949	0.1%
EMBAKASI	346,462	0.1%
KAMUKUNJI	83,680	0.1%
KASARANI	268,611	0.2%

SUB-COUNTY	TOT. POPULATION	% WITH SOLAR LIGHTING
KIBRA	61,651	0.3%
LANG'ATA	60,187	0.7%
MAKADARA	70,080	0.1%
MATHARE	74,967	0.1%
NJIRU	204,492	0.4%
STAREHE	66,108	0.1%
WESTLANDS	103,489	0.3%
TOTAL	**1,494,676**	**0.2%**

Source: (Kenya National Bureau of Statistics, 2019b)

3.2.2 Sampling

The study assumes that Nairobi in a heterogeneous population, and as such, it was essential to design the sampling frame to be fair enough to represent the diversity in all households. Probability/systematic sampling was, therefore employed. This was done in two ways; snowballing and systematic random sampling.

As indicated above, a tiny percentage of the population was found by the 2019 Census to use solar for lighting. It was therefore anticipated that it would be hard to find respondents that owned solar PV gadgets. Snowballing was therefore chosen to be the method of sampling those that owned these units.

Proportionate stratified sampling was used in order to group together households by socio-economic categorization and by location. This was relevant for this study as it distributed the respondents' fairly. The strata also allowed for just three areas; that are representative of each socio-economic group; to be sampled. Implicit stratification was used to stratify various locations in Nairobi County. This was used as weightings on strata were not availed and also to avoid the problem of fractional sample sizes (Kish, 1965).

This resulted in a sample size of 209 units assuming that the population varies by 5% of the actual value, a confidence level of 95% and an acceptable defect level in the population of 2%. These were distributed into three geographical areas; Kitusuru – for the high-income bracket, Buruburu phase 1 – for the middle-income bracket and Mlango Kubwa – for the low-income category.

In each household, the head was the expected respondent for purposes of consistency in the questionnaire. This is because members of each household often have differing perceptions on different subjects (Schelly, 2014), including solar energy, and so, it was prudent to have consistent and structured respondents.

Factor analysis was undertaken to measure the adequacy of the sample for the study, and results gave a Kaiser-Meyer-Olkin (KMO) factor of 0.602 that was found to be accepted scientifically. It was also used as a measure of the internal validity of the variables. Social value and expenditure (used to measure income) were found to be the least significant variables, as shown below.

Table 6: KMO Table for Testing Sample and Variable Adequacy

Emotional value	Conditional value	Social value	Functional Value	Novelty value measure	Expenditure/Income	
0.617512	0.663844	0.47094	0.579169	0.605806	0.285752	0.601698

Source: Author

3.2.3 Area of Study

The area of study is Nairobi County. This study area was chosen for this study since its population is diverse and can be used to generalize for trends in other parts of the country, especially urban areas. The area also happens to have recorded significant growth in terms of the percentage of those that opted to use solar PV in the last decade. According to the national census of 2009, there were 985,016 households in Nairobi County. Of these, 992 (0.01%) of them used solar for lighting (Karekezi et al., 2008). Currently, 0.2% of them use solar for lighting, which is a 0.19% growth.

Beyond its significant growth in the consumption of solar PV products, Nairobi County is an ideal study area as it is relatively small geographically. This was critical cost-wise as it was cheaper and faster to sample this population. This was also justified by the timing of the data collection as it was done when the Nairobi Metropolitan area was partially locked down to contain the spread of COVID19.

3.2.4 Data collection

Snowballing was done by first targeting suppliers of solar PV products. These were easily identifiable using the Kenya Revenue Authority importers database, which the researcher requested to access. Others were also identified by visiting their physical locations where they conducted their business in the Nairobi central business district. These suppliers then assisted in the identification of electricians who installed and maintained solar PV systems for their clientele. Electricians then pointed the researcher to specific households that had solar PV products either installed or maintained by the said electricians.

Stratified sampling was used for households that did not own solar products. This was done by randomly picking every tenth household in each socio-economic area and physically interviewing them. Structured surveys were then applied using structured questionnaires. The questionnaire had a list of seventy-two questions that were derived from the variable statements contained in the conceptual framework. Initially, only the respondents' contacts; phone and email address; were collected. This was done in order to reduce physical contact with respondents in compliance with the COVID19 containment guidelines. They were later phoned and or emailed the questionnaire in compliance with Ministry of Health Guidelines for the control of COVID19, which included staying home and physical separation. The response rate for these turned out to be low at about 10% for the first 27 interviews. The phone interviews also acted as a pilot for the survey questionnaire and informed most of the changes that were done to it.

Physical interviews were used in the primary survey. Contacts previously obtained from respondents were used to schedule for physical meetings. The response rate for these was found to be much better as compared to that of emails and phone calls. All the questions were asked to all households in the same way. These were divided into four sections. The first section was recorded prior to doing physical interviews during the phase where contacts were obtained. Here, the researcher would make observations about the respondents' environment. They would then introduce themselves, and if the respondent accepted to be interviewed, they would collect data about the respondent's demographics. Thereafter, respondents had to score each question on a scale of 1 to 10; where 1-very weak, 5-neutral, and 10-very strong. Data cleaning was then done once the questionnaires had been filled and returned.

3.2.5 Data Analysis

The research paper is mainly descriptive with some explanatory analysis. This was done, first, in order to achieve the set-out objectives and second, due to the type of data that was generated. Data collection produced both qualitative and quantitative data. The data was entered and then cleaned to remove unresponsive respondents and questionnaires that were not fully filled. The data was also coded to facilitate analysis.

Descriptive statistics were used to analyse the demographics of the respondents. Statistical analysis was used to test the validity and reliability of the data collected. Factor analysis was used to determine the validity of the sample and to test the relevance of the variables that were to be used in the study. Correlation analysis was done to analyse the strength of the relationships between variables. Specifically, a hierarchical multiple regression analysis was used for this. The logit model was used to analyse how perceived values are able to predict the possibility of solar PV adoption.

3.3 Weaknesses of the study

The measure under study is that of perception. This means that the subjects under study could change their responses with the passage of time or change in circumstances. As a result, future studies on the same could have different findings. It also creates opportunities in future to replicate and undertake comparative and longitudinal studies for purposes of validation and generalization.

There was an issue of the language barrier, especially when interviewing respondents that did not understand English well. This is because the language used (English) to establish the perceived values was difficult to interpret to Kiswahili without distorting the intended meaning. Some words also did not have direct interpretation, e.g., Renewable energy.

The study was also only focusing on pre-purchasing scenarios. Future studies could look at post-purchasing scenarios as well and maybe make comparisons as to the changes in the values that may happen then. The studies may also focus on trends to ascertain how the consumer market is changing.

The study relies on a single measure of value based on the index developed by (Sangroya & Nayak, 2017). This is due to there being little in terms of empirical literature that has been published on the measurement of the concept of green consumer value. In the future, the study may be undertaken using different scales to verify or challenge these findings.

The study was also carried out within a limited timeframe and resources. This was further complicated by the COVID19 pandemic, which made it harder and more expensive to collect data. This limited the depth to which the study could be undertaken.

CHAPTER FOUR

4. RESEARCH FINDINGS

4.1 Introduction

The data collected comprised of both parametric and non-parametric data. All the measurements of perceived value were non-parametric, and therefore, hierarchical multiple regression was used to analyse each question. Logit model was used to analyse by how much-perceived value influenced the probability of adoption. Descriptive statistics were employed to analyse demographic data. Some of the demographic data was compared to recently done surveys, especially the 2019 census, to establish validity and reliability.

A total sample of 209 was targeted. Of this, 166 were accessed and interviewed while 43 were non-responsive for varied reasons. The main reason found for non-responsiveness was the unavailability of the head(s) of households (63%). It was followed by those who, for some reason, could not sit through the whole interview (28%). Finally, there are those whose contacts were given irregularly and therefore turned out not to have fallen within the targeted group (9%). This gave an average response rate of 69%, which was acceptable.

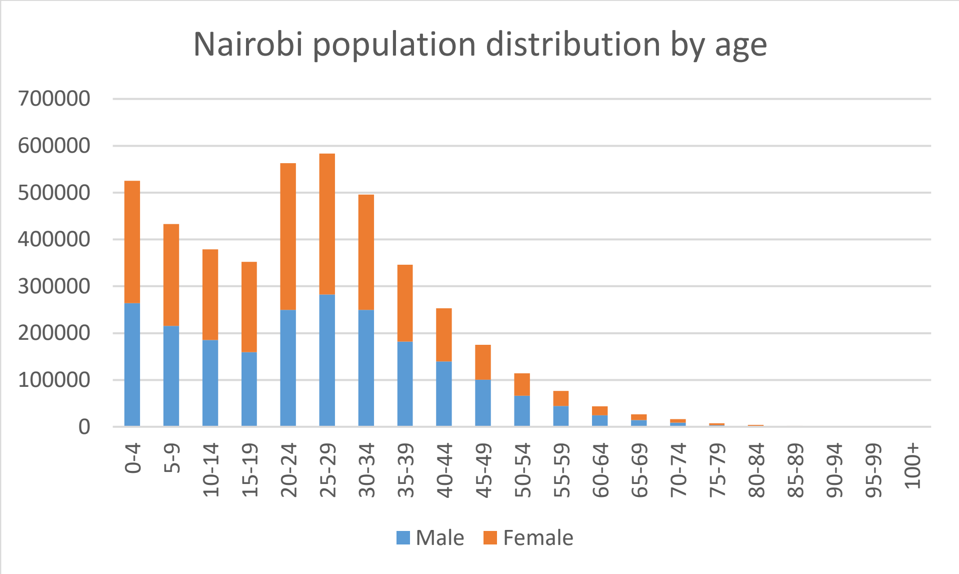
4.2 Findings & Discussion

4.2.1 Profile of Households in Nairobi County

According to (Kenya National Bureau of Statistics, 2019b), there are 1,494,676 households in Nairobi county with a total population of 4.3million residents. It is the most populous county in Kenya. 78.7% of this rent while 21.3% own their own homes.

Nairobi's population is majorly youthful. The group with the highest population is the 25-29 age group that has a total population of 583,548. The population distribution is as shown in Figure 4 below. Most of those who were interviewed were young. Their age ranged between age between 24 and 59. Their mean age was found to be 34. According to (Ministry of Youth Affairs, 2006) the youth are person resident in Kenya in the age bracket 15 to 30 years. This definition was however revised in the 2010 Kenyan Constitution to range from between 18 and 35years. This was done to account for the physical, psychological, cultural, social, biological and political definitions of the term. (State Department for Youth Affairs, 2019) reflects this through their acknowledgement that youth-hood is a period of transition and susceptibility when the youth have to learn, transitioning to work, forming families, stay healthy and safe, exercise citizenship and adhere to national values and principles of governance.

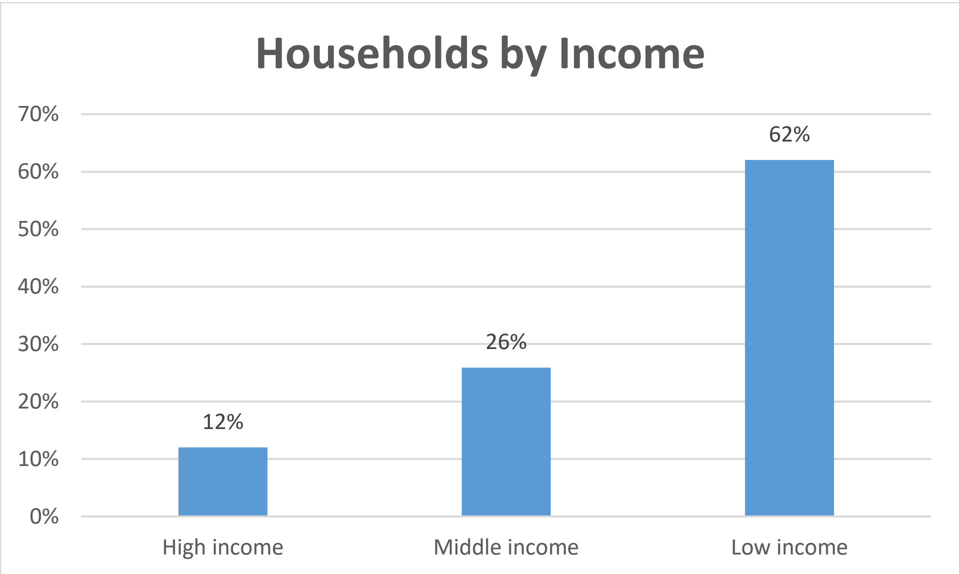
Figure 4: Nairobi population distribution by age



Source: Author manipulation of (Kenya National Bureau of Statistics, 2019a) data

Nairobi households are mainly supplied power from mains electricity (96.5%). The (Kenya National Bureau of Statistics, 2019b) found that 0.2% of the population used solar for lighting. This is significantly low compared to the national average of 19.3%. None of the households used solar for cooking fuel.

Figure 5: Households by Income



Source: Author

The socio-economic distribution of respondents was categorised based on the researcher's findings on the monthly expenditure they gave. The categories were based on the (Kenya National Bureau of Statistics, 2020) definition of low-, middle- and high-income segments of the population. According to the survey, low-income households were households whose monthly expenditure was Ksh23,670 or less. The middle-income category ranges between those whose monthly expenditure was Ksh23,671 to Ksh119,999. High-income households are those whose monthly expenditure was Ksh120,000 and above. This study, low-income households were 62%, middle income was 26% while high income was 12% as illustrated in Figure 5 below.

Household expenditure was used to determine respondent income. This data was collected as such as in the pilot study respondents were found to be reluctant to give this information; instead, respondents filled-in data on their expenditure for basic needs (housing, food, education & clothing) and entertainment expenses. This choice of indicators was informed by economic and social rights as enshrined in the Kenyan Constitution (The Constitution of Kenya, 2010). These were then summed for each respondent to derive their income. It was found to range between Ksh600,000 and Ksh5,000 with the median household expenditure of Ksh20,000 and a mean coming to about Ksh54,420.

Table 7: Descriptive Statistics on Expenditure of Households in Nairobi County

Expenditure	
Mean	54419.27711
Standard Error	6893.937732
Median	20000
Mode	18000
Standard Deviation	88822.17435
Sample Variance	7889378656
Kurtosis	15.87006492
Skewness	3.704778843
Range	595000
Minimum	5000
Maximum	600000
Sum	9033600
Count	166
Confidence Level (95.0%)	13611.70523

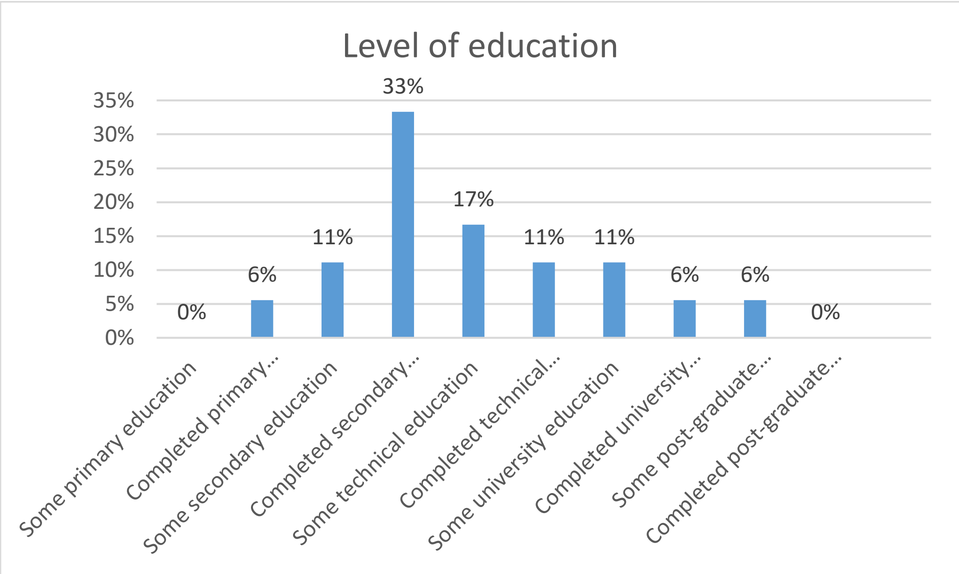
Source: Author Analysis

Most of the households in Nairobi County are close to main electricity power lines with the average distance between the house and the powerline being 11metres. This would explain high access to mains power and the low percentage of those using solar PV as was found in the 2019 census. Distance to mains was found not to be significantly different between households in different income areas as the regression factor for this was at 0.002879. Low-income households were, however, found to be too close to the mains. As many as 50% of them lived right under the mains lines, thus recording no distance between their household location and the main electricity power lines.

The average household size was found to be 3.38persons per household. The ratio of male to female was 1:1. There were slightly more males (51%) as heads of households as there were females (49%). Their distribution by economic status found that there were disproportionately more women as heads of households in low-income households (60%) as compared to other socio-economic groups.

All the respondents interviewed had achieved some level of formal education. Half of them had completed secondary education while the other half had either some or completed tertiary education. Their distribution by the level of education is as below.

Figure 6: Distribution of sample by the level of education



Source: Author analysis

Most of the respondents were members of saving and financial institutions at 56% and 94% respectively. 36% were members of a professional body, while 27% were members of a regulatory body. More women than men were members of saving institutions, as illustrated in Table 3 below. Some middle-income and low-income respondents identified more with informal saving and financing institutions otherwise called ‘chamas’ while those in higher income brackets identified with more formal institutions such as banks and Saving and Credit Co-operatives (SACCOs).

Table 8: Distribution of sample by membership in saving organizations

Gender	Member in saving org	Not member in saving org
Female	86%	14%
Male	36%	64%

Source: Author analysis

78% of them were also desirous of accessing financing for the purchase of solar PV units if it was to be provided by their respective financing institutions. However, many of them (61%) did not know whether the service was provided for by their respective financing institutions. Only 22% acknowledged having solar PV financing services from their financiers while 16% reported the service as not being available. 6% of respondents were members in institutions and groups that advocated for environmental conservation.

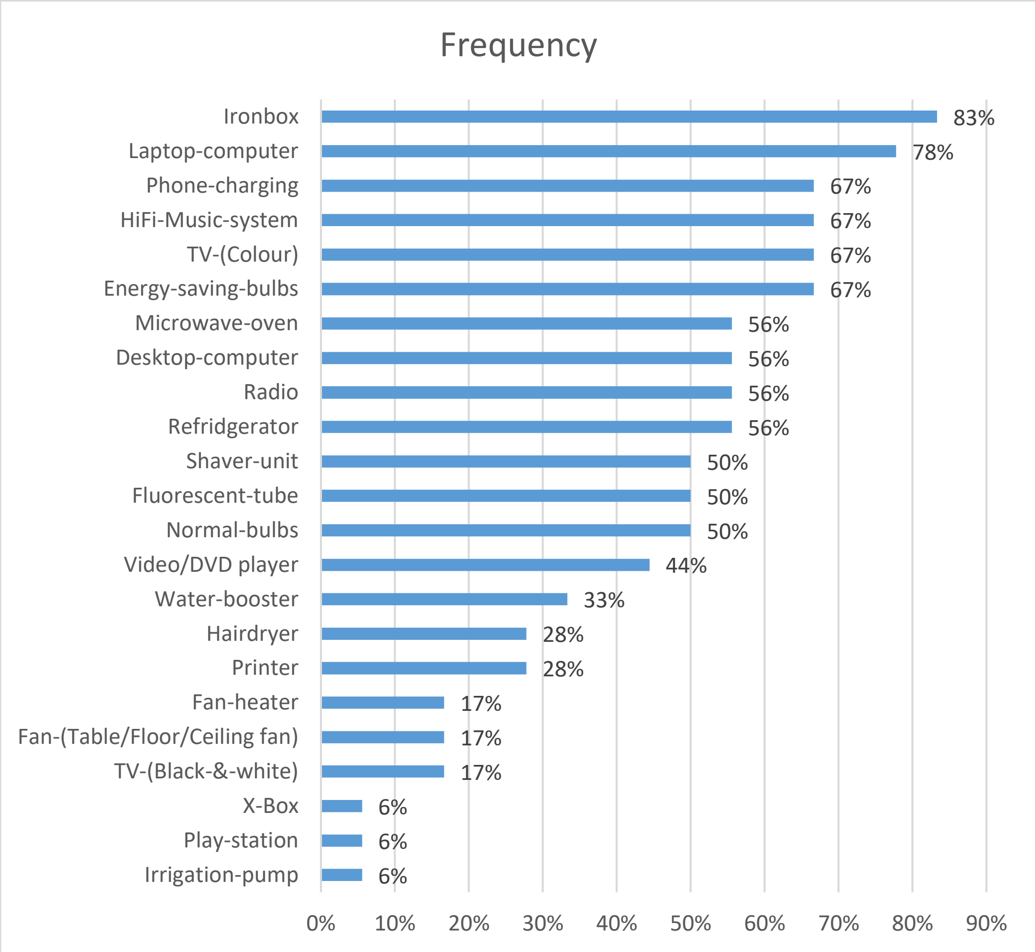
4.2.2 Solar PV Units Owned & Used by Households in Nairobi County

A sizable portion of the respondents (36%) were found to own solar PV gadgets and systems. Of these, only four individuals (representing 0.024% of the population) had solar home systems which they used on a regular basis. The rest of the respondents had some form of smaller PV unit such as torches, lighting, radio and phone charging systems. Torches and lighting systems were the most common gadgets (35.8%), most of which were used when the mains electricity power supply failed.

All the respondents who had installed solar home systems were also found to be owners of their houses. They also happened to own land and at least a car each. Two of the four were middle-class income earners while the other two were high-income earners. All those who were renters and owned solar PV systems had Pico units such as lighting torches, lamps and small phone charging devices.

The units were bought between 2014 and 2020. Bigger units were found to be older (2014-2019) while smaller units were found to be newer (2019-2020). All respondents wanted more of their electrical gadgets to be powered by solar. This quantity was noted to vary depending on the number of electrical appliances in the household; high-income households wanted more gadgets to be connected as compared to low-income households. The iron box was the gadget that was most desired to be connected to solar PV, followed by the laptop computer. X-box, play-station and irrigation pumps were the least desired to be connected as illustrated above.

Figure 7: Frequency of Appliances Desired by Respondents to be Powered by Solar PV

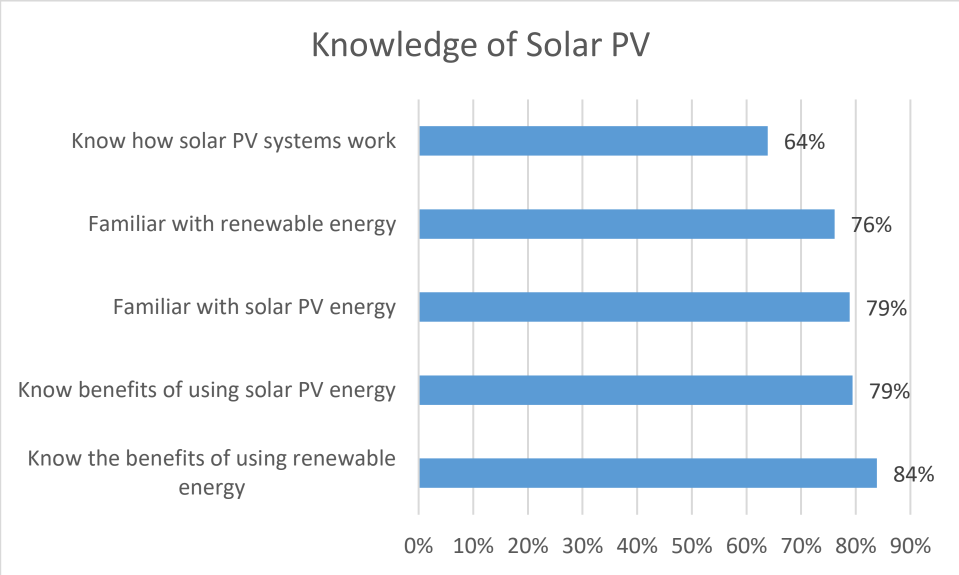


Source: Author Analysis

The most common modes of getting information about solar PV systems, their installation and maintenance were found to be that of 'observation of a neighbour installation' and ‘education/training forum’ at 43% each. Media advertising was found to be inferior to these two coming at 14%. None got to learn about solar PV through ‘observation of institution installation' or other means.

76% of Nairobi residents perceived themselves to be knowledgeable of solar PV. 84% of them said they knew of the benefits of using renewable energy and 89% solar PV in particular. Much as a significant number of them are familiar with the benefits of using solar PV, and this is not reflected in their ownership. This goes to show that knowledge alone is not the only factor that is considered in the purchase of solar PV.

Figure 8: Individual variable score for the measurement of knowledge of solar PV

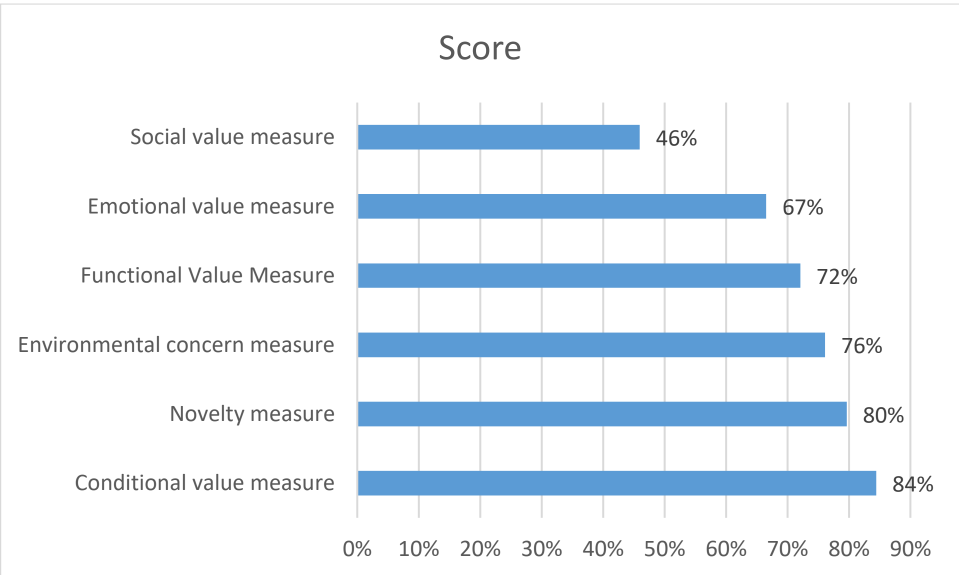


Source: Author

4.2.3 Perceptions of Solar PV Owners in Nairobi County

Perceived values were found to score in an exciting fashion. Social value had the lowest score among the respondents getting a 46% mark. This means that social pressure and peer pressure has the least effect in getting them to decide on whether they will adopt solar PV technology. This finding is consistent with the findings of (Lai, 2017; Viswanath Venkatesh & Bala, 2008) who postulated that for voluntary situations, social value is the least of values that affect renewable technology adoption. It also disproportionately scores lower in terms of range from the next value.

Figure 9: Score of perceived values

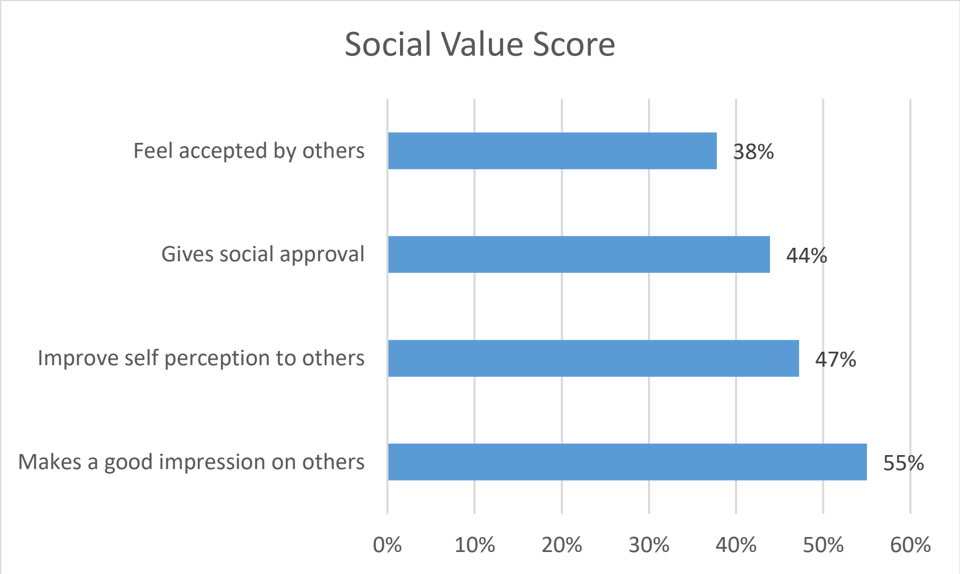


Source: Author

It is also consistent with the factor analysis factor that found it to be a variable that scored low compared to its counterparts. While other values differ by about four percentage points, social value has a range of 21 percentage points from the emotional value.

55% of the respondents thought that owning a solar PV unit would make a good impression on others, while 38% felt that owning a solar PV unit would make them socially acceptable. This was besides the fact that 57% of them belonged to a social or social organization.

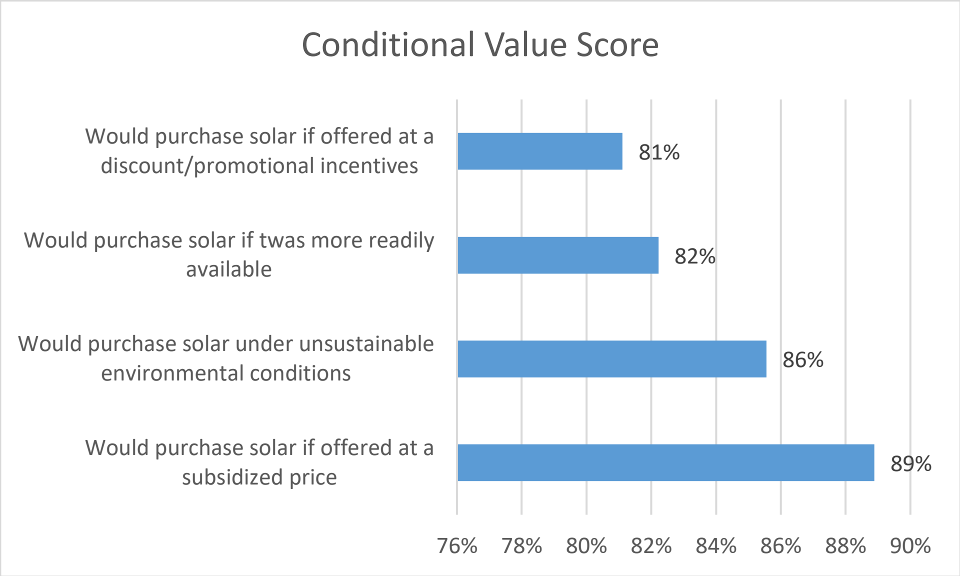
Figure 10: Social value individual variable scores



Source: Author

The conditional value was found to be the most robust perception that the respondents had, unlike other studies that found the functional measure to be the most significant. This high score for conditional value means that a sizable number of Nairobi residents would adopt solar PV, should conditions favouring the purchase of solar PV improve and vice-versa.

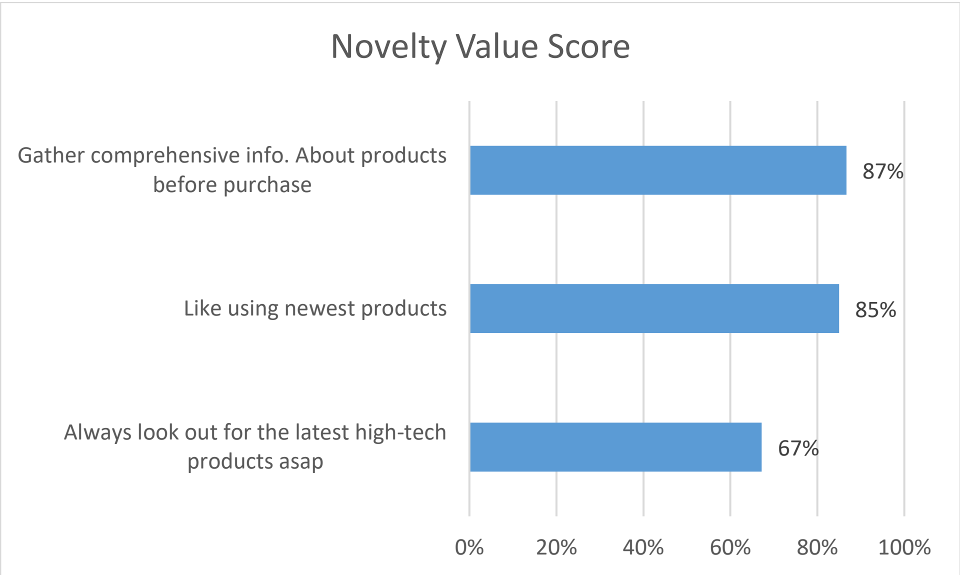
Figure 11: Conditional value individual variable scores



Source: Author

The condition that scored the highest is that which affects price; 89% of the respondents would purchase solar PV units if it were offered at a subsidized price and 81% if it was offered at a discount. This underscores the importance of pricing in determining consumption of solar PV. 86% of residents of Nairobi would also purchase solar PV under unsustainable environmental conditions.

Figure 12: Score of individual perceived novelty values



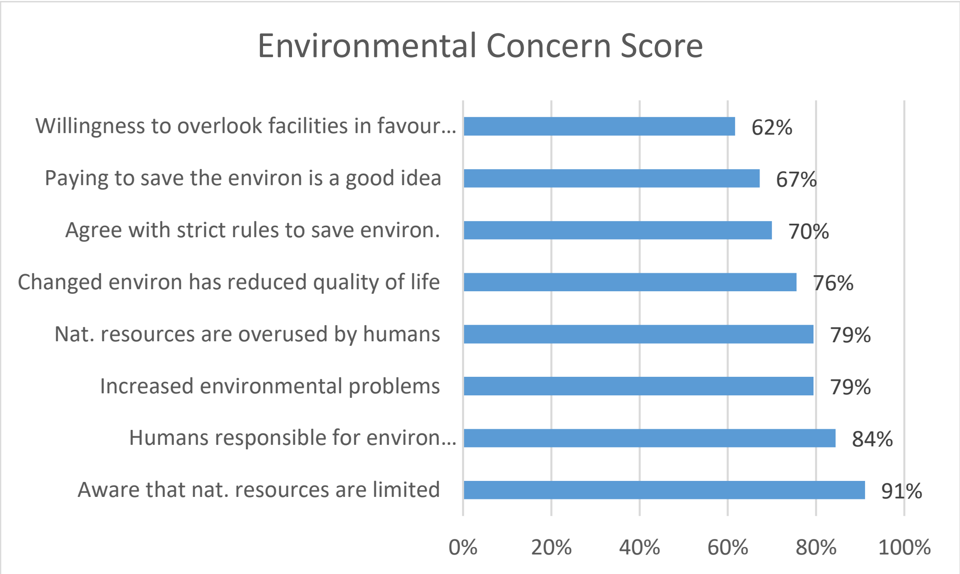
Source: Author

This was followed by the novelty measure at 70.95%. Residents of Nairobi were found to be conversant with technology in general and took time to study technology before making a purchase as their novelty measure indicated. Their score of environmental concern matched their score of the knowledge of solar PV at 76%. This may be a hint that they are learning of solar PV (and other renewable energy technologies) through environmental sensitization. This is, however, subject to further research.

Gathering comprehensive information about technology was the novelty indicator that scored the highest at 87%. This indicates that Nairobi residents try to find out as much as possible about new technologies before making a purchase. This could indicate that they are likely to gather information about solar PV before finally making a purchase. 85% of them like using the newest products. This means that as the solar PV technology improves and better gadgets released, households in Nairobi will purchase and utilise them. It also explains the tremendous growth in the consumption of solar PV gadgets that has been observed over the last decade.

Environmental concern was the third-highest measured perceived value having been given a score of 76%. This is a relatively high score considering that only 6% of those interviewed belonged to an environmental conservation society/group. It is interesting that the average score for this value tallies with their score for ‘the changed environment has reduced the quality of life’. Findings also show that 91% of residents of Nairobi are aware that environmental resources are limited. Regardless, fewer are willing to make sacrifices in favour of the environment. For example, 62% are willing to overlook facilities in favour of environmental conservation, 70% agree with the strict rule to conserve the environment, while 67% think that it is a good idea to pay to save the environment. This would also explain why 94% are not enrolled in environmental conservation groups.

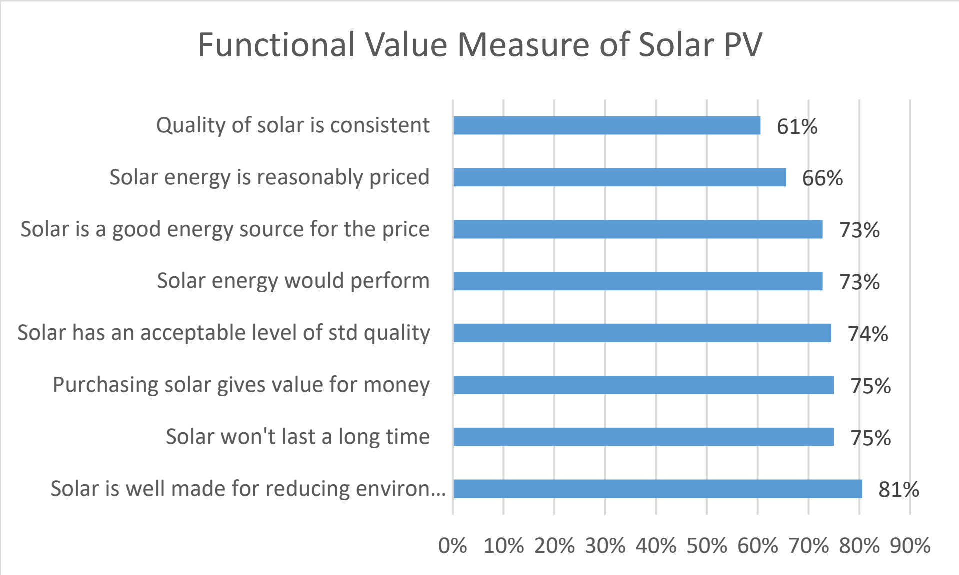
Figure 13: Individual variable scores of respondents' environmental concern



Source: Author

The functional value was one of the perceived values that were thought might have been among the highest of all perceived values. It was found to be a significant value having an overall score of 72% among Nairobi households. 81% of them perceived solar PV to be well made for reducing environmental distortion. 75% of them thought solar PV gives value for money, while 61% of them thought that solar PV energy is consistent.

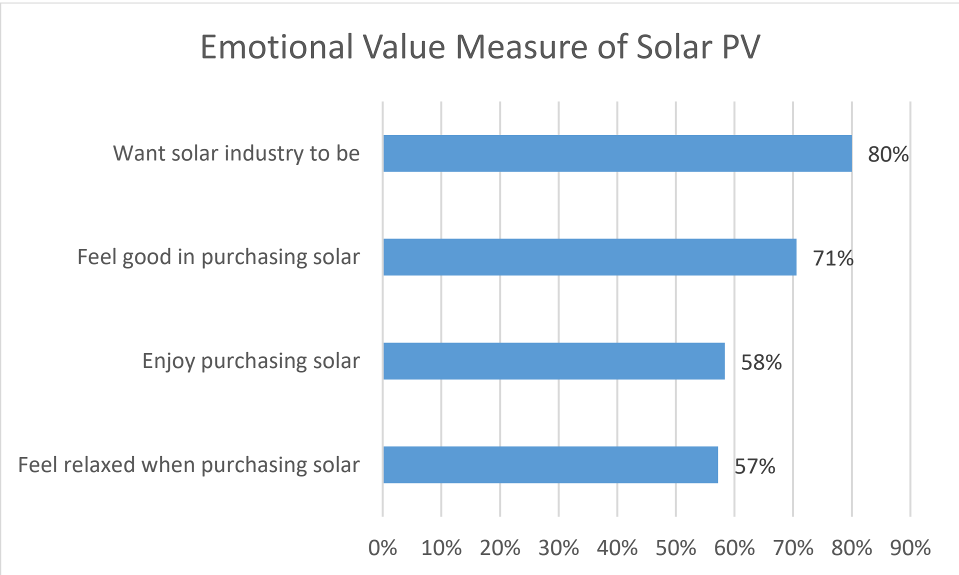
Figure 14: Score of individual perceived functional values



Source: Author

Emotional value perception attached to solar PV was found to be 67% among Nairobi households. This was found to be the second-lowest score after social value. 80% wanted the solar PV industry to be, 71% felt good to purchase solar PV, 58% enjoyed purchasing solar OV products, while 57% felt relaxed when purchasing solar.

Figure 15: Individual variable scores for emotional perceived value



Source: Author

4.2.4 The status of investment in solar PV

The status of investment in solar PV was determined by looking at the state of ownership of solar PV units in Nairobi. This was found to be relatively high (36%) compared with the 2019 census findings. This difference is explained in the difference of gadgets that were considered in the census. This study considered ownership of any solar PV unit while in the census, considered those who used solar PV consistently for lighting. Ownership of 36%, when compared to those that use grid electricity, is still relatively low, considering that 0.2% only use solar PV consistently. This means that 35.8% of households in Nairobi County use solar PV gadgets irregularly for when grid electricity power fails.

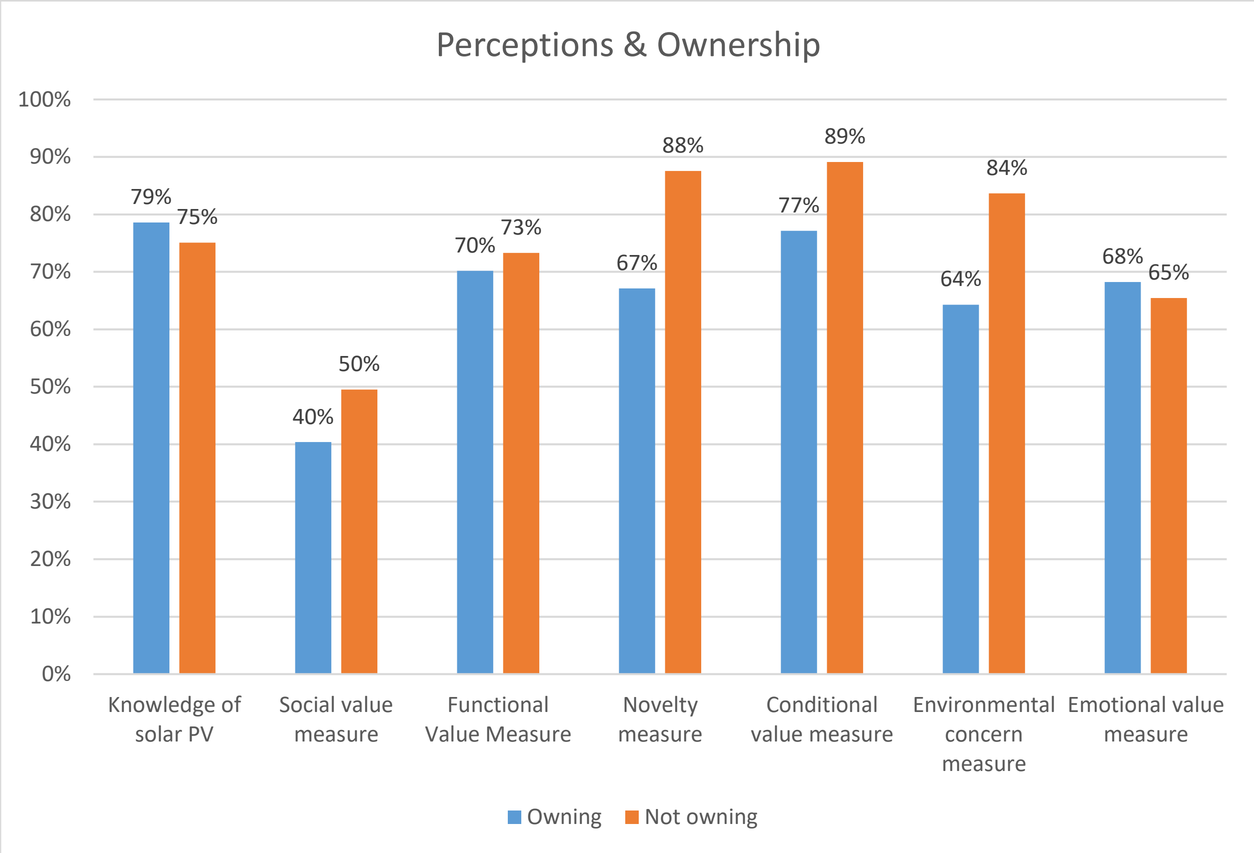
Income, which in this case was inferred from expenditure, was found to be a statistically significant predictor of adoption of solar PV technology with a regression index of 0.997. This may also explain why conditional value, especially that which affects the price of solar PV, is a strong perception among people in Nairobi. This is like findings of other researchers who also found income as a strong predictor of the adaptability of renewable energy (Bashiri & Alizadeh, 2017; Sadorsky, 2009; Sarkodie & Adom, 2018).

Knowledge was found to depend on other variables to determine ownership of solar PV. This is indicated by the high percentage of those who perceived themselves to be knowledgeable about solar PV (84%) even though the overall percentage of those who owned solar PV units was way lower (36%).

4.2.5 Perceived values and adoption of solar PV

Perceived values were found to differ among adopters and non-adopters. A look at the difference in margins between them shows that adoption is driven by emotional values and knowledge of solar PV. From Figure 16 above, there is a difference of 21% in the novelty value measure between owners and non-owners. This means that owned solar PV products were not as keen on following up and learning about technological development as compared to those that owned. Non-adopters were 20% more concerned with their environment compared to their adopting counterparts. This shows that environmental concern alone cannot be relied on to predict the adoption of solar PV. Similar results are also found when regression analysis is done.

Figure 16: Perceived values and Solar PV Ownership



Source: Author analysis

Linear regression was undertaken for all perceived values in relation to adoption. The aim of doing this was to establish if there existed linear relationship(s) between ownership of solar PV products and respective values and also to find how much the perceived values contributed to the decision on whether to adopt. It was found that all perceived values were not contradicting the linear assumption. Each perceived value, however, had differing relations with the dependent variable – ownership. Overall, perceived values, along with the knowledge and environmental concern, were responsible for 27% of the adoption decision, as shown in Table 8 below.

Table 9: Multiple Regression Analysis of Perceived Values

Regression Statistics	
Multiple R	0.273225
R Square	0.074652
Adjusted R Square	0.033655
Standard Error	0.475368
Observations	166

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	7	2.880395	0.411485	1.820937	0.08669
Residual	158	35.70394	0.225974		
Total	165	38.58434			

	Coeffi-cients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.751037	0.516489	1.454118	0.147897	-0.26908	1.771151	-0.26908	1.771151
Emotional value measure	0.094489	0.210369	0.44916	0.653932	-0.32101	0.509987	-0.32101	0.509987
Knowledge	0.331432	0.209754	1.580096	0.116085	-0.08285	0.745717	-0.08285	0.745717
Conditional value measure	-1.61702	0.503354	-3.21249	0.001595	-2.61119	-0.62285	-2.61119	-0.62285
Social value	-0.00129	0.138328	-0.00935	0.99255	-0.2745	0.271918	-0.2745	0.271918
Functional Value Measure	0.708198	0.872533	0.811658	0.418209	-1.01513	2.431531	-1.01513	2.431531
Novelty measure	0.178722	0.328048	0.544805	0.586656	-0.4692	0.826647	-0.4692	0.826647
Environmental concern measure	0.024585	0.321374	0.076499	0.939119	-0.61016	0.659329	-0.61016	0.659329

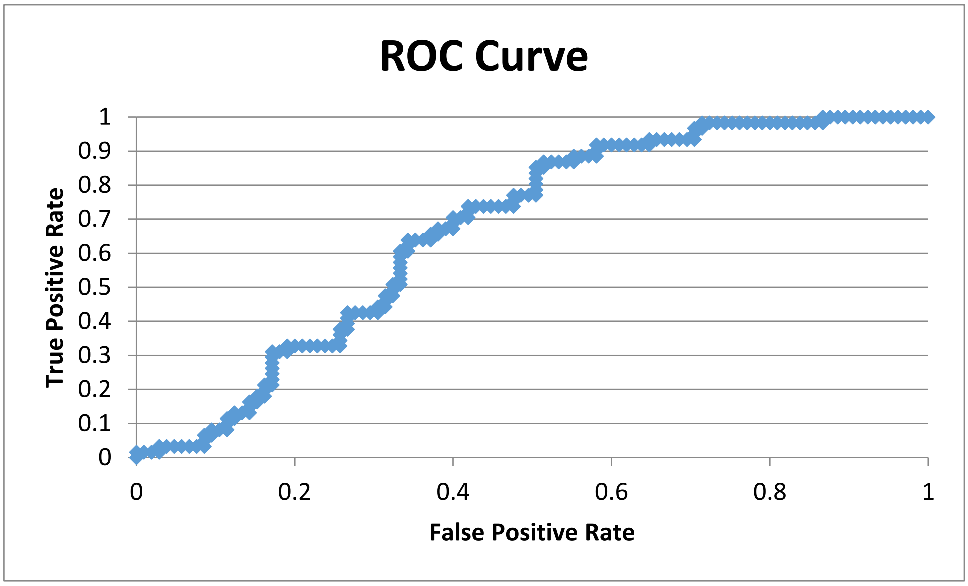
Source: Author analysis

From above, it is observable that knowledge has a positive effect on adoption having a t-statistic factor of 1.58. Functional value, novelty value and emotional value also influence ownership of solar PV units positively, although by a smaller margin. The conditional value was also found to be significantly affecting adoption, although in the negative sense. This means that more people are failing to adopt due to conditional issues.

It was also noted that conditional value has a linear relationship with the ownership of solar PV as indicated by a smaller p-value. Social value has the highest contradiction to the linear equation with a 99.23% coefficient. This means that is social value was to be represented in a scatter plot indicating adopters and non-adopters, there would be no linear patterns. Instead, points will be seen to be scattered all over the graph. Empirically, it can be interpreted to mean that both the adopters and non-adopters care for the environment and are socially responsible, but that does not influence their decision to adopt solar PV.

Further logistical regression analysis was done against the perceived values in order to establish how much-perceived values can predict adoption. Figure 17 below shows a receiver operating curve that indicates that it is possible to predict the adoption of solar PV based on perceived values. There exists a positive relationship between perceived values and adoption, as shown by the steady and gently sloping curve. Of 166 observations made, 86.6% were predicted accurately to have a positive impact on adoption.

Figure 17: Receiver operating curve indicating adoption based on perceived values



Source: Author analysis

Table 10: Predictability of Adoption Based on Individual Perceived Values

	coeff b	*s.e.*	*Wald*	*p-value*	*exp(b)*	*lower*	*upper*
Intercept	1.669887	2.374558	0.494548	0.481905	5.311569		
Emotional value measure	0.313147	0.964976	0.105309	0.74555	1.367723	0.206352	9.065397
Knowledge	1.665268	0.998556	2.78114	0.09538	5.287089	0.746868	37.42738
Conditional value measure	-9.03477	3.079248	8.608841	0.003345	0.000119	2.85E-07	0.049809
Social value	0.034233	0.626218	0.002988	0.956404	1.034826	0.30327	3.53106
Functional Value Measure	3.342737	4.110117	0.661449	0.416049	28.29648	0.008978	89180.64
Novelty measure	1.441445	2.212124	0.424597	0.514652	4.226799	0.055341	322.8308
Environmental concern measure	0.412631	1.553711	0.070531	0.790565	1.510787	0.071892	31.74859

Source: Author analysis

This means that with a combination of the perceived values, environmental concern, and knowledge yield a probability of adoption index of 0.866, which is relatively high. This underscores that perceived values are but a small part of the factors that affect adoption, even though they are equally important. This is emphasised when the regression is undertaken without perceived values. Table 10 below shows that these factors influence the adoption of solar PV drops from 0.27 to 0.098, representing a 17.2% difference.

Table 11: Influence of Conditional Variables on Solar PV Adoption

Regression Statistics	
Multiple R	0.098589
R Square	0.00972
Adjusted R Square	-0.00862
Standard Error	0.485654
Observations	166

ANOVA

	df	SS	MS	F	Significance F
Regression	3	0.375032	0.125011	0.53002	0.662301
Residual	162	38.20931	0.23586		
Total	165	38.58434			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	0.328387	0.181418	1.810114	0.072131	-0.02986	0.686635	-0.02986	0.686635
Expenditure	-3E-07	4.26E-07	-0.71428	0.476083	-1.1E-06	5.37E-07	-1.1E-06	5.37E-07
Knowledge of solar PV	0.184814	0.186588	0.990495	0.323409	-0.18364	0.553271	-0.18364	0.553271
Environmental concern measure	-0.11224	0.188614	-0.59509	0.552613	-0.4847	0.260217	-0.4847	0.260217

Source: Author analysis

This is also witnessed with a logit model for income, knowledge and environmental concern. The predictability drops when perceived values are omitted by 23.35% to 63.25% as worked form the logit table below (Table 11).

Table 12: Logit Model of Conditional Variable Influence on Adoption of Solar PV

	coeff b	s.e.	Wald	p-value	exp(b)	lower	upper
Intercept	-0.71563	0.783881	0.833442	0.361279	0.488885		
Expenditure	-1.4E-06	2E-06	0.51486	0.473043	0.999999	0.999995	1.000002
Knowledge of solar PV	0.813161	0.814531	0.99664	0.318125	2.255026	0.4569	11.12965
Environmental concern measure	-0.49491	0.810503	0.372851	0.541454	0.609629	0.124498	2.985152

Source: Author analysis

Factor analysis was determined for the income variable along with perceived values in order to determine whether there existed local independence within each variable. The first factor that is influenced by income is the functional value (87.7%), followed by novelty value (76.9%), conditional value (76.7%), then the emotional value (39.4%) and finally social value (9.6%). However, further analysis of the factor was found to be statistically unnecessary as it was established to be the least factor variable having a factor of 0.28, followed by social value at 0.48 (Refer to table 7 above). This verdict is consistent with theoretical predictions that social value in voluntary conditions will not be a significant factor for adoption.

Table 13: Unrotated Factor Matrix for Perceived Values and Expenditure

	1	2	3	4	5	6
Emotional value measure	0.394419	-0.65205	0.191445	-0.5173	0.338735	-0.01949
Conditional value measure	0.767672	-0.08334	-0.05834	-0.25847	-0.54671	0.186082
Social value	0.096169	-0.13366	0.918849	0.341645	-0.10931	0.00782
Functional Value Measure	0.877645	0.112267	-0.09666	0.183166	0.003855	-0.41742
Novelty measure	0.769549	0.3257	-0.03492	0.256271	0.382323	0.297754

Source: Author

This finding on income leads one to conclude that all income groups are equally influenced by income to purchase solar PV products. The only difference might be in the amount set aside for purchase and the size of the unit that is purchased.

From the findings, it is clear that perceived values have an influence in the adoption of technology, with specific reference to solar PV in Nairobi county. The conditional value was found to be the most influential empirically and significant statistically. Functional, novelty and environmental concern were also found to influence adoption, although by a smaller factor compared to conditional value. Social value was found to have the least influence.

Other conditioning variables such as environmental concern and knowledge were found to have a positive effect in predicting the probability of adoption. They were noted to be significant as the probability of adoption reduced when they were omitted in the logit regression model.

CHAPTER FIVE

5. RECOMMENDATIONS AND AREAS OF FURTHER STUDY

5.1 Conclusion

The study set out to find out the status of investment in solar PV for electricity generation for Nairobi households. The study found that 36% of households use various forms of solar PV, while 0.2% of them used solar PV systems continuously. The percentage of those with solar PV is higher compared to that found in the household survey. This can be enlightened by the difference in consideration of the type of solar PV and its usage. In this survey, any gadget that was used to produce any form of solar electricity was considered while in the census, only those that were used regularly for lighting were considered. Overall, the study found that investment in solar PV energy systems is low in Nairobi County.

The dissertation also sought to find out the perceived values that were most significant to households in Nairobi county. These were found to perform as follows; conditional value (84%), novelty value at (80%), environmental concern and knowledge of solar PV (79%), functional value (72%), emotional value (67%) and social value (46%). Social value was found to score significantly lower than the other perceived values, which means that it had the lowest influence on whether households in Nairobi County would adopt solar PV technology.

5.2 Recommendations

This study set out to find out the state of solar PV adoption in Nairobi County through measurement of the state of ownership. It found that indeed a portion of residents of Nairobi do own solar PV units. These units are owned and kept in case of failure of mains power mostly for purposes of lighting. The need to have other electrical gadgets connected to solar PV was identified. Manufacturers are therefore encouraged to device systems and products that can be used to fulfil this need.

It was also found that solar PV systems are highly specialised. This has made them complex to understand especially for consumers. There is a need for getting simpler Pico units that can easily be maintained by the owners. Most of the Pico units that are in the market can be recharged by either solar power or mains electricity, which is a factor that has made them more popular. They can, however, be made in a wide range to cover for more functions besides lighting and phone charging. Manufacturers and innovators can think of also developing 'stand-alone-plug-and-play' gadgets to remove the complexity of making connections to larger solar PV systems.

The issue of pricing was also noted to be sensitive to promoting consumption of solar PV. It would be necessary for the government and solar PV innovators to work out pricing mechanisms that make solar PV systems competitive for the price. The government can consider pricing incentives such as Tax incentives, promotional incentives innovation incentive etc.

Financing was noted to be a need among the residents of Nairobi County. Financiers can think of providing products that are aimed at financing renewable energy products, including solar PV. It would also be necessary if financiers communicated the availability of these products to their clientele. This is because it was noted at that as much as 60% of the respondents did not know whether this product was offered by their financier. Of the 20% that we are aware of the availability of solar financing, 80% of them admitted to wanting access to the product.

In terms of perceptions, it was noted that most respondents considered conditions as the most important in determining whether they would purchase a solar PV product. It is therefore, vital for the government to set up policies that better the conditions for the use of solar PV.

Solar PV vendors are also encouraged to market their products more aggressively by using media advertisement. It was noted that most of the consumers of solar PV found out about solar PV technology by observing their neighbours. This may be one of the ways to spread knowledge about solar PV systems and how they can be beneficial to consumers without risking miss-information and distortions that consumers may be exposed to by just observation of their neighbours. Institutions are also encouraged to train more about technology.

Homeownership was found to be a factor for the type of solar PV unit installed. Those that owned their own homes seemed to be more motivated in purchasing more effective systems such as the solar home system while those who rented seemed to be content with smaller mobile units. The government could encourage the consumption of larger units by encouraging homeownership, especially in urban areas.

5.3 Areas for further research

There has been a limited study in terms of the level and renewable energy consumption patterns in Kenya, and so there is little in terms of empirical evidence in this regard. The closest studies that are related to renewable energy consumption in Kenya relate to market segments with more emphasis on household consumption. It would be interesting to assess consumption patterns, especially in the commercial sector, since this is a trend that is newly emerging and has a more significant sustainability effect in the economy.

In the preparation of the paper, it was also noted that there is need to study the relationships between income, expenditure and consumption of renewable energy, with particular attention being given to solar PV energy in developing and emerging economies. This is because these areas are facing growing energy demand that is more acute as compared to other areas. They are also in need of energy policies that are informed by the per capita income – renewable energy consumption patterns.

Another area that would require further research is that of behaviour. It would be interesting to understand why residents of Nairobi are not willing to make sacrifices in favour of the environment. This is the case despite their being aware of environmental issues.

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7.

APPENDICES

8. Structured Questionnaire

8.1.1 General Information

The interviewer is to enter this information from their own observation.

a) The approximate distance between grid line and the house of respondent. ***(Count the number of walking steps from the power line to the respondent's house and enter the number) ... Enter number*** …

b) Date of interview: Click here to select a date.

c) General location details ***(All locations to be within Nairobi County)***

Constituency	***Choose an item***….
Ward	***Choose an item***….
Estate/Village	***Enter estate/ village name*** …

d) Developmental status of area ***Select 1 option only***

Low-income area ☐

Middle-income area ☐

High-income area ☐

8.1.2 Introduction

My name is Mercyline Aseti, and I am a student at the Institute for Development Studies at the University of Nairobi. I am undertaking a research project that seeks to understand the perceptions that Nairobians have toward Solar PV installations and how those perceptions may have influenced their adoption or non-adoption of Solar PV. Your household has randomly been selected to take part in this survey. Your responses will be treated confidentially. You will also not be penalised for not participating so please feel free to answer the questions to the best of your knowledge. This interview will last approximately 20 minutes.

1. Will I get the head of your household to participate?

YES☐ NO☐

(If Yes, Proceed to Qn 3. if No Proceed to Qn 2.)

2. Why?

He/she is not available at the time of the interview ☐

Declined to participate ☐

Household/ Premises empty ☐

8.1.3 Section I: Respondent Demographics

3. Thank you for taking the time to participate. I will start by getting some information about yourself and your household.

i. What is your name? ... ***Enter your first name*** …

ii. Gender: Male ☐ Female☐

iii. How old are you? ... ***Enter number*** …

iv. How many people live in your household?... ***Enter number*** …

v. What did you do to earn a living last month?... ***Enter job designation*** …

vi. Average monthly expenditure indicators in the household

Do you own a car?	YES☐	NO☐
Do you own land?	YES☐	NO☐
Is your house owned or rented?	Owned☐	Rented☐
How much do you spend monthly on housing?	.. ***Enter number*** …	
How much do you spend monthly on clothing?	.. ***Enter number*** …	
How much do you spend monthly on food?	.. ***Enter number*** …	
How much do you spend on education expenses?	.. ***Enter number*** …	
How much do you spend on transport?	.. ***Enter number*** …	
How much do you spend on entertainment and recreation?	.. ***Enter number*** …	

vii. What is your highest level of education? ***Select 1 option only***

Some primary school education ☐

Completed primary school education ☐

Some secondary school education ☐

Completed secondary school education ☐

Some technical education ☐

Completed technical education ☐

Some university education ☐

Completed university education ☐

Some post-graduate education ☐

Completed post-graduate education ☐

viii. Are you a member of any of the social organizations below? ***Select 1 option either YES or NO only***

Saving organization, e.g., Chama or Sacco	YES☐	NO☐
A professional body, e.g., KNUT	YES☐	NO☐
A regulatory body, e.g., TSC	YES☐	NO☐

ix. Are you a member of any association or group that advocates for environmental preservation or protection? ***Select 1 option only***

YES☐ NO☐

If yes, Proceed to Qn 3x If no Proceed to Qn 3xi

x. Please name it. …***Enter organization name***….

xi. Are you a member of a financing institution, e.g. a Bank or Sacco? ***Select 1 option only***

YES☐ NO☐

xii. Does your financing institution provide you with facilities to finance solar installations, e.g. loans? ***Select 1 option only***

YES☐ NO☐ DON'T KNOW☐

xiii. If financing facilities for solar products was provided by your bank, would you like to access it? ***Select 1 option only***

YES☐ NO☐

xiv. Do you own a solar PV unit, that is, one that produces electricity? ***Select 1 option only***

YES☐ NO☐

If yes, Proceed to Qn 4 If no Proceed to Qn 7

8.1.4 Section II: Solar PV Demand and Consumption Patterns

4. When did you purchase your Solar PV Unit? …***Enter year*** …

5. How did you find out about solar PV? ***(Select one or multiple choices)***

Media advertisement	☐
Observation of neighbour installation	☐
Observation of institutional installation	☐
Educational forum/training	☐
Other	…***Specify***…

6. What type of solar PV unit do you have installed? ***(Select one or multiple choices)***

Lighting & phone charging kit	☐
Lighting kit	☐
Phone charging kit	☐
Solar home system	☐
Mini-grid connection	☐
Security & street lighting	☐
Other	… ***Specify*** …

7. Please indicate the number of appliances that are currently using grid power that you would like to be completely connected to your solar PV system. ***(You can select multiple choices. The blank rows are left for you to add any other appliances you may be using in your house)***

Filament/Normal round bulbs	☐
Fluorescent tubes (18-75W)	☐
Energy-saving bulbs (11-21W)	☐
Refrigerator	☐
TV (Colour)	☐
TV (Black and white)	☐
Video/DVD	☐
HiFi Music system	☐
Radio	☐
Desktop computer	☐
Laptop computer	☐

Printer ☐

Iron box ☐

Microwave oven ☐

Phone charging ☐

Fan (Table/Floor/Ceiling fan) ☐

Fan heater ☐

Water booster pump ☐

Shaver unit ☐

Hairdryer ☐

Others … *Specify* …

… *Specify* …

… *Specify* …

8.1.5 Section III: Measure of Perceived Values

I'll now ask you questions in relation to your solar PV installation and what your perception is toward the system.

8. On a scale of 1 to 10; one being "very strongly disapprove" and 10 "very strongly approve", how would you say you feel about the environment in relation to global warming and environmental degradation? ***(Select 1 score only per row)***

Environmental concern Measure	**Score**									
Environmental problems have increased recently	1.☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	7. ☐	8. ☐	9. ☐	10. ☐
Humans are the most responsible factors of environmental changes	1.☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	7. ☐	8. ☐	9. ☐	10. ☐
Changing the environment has reduced human's quality of life	1.☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	7. ☐	8. ☐	9. ☐	10. ☐
Paying to save the environment is a good idea	1.☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	7. ☐	8. ☐	9. ☐	10. ☐
I am willing to overlook some facilities of my life in favour of the environment	1.☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	7. ☐	8. ☐	9. ☐	10. ☐
I agree with some strict rules and taxes in favour of saving the environment	1.☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	7. ☐	8. ☐	9. ☐	10. ☐
I am aware that natural resources are limited	1.☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	7. ☐	8. ☐	9. ☐	10. ☐

Environmental concern Measure	**Score**									
Natural resources have been overused by humans	1.☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	7. ☐	8. ☐	9. ☐	10. ☐

9. On a scale of 1 to 10; one being "very strongly disapprove" and 10 "very strongly approve", how would you rate your likelihood to buy the latest technology and innovation products? ***(Select 1 score only)***

Novelty seeking Measure	**Score**									
I would like to use the newest products	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	7. ☐	8. ☐	9. ☐	10. ☐
I always lookout for the latest high-tech products as soon as possible	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	7. ☐	8. ☐	9. ☐	10. ☐
Before buying new products, I usually gather comprehensive information about them	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	7. ☐	8. ☐	9. ☐	10. ☐

10. On a scale of 1 to 10; one being "very strongly disapprove" and 10 "very strongly approve", how would you rate your knowledge or familiarity with renewable energy systems? ***(Select 1 score only)***

Measure of knowledge of solar PV	**Score**									
I am familiar with renewable energy	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	7. ☐	8. ☐	9. ☐	10. ☐
I know the benefits of using renewable energy	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	7. ☐	8. ☐	9. ☐	10. ☐
I am familiar with solar PV energy	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	7. ☐	8. ☐	9. ☐	10. ☐
I know the benefits of using solar PV energy	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	7. ☐	8. ☐	9. ☐	10. ☐
I know how solar PV systems work	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	7. ☐	8. ☐	9. ☐	10. ☐

11. On a scale of 1 to 10; one being "very strongly disapprove" and 10 being "very strongly approve", how would you rate the performance of solar PV systems? ***(Select 1 score only)***

Functional Value Measure	Score									
Quality of solar energy is consistent	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	7. ☐	8. ☐	9. ☐	10. ☐
Solar energy is well made for reducing environment distortion	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	7. ☐	8. ☐	9. ☐	10. ☐
Solar energy will last a long time	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	7. ☐	8. ☐	9. ☐	10. ☐
Solar energy has an acceptable level of standard quality	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	7. ☐	8. ☐	9. ☐	10. ☐
Solar energy would perform compared to other electricity sources	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	7. ☐	8. ☐	9. ☐	10. ☐
Solar energy is reasonably priced	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	7. ☐	8. ☐	9. ☐	10. ☐
Purchasing solar energy gives value for money	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	7. ☐	8. ☐	9. ☐	10. ☐
Solar energy is a good energy source for the price	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	7. ☐	8. ☐	9. ☐	10. ☐

12. On a scale of 1 to 10; one being “very strongly disapprove” and 10 “very strongly approve”, how would you rate the conditions that influenced or are likely to influence your purchase of a solar PV system? ***(Select 1 score only)***

Conditional Value Measure	Score									
I would purchase solar energy over conventional energy if offered at a subsidized rate	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	7. ☐	8. ☐	9. ☐	10. ☐
I would purchase solar energy over conventional energy if offered at a discount or with other promotional incentives	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	7. ☐	8. ☐	9. ☐	10. ☐
I would purchase solar energy over conventional energy if it was more readily available	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	7. ☐	8. ☐	9. ☐	10. ☐
I would purchase solar energy over conventional energy under unsustainable environmental conditions	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	7. ☐	8. ☐	9. ☐	10. ☐

13. On a scale of 1 to 10; one being “very strongly disapprove” and 10 “very strongly approve”, how would you rate the emotional attachments that influenced or are likely to influence your purchase of a solar PV system? ***(Select 1 score only)***

Emotional Value Measure	**Score**									
I enjoy purchasing solar PV energy	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	7. ☐	8. ☐	9. ☐	10. ☐
I want solar energy industry to be	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	7. ☐	8. ☐	9. ☐	10. ☐
I feel relaxed when I purchase solar PV energy	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	7. ☐	8. ☐	9. ☐	10. ☐
Purchase of solar energy would make me feel good	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	7. ☐	8. ☐	9. ☐	10. ☐

14. On a scale of 1 to 10; one being “very strongly disapprove” and 10 “very strongly approve”, how would you rate the social attachments that or are likely to influence your purchase of a solar PV system? ***(Select 1 score only)***

Social Value Measure	**Score**									
Purchasing solar energy would make me feel accepted by others	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	7. ☐	8. ☐	9. ☐	10. ☐
Purchasing solar energy would improve how others perceive me	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	7. ☐	8. ☐	9. ☐	10. ☐
Purchasing solar energy would make a good impression on others	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	7. ☐	8. ☐	9. ☐	10. ☐
Purchasing solar energy would give me social approval	1. ☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	7. ☐	8. ☐	9. ☐	10. ☐

For purposes of verification or further reference, kindly fill in your phone number ***here***. Please click on the button below to submit the questionnaire

Kindly submit your filled questionnaire to mercylina2@gmail.com or via WhatsApp on +254738135379

Thank you so much for your time.