ASSESSING THE FACTORS INFLUENCING THE ADOPTION OF OFF GRID RENEWABLE ENERGY TECHNOLOGIES IN KENYA. A CASE FOR KISII COUNTY.

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Assessing the factors influencing the adoption of off grid renewable energy technologies in Kenya - a case for Kisii County.

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DECLARATION.

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

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APPROVAL

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DEDICATION

To my two sons, Michael and Marktom, your unwavering smile and boundless love has been the cornerstone of my journey through this dissertation. Your patience and understanding have given me the strength to push on through challenges and celebrate triumphs.

To my parents, and my in-law TJ, your guidance, wisdom, and unwavering belief in me have played an indispensable role in shaping this dissertation. Your insightful comments and thoughtful advice have helped refine my ideas and strengthen my arguments.

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ABBREVIATIONS

BIPV	Building Integrated Photovoltaics.
EU	European Union.
GHG	Greenhouse Gas.
GWh	Gigawatt hours.
KIHBS	Kenya Integrated Household Budget Survey.
KNBS	Kenya National Bureau of Statistics.
OGRET	Off-Grid Renewable Energy Technology.
PEOU	Perceived Ease of Use.
PU	Perceived Usefulness.
RE	Renewable Energy.
REREC	Rural Electrification and Renewable Energy Corporation.
SDG	Sustainable Development Goal.
SETA	Sustainable Energy Technical Assistance.
SSA	Sub-Saharan Africa.
TAM	Technology Acceptance Model.

ABSTRACT

Developing resilient energy systems is imperative for enhancing electricity accessibility, mitigating greenhouse gas emissions, and improving the welfare of residents in remote areas. However, many Sub-Saharan Africa countries with inadequate national power distribution systems often overlook energy provision in remote settlements due to their geographical isolation, low electricity demand, and limited financial resources. This study addresses the critical factors surrounding the low uptake of Off-Grid Renewable Energy Technologies (OGRETs) in Kisii County, Kenya, aiming to assess the constraints households face in adopting these technologies. Anchored in the Technology Acceptance Model (TAM) and the Diffusion of Innovation theory, the research investigates how technological characteristics, socioeconomic conditions, environmental considerations, and psychosocial factors influence the adoption of OGRETs. The study is aligned with Sustainable Development Goal 7 (SDG7) and aims to contribute to meet the Kenya's Vision 2030 and climate change agenda by tackling the slow progress towards universal energy access. Utilizing a cross-sectional survey employing structured questionnaires incorporating the TAM framework with Likert scale responses, data were collected from a sample of 400 households. Analysis involved inferential statistics and a multiple regression. The findings highlight environmental concerns as a significant driver of adoption, with higher levels of concern positively associated with increased adoption. Additionally, risk and trust, awareness levels, relative advantage, and ease of use displayed significant positive associations. However, initial cost and financial incentives showed minimal impact. Policymakers should prioritize implementing targeted financial incentives and support mechanisms, alongside comprehensive awareness campaigns, to promote OGRET adoption in Kisii County, Kenya.

Keywords (Energy access barriers, renewable energy adoption, renewable energy technologies, off-grid, Technology Acceptance Model, sustainable energy, energy access)

CHAPTER ONE

1.1 Introduction.

This chapter establishes the essential groundwork for the study by first exploring its background and delving into the energy scenario in Kenya. It introduces the problem statement, highlighting core issues within the energy sector, which in turn informs the research objectives and shapes the formulation of research questions. Furthermore, this section outlines the study's scope and significance, elucidating its potential impact and contributions.

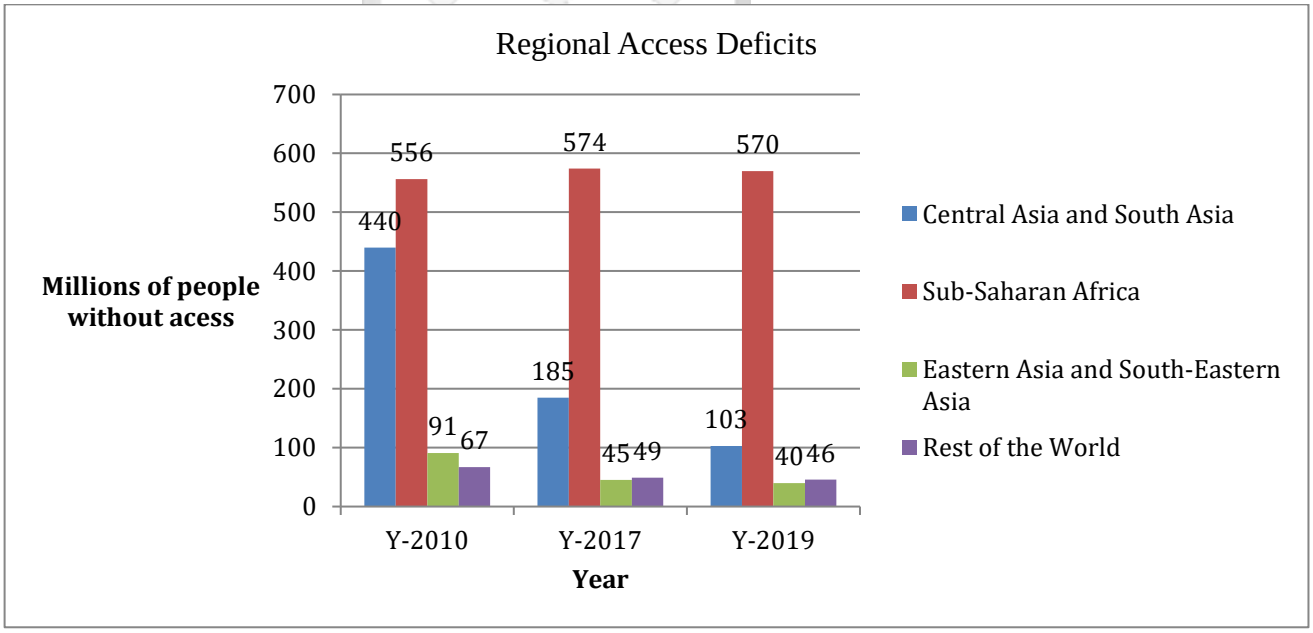
1.1.1 Background of the Study.

Sustainable Development Goal 7 (SDG7), a cornerstone of the 2030 Agenda, underscores the urgent need to achieve "affordable, reliable, sustainable, and modern energy for all" by the end of the year 2030. The SDG7 aims to ensure everyone has access to electricity and enjoys availability of clean cooking solutions, increase the utilization of Renewable Energy (RE) sources, enhance community energy efficiency practices, and foster international collaboration to bolster clean energy initiatives. When a country enjoys sustainable electricity production, it acts as a catalyst in meeting the other international developments initiatives thus it plays a pivotal role in providing jobs, spurring economic development, ensuring peaceful coexistence, and advancing the availability of various developmental programs for women (Bukari et al., 2021; SDG, 2020).

Despite significant global advancements in electrification, evidenced by a reduction where the numbers of households who do not have electricity were about1.15 billion as at the year

2010 and they reduced to 755 million in the year 2019, there still exist regional disparities (Figure 1). Asia has played a significant role in driving improvements, notably reducing its un-electrified population. However, Africa, marked by a rapidly growing population, has experienced only marginal progress. The 2023 Tracking SDG7 Report underscores the distinctive challenge of insufficient access of clean energy in Sub-Saharan Africa (SSA) mostly in rural places, which constitutes 75% of the rural population globally. This challenge requires special attention to meet the SDG7 by 2030 (S. C. Bhattacharyya & Palit, 2021; International Energy Agency, 2023).

Figure 1: Regional access deficits (in millions of people without access) for 2010, 2017, and 2019



Source of Data: World Bank, 2021.

On a global scale, sub-Saharan Africa encompasses 75 percent when looking at the entire population lacking access to electricity. Figure 1 illustrates that the region's deficit in access has risen from 556 million individuals in the year 2010 to about 570 million in the year 2019. Notably, while the overall statistics of individuals lacking electricity increased in sub-Saharan Africa, growing from 33 percent as at 2010 to about 46 percent in the year 2019,

the proportion has decreased due to quick population expansion. This suggests that electrification efforts are struggling to keep pace with the expanding population, particularly evident in countries like Malawi, the Democratic Republic of the Congo and Nigeria. In Mali and Kenya, advancements in electrification have outperformed their annual population growth.

Sub-Saharan Africa faces distinctive challenges in achieving SDG7. In terms of clean cooking access, Sub-Saharan Africa faces persistent hurdles. As of 2021, approximately 900 million people coming from the region lack access to clean cooking facilities. Stagnation in progress since 2010 poses a critical challenge, leading to severe health implications, including millions of deaths annually due to exposure to cooking smoke. Without urgent and substantial interventions, the region is poised to fall significantly short of its clean cooking target by 2030. In a 2011 study, the International Energy Agency (IEA) highlighted the efficacy of grid expansion for urban areas and around 30% of rural regions without electricity access. However, the remaining 70% of un-electrified rural areas are deemed more suitable for off-grid systems. The IEA further estimates that to achieve universal energy access by 2030, decentralized systems should cater to approximately 43% of the un-electrified population (International Energy Agency, 2019).

Kenya, positioned in East Africa, stands at the intersection of progress and challenges in the pursuit of SDG7 targets. The electrification landscape has witnessed significant advancements, with the number of households and businesses lacking access to electricity decreasing from about 16 million as at 2010 to about 9 million by the year 2021. However, County based disparities persist, revealing that approximately 27% of the households and businesses still lack access to this crucial electricity and this could be contributed by a

number of issues such as geographical remoteness, economic constraints, and infrastructural limitations, particularly in rural areas.

1.1.2 Factors Influencing Adoption of Off Grid Renewable Energy Technologies

The progress of renewable energy in different countries globally relies on both the factors that encourage its growth and those that hinder it. As per Li et al., (2020), multiple factors, encompassing legal, physical, and psychological aspects, shape the adoption of renewable energy.

Costs pose the most formidable challenges to the widespread adoption of renewable energy. The costs, linked to the development of renewable energy, encompass the construction and installation of facilities (Board, 2020). For instance, while solar and wind energy sources are cost-effective due to utilizing free resources like sunlight and wind, the bulk of expenses arise during the initial installation stages. These high initial costs for renewable energy adversely impact consumer perceptions, resulting in a sluggish uptake of these new technologies. Similarly, financial institutions interested in financing renewable energy development may view such ventures as risky, thereby imposing higher lending rates on developers in this sector.

Energy derived from fossil fuels is disreputable for its detrimental environmental effects, notably the emission of greenhouse gases that contribute to climate change. Environmental considerations significantly influence both the production and adoption of renewable energy, which stands as an alternative to fossil fuels in environmental preservation. Renewable energy emits 99% fewer greenhouse gases compared to energy sourced from traditional coal and oil. The utilization of renewable energy plays a pivotal role in environmental conservation by mitigating global warming and, consequently, addressing climate change.

Heightened environmental awareness fosters a positive impact on the adoption and utilization of renewable energy (Wall et al., 2021).

Trust and risk serve as crucial considerations when investing in renewable energy infrastructure. RE utilization is susceptible to fluctuations in power prices and other risks inherent in renewable energy, thereby impacting its adoption. Wall et al., (2021) asserts that investment in renewable energy continues to experience robust growth; however, such investment is contingent upon various risks associated with renewable energy. For example, political and regulatory risks that influence the progression of renewable energy projects affect the investment rates within the country, consequently affecting the pace of renewable energy adoption.

The adoption of renewable energy entails a multifaceted process that often demands streamlining various procedures to ensure sustainability and enhance ease of use. Consumer acceptance of new renewable technologies hinges on the simplicity of renewable energy utilization.

Financial incentives also serve as pivotal drivers in promoting and facilitating the global adoption of renewable energy. Governments, aiming to foster sustainable growth through renewable energy uptake, leverage financial incentives to address barriers hindering its development. These incentives, for instance, help alleviate the high initial installation costs associated with renewable energy infrastructure. Additionally, the relative advantage in technology, measured in terms of convenience, satisfaction, economic benefits, and social prestige, determines the competitiveness of renewable energy against traditional fossil fuels and their installations. As societal awareness regarding climate change effects grows, so does the social inclination toward adopting green energy solutions. Consequently, ensuring

environmental sustainability emerges as a relative advantage in favor of renewable energy adoption over traditional fossil fuel alternatives (Bulut et al., 2021; Idzikowski & Cierlicki, 2021).

1.1.3 Kenya Energy Scenario

Kenya has positioned itself as a frontrunner in the adoption of renewable energy, with an impressive 85% of its electricity supply sourced from RE sources as at the year 2021, surpassing the global target outlined in SDG7. This underscores the nation's unwavering commitment to sustainable energy practices, particularly evident through the availability of various collaborative initiatives. Despite these strides, a persistent challenge persists in the domain of clean cooking, where an alarming 80% of the population relies on traditional biomass. Urgent intervention is imperative, given the stagnant progress in clean cooking since 2010, posing severe health risks such as millions of annual deaths attributable to exposure to cooking smoke (Liu et al., 2020).

The primary influence on Kenya's energy market stems from the synergy of oil and electric power. Wood, employed as a cooking fuel source, caters to the fundamental energy needs of remote homes, the poor households in the urban places, and the informal producers of various products. The government's commitment to clean cooking is underscored by recent legislative actions, including the Finance Act, 2021, which reinstated essential VAT exemptions on renewable energy items. This commitment aligns with clean cooking solution providers, manufacturers, and governmental agencies dedicated to ensuring clean energy access for all. The focus on clean cooking contributes to health, safety, and environmental sustainability, reflecting a holistic approach to energy development in Kenya.

According to international standards, Kenya's energy consumption remained relatively modest in 2022. The total electricity generation for the year reached 12,669 GWh, in 2022 marking a notable increase from the 2017 figure of 10,360 GWh. This represents a growth of approximately 22.6 percent as reported in the Economic Survey of 2023. Hydro-generated power experienced an increase of 9.5 percent from 2,776.6 GWh in the year 2017 to 3,039.9 GWh in 2022. Solar power generation also witnessed a noteworthy rise, escalating from 0.30 GWh in the year 2017 to 383.7 GWh in the year 2022, largely attributed to the contribution of the 50MW produced at Garissa Solar Power plant that is managed by Rural Electrification and Renewable Energy Corporation (REREC), commissioning of Alten Solar Power plant, and the full Operationalization of Selenkei, Cedate and Malindi Solar plants. Wind power generation saw a significant boost from 60.98 GWh in 2017 to 2,143.0 GWh in 2022 driven by the contribution of Lake Turkana Wind Power Plant. Additionally, geothermal power generation increased by 25.6 percent reaching 1,584.9 GWh in 2022. Since 2017, the annual energy output in Kenya has shown a consistent increase of around 5% each year. However, during the 2019/2020 financial year, there was a slight decline of 0.25% attributed to the impact of the COVID-19 pandemic (KNBS, 2023).

Domestic demand for electricity also showed an upward trend, climbing from 8,410.1 GWh in the year 2016 to 12,985.4 GWh in the year 2022. Supply to various domestic and those regarded as small commercial users increased from about 3,528 GWh to an estimate of 4,291.5 GWh during 2016-2022 (KNBS, 2023). The survey report done in the year 2016 revealed that the use of firewood, usage of LPG, and the use of charcoal continue to be the primary sources of cooking energy where, firewood accounted for 54.6 percent LPG accounted for 13.4 percent while charcoal accounted for 14.6 percent of total households.

Notably, the over reliance on firewood as cooking fuel was common in rural places where about 84 percent of the country households use it (KIHBS, 2020)

Remarkably, 85 percent of Kenya's electricity is created from RE sources, with geothermal and hydro power contributing significantly at 45.4 percent and 19.3 percent respectively. In contrast, 10.5 percent is derived from non-renewable thermal sources. This widespread electricity generation is accessible to over 74 percent of the country's people, with less than 25 percent deprived of access to electricity. Consequently, some individuals, particularly in rural areas, still rely on charcoal or firewood as their primary sources of energy. Captive generation, which refers to self-produced energy for personal use, saw a significant uptick to 402.3MW between 2022 and 2023, driven by heightened interest from commercial and industrial consumers representing 10.83% of the total installed capacity. Solar photovoltaic generation emerged as the top choice, accounting for 38.5% of the total installed captive capacity, closely followed by bioenergy (including biomass, bagasse, and biogas) and waste heat recovery generation, at 26.3% and 20.7% respectively. Noteworthy is the waste heat recovery plant at Devki Steel Mills in Kwale County, boasting a capacity of 55 MW, making it the largest captive generation facility in the region (EPRA, 2023).

Kenya's entrepreneurial landscape has witnessed the emergence of dynamic energy start-ups, each contributing uniquely to the renewable energy ecosystem. M-kopa, for instance, provides affordable energy solutions through a flexible micro-payment model, gradually increasing consumers' ownership over time. Strauss Electricity focuses on "pay as you go" solutions and advocates for Building Integrated Photovoltaics (BIPV) systems, while PowerGen Renewable Energy specializes in installing off-grid power systems. Vuma Biofuels stands out by converting agricultural waste into renewable energy, aiming to stop

the employment of firewood in the industrial production division (Otieno et al., 2018; Rastogi, 2018; Williams et al., 2017).

The rationale behind choosing Kisii County as a focal point for renewable energy research stems from several key factors. With a population of approximately 1.27 million residents in 2019 and projected growth, Kisii County presents a significant energy demand that necessitates attention (County government of Kisii, 2022). This burgeoning population underscores the importance of exploring sustainable energy solutions to meet the rising demand for electricity and other energy services. Moreover, Kisii County's strategic location within the Western/Nyanza region positions it as a vital business hub, offering ample opportunities for renewable energy investments and collaborations with local businesses and entrepreneurs.

The diverse landscape of Kisii County, which includes the presence of Gucha River and its waterfalls, presents promising prospects for renewable energy generation, particularly in the form of mini-hydroelectric power (County government of Kisii, 2022). The abundance of natural resources in the region provides an opportunity to harness renewable energy and contribute to the county's energy mix while potentially supplying surplus electricity to the national grid. Additionally, Kisii County's favorable environment for solar photovoltaic (PV) and wind energy projects further enhances its suitability for renewable energy investments. The region's ample sunlight and wind resources make it viable for solar and wind energy generation, aligning with efforts to transition towards cleaner and more sustainable energy sources.

Furthermore, Kisii County's significant agricultural sector, which contributes 21.0% to the GDP, presents opportunities for biogas investments derived from agricultural waste (County

government of Kisii, 2022). Biogas production offers a renewable energy solution that not only addresses energy needs but also supports rural farmers and promotes sustainable agricultural practices. By focusing on Kisii County, researchers can gain valuable insights into the challenges and opportunities of renewable energy adoption in a diverse socio-economic and geographical context. This research has the potential to inform policy decisions and investment strategies aimed at advancing renewable energy initiatives and contributing to the county's sustainable development goals (County government of Kisii, 2022).

In 2019, the lighting fuel landscape in Kisii County revealed that electricity was the dominant lighting source, constituting 39.3% of the total. Paraffin pressure lamps were minimal at 0.4%, while paraffin lanterns accounted for 13.6%, and paraffin tin lamps represented 20.1% of the lighting sources. Solar lighting solutions gained prominence, reaching 20.5%, indicating a growing preference for sustainable and renewable alternatives. This snapshot of the lighting fuel status in 2019 highlights the diverse sources used for lighting in the county, with a notable reliance on main grid electricity and an increasing adoption of solar solutions (KNBS, 2019b).

In Kisii County, cooking fuel sources present a concerning scenario, as indicated by the Kenya Integrated Household Budget Survey (KIHBS) in 2016 and the 2019 population and housing census. Firewood remains the predominant choice, with approximately 77.8% of households relying on it for cooking. However, there has been a notable increase in the popularity of Gas (LPG), constituting 13.5% of cooking fuel sources in 2019. Charcoal use has declined to 5.5%. Despite this shift, electricity and biogas remain limited sources of cooking fuel. Women and children in rural areas bear the primary responsibility of gathering

firewood and crop residues, exposing them to indoor air pollution and associated health risks when cooking three meals a day using resources such as wood and biomass-related products (Baland et al., 2010).

OGRETs are independent power projects with connected purposes that function autonomously devoid of being connected to the main national grid (Mugisha et al., 2021). They are often more appropriate sources of power where the main national grid connectivity misses to reach. OGRETs in Kenya mainly depend on the utilization of RE sources like wind, solar from the sun, biomass sources, and hydro to provide power to areas which lack the national power main grid. The key objective is to bring clean and sustainable energy solutions to remote and underserved communities, improving access to electricity and promoting economic development (Mugisha et al., 2021).

OGRETs in Kenya often involve the installation of various types of solar panels, wind turbines, small hydroelectric plants, and biogas digesters to generate power locally (Roche & Blanchard, 2018).The systems are critical in addressing energy poverty, lowering greenhouse gas emissions, and improving energy resilience in areas with challenges of grid connectivity.

Among the crucial initiatives to enhance clean energy access, the Rural Electrification and Renewable Energy Corporation (REREC) was established to fulfill the mandates of the Kenya's Energy Act, 2019, succeeding the Rural Electrification Authority (REA) and expanding its scope. With an expanded mandate, REREC oversaw rural electrification programs and led Kenya's renewable energy initiatives, administering funds, drafting master plans, and supporting energy centers in counties. In Kisii County, the REREC Energy Centre served as a vital platform for demonstrating various renewable energy technologies,

including agro-forestry practices, biogas production, solar energy applications, and improved cooking stoves. By showcasing these technologies, the Energy Centre aimed to raise awareness, educate communities, and promote the adoption of sustainable energy solutions, contributing to local development, environmental conservation, and improved power availability in Kisii County (Takase et al., 2021).

Despite the efforts to enhance access to electricity, there are still remote and marginalized communities that lack access to these services because of inadequate infrastructure, affordability changes, and geographical barrier (Aemro et al., 2020). Jeuland et al. (2023) highlighted challenges in extending infrastructure such as roads and markets due to the region's low population density and challenging terrain. Additionally, Lestari et al. (2018) emphasized that the anticipated low levels of consumption and poverty prevalent in rural areas render investments in grid connections highly impractical. Off-grid renewable systems are economically viable options to offer larger access to electricity energy (Weinand et al., 2023). OGRET adoption reduces poverty, enhances low-carbon access, and diversifies livelihoods away from highly vulnerable climate change (Sen & Ganguly, 2017). The usage of RE resources has the potential to lower greenhouse gas emissions, protect the community from increasing diesel and petrol prices, and provision for increased access to the very useful resource called electricity (Backer et al., 2023).

In Kenya, the issues of off-grid renewable energy are fairly explored (Mugisha et al., 2021; Sergi et al., 2018; Ulsrud et al., 2015) mainly to provide a deeper understanding of the potential factors to assist people in remote areas in adopting off-grid renewable energy. This is crucial because Odhiambo Ponde et al., (2019) posits that not more than 5 percent of the rural population has access to electricity yet there is growing demand from both off-grid and

on-grid consumers. This is apparent from the frequent power outages and the increasing adoption of OGRETs alternatives, such as the use of diesel generators and the utilization of small-scale hydroelectric units in Kisii County, where energy regulation is inadequate.

A number of studies predominantly focus in the realm of off-grid renewable energy on socio-economic and socio-cultural aspects concerning consumers (Ahmed et al., 2022; Kumar et al., 2024; Tetteh & Kebir, 2022). However, there has been a notable gap in research, with limited attention given to the combined aspects involving both government managerial/regulatory and consumer perspectives in the context of OGRETs adoption. Studies in this domain have been scarce, leading to a lack of comprehensive insights into the key factors influencing the adoption of OGRETs in rural areas (Moran et al., 2022; Simpson et al., 2021). It is within this locus that our study aims to carry an assessment of the factors influencing the adoption of OGRETs in Kisii County.

1.2 Problem Statement

Kisii County grapples with a substantial challenge in meeting Sustainable Development Goal 7 (SDG7), embedded in Kenya's Vision 2030 and Climate Change Agenda. Despite the institutional frameworks in place, progress toward achieving universal access to energy that is affordable to everyone, reliable to everyone, sustainable to the environment, and enjoy modern forms of energy by 2030 is slow within the county. OGRET has been recognized as an efficient innovation for people in rural areas to solve issues related to the occurrences of these related incidents (Aemro et al., 2020; Kitson et al., 2018). The existing gaps in the OGRETs contribute to over reliance on environmentally harmful and non-renewable energy sources, particularly firewood, and an over-dependence on the main electricity grid for lighting.

KIHBS 2015/2016 report show that about 77.8% of households in Kisii County primarily relied on firewood for cooking, contributing to deforestation, respiratory infections, and environmental degradation. Simultaneously, dependence on the main electricity grid for lighting faced challenges like persistent blackouts, expensive extension to remote areas, high connection costs, and unaffordable electricity bills for most residents. Factors such as low energy demand, costly grid extension, limited industrialization, rough terrain, and low economic activities compounded these obstacles (Longe et al., 2013). Addressing these challenges, OGRETs sources emerge as a viable alternative for comprehensive electrification (Ugwoke et al., 2021). Kisii County possesses untapped natural RE resources such as those from solar, those from wind, and those from biomass, providing feasible alternatives. The appeal of renewable energy sources compared to fossil fuels is enhanced by their competitive edge, fueled by fluctuating petroleum pricing and the urgent need to mitigate Greenhouse Gas (GHG) emissions (Aliyu & Tekbiyik-Ersoy, 2019). Despite these opportunities, there are a few studies examining factors influencing adoption off-grid renewable energy technology in Kisii County.

The adoption of Off-Grid Renewable Energy Technologies (OGRETs) hinges on various influential factors that shape consumer behavior and decision-making processes. Among these factors, the initial cost emerges as a pivotal determinant, influencing perceptions of affordability and investment feasibility. Complementing this, financial incentives play a crucial role, alleviating upfront expenses and enhancing long-term cost-effectiveness. Moreover, heightened environmental consciousness propels demand for cleaner, renewable energy options, underlining the significance of environmental considerations in consumer choices. Concurrently, awareness levels within communities directly impact adoption rates,

with increased knowledge often correlating with higher uptake of OGRETs. Additionally, factors such as perceived risk, trust, relative advantages compared to conventional energy sources, and ease of use further influence consumer decisions, collectively shaping the trajectory of OGRET adoption (Khalid et al., 2021; Luthra et al., 2015; A. Palm, 2020; Zeng et al., 2022).

This study aims to uncover the factors contributing to the sluggish progress in SDG7 attainment within Kisii County. By examining factors influencing the adoption of OGRETs and underlining the untapped potential of natural resources, the research seeks to offer actionable insights for policymakers and stakeholders. Addressing these challenges is not only vital for aligning with national and global sustainability goals but also for mitigating environmental impacts, enhancing energy resilience, and improving the overall well-being of Kisii County residents.

1.3 Objectives of the Study

The main objective of this study is to assess the factors influencing adoption of off-grid renewable energy technologies in Kisii County. The specific objectives are to:

i. To ascertain the extent to which socioeconomic factors influence adoption of off-grid renewable energy technologies in Kisii County.
ii. To explore the influence of environmental considerations on adoption of off-grid renewable energy technologies in Kisii County.
iii. To establish the influence of psychosocial factors on adoption of off-grid renewable energy technologies in Kisii County.
iv. To evaluate the influence of technological factors on adoption of off-grid renewable energy technologies in Kisii County.

1.4 Research Questions

The following research questions will guide this:

i. To what extent do socioeconomic factors influence the adoption of off-grid renewable energy technologies in Kisii County?

ii. What is the influence of environmental considerations on adoption of off-grid renewable energy technologies in Kisii County?

iii. How do psychosocial factors affect the adoption of off-grid renewable energy technologies in Kisii County?

iv. Which technological factors influence the adoption of off-grid renewable energy technologies in Kisii County?

1.5 Scope of the Study

The scope of this study is to assess the factors influencing adoption of OGRETs in Kisii County, Kenya. The study will focus on understanding the perceptions, attitudes, and behavioral intentions of households toward adopting renewable energy technologies for cooking and lighting.

Key components of Technology Acceptance Model (TAM), such as perceived ease of use which is a core component and another variable termed as perceived usefulness, will be analyzed to assess how these factors impact the willingness of individuals in Kisii County to embrace off-grid renewable energy technologies. Additionally, the study will consider external variables, including socio-economic factors, awareness, and accessibility, to provide a holistic view of the factors shaping technology acceptance.

1.6 Significance of the Study

This study is of paramount importance as it sought to address critical energy challenges faced by Kisii County households, by employing the Technology Acceptance Model (TAM) and the Diffusion of innovation theory to assess the factors influencing the adoption of OGRETs. Aligned with the Sustainable Development Goal 7 (SDG7), which emphasizes universal accessibility to reasonable, dependable, and contemporary energy, the research contributes to broader efforts in achieving sustainable development. By uncovering the factors influencing the uptake of OGRETs, the study aimed to facilitate the transition toward cleaner and more sustainable energy sources, thus promoting environmental conservation.

The outcomes of the study can inform policymakers at the county and national government, in the formulation of effective policies, incentives, and regulatory frameworks to encourage widespread adoption of off-grid renewable energy. Ultimately, the study's significance lies in its potential to drive sustainable energy practices, improve energy access, and contribute to the overall well-being of residents in Kisii County. In addition, the study will also serve as a foundation for future research on the adoption of renewable energy in rural areas, particularly in developing countries.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter offers a literature review on the adoption and development of OGRETs. The initial section provided a theoretical review and discussed the significance of RE for sustainable development. The subsequent sections examine existing empirical literature on factors influencing the adoption of OGRETs, barriers to adoption, and strategies for promoting uptake of OGRETs.

2.2 Theoretical Review

The theoretical examination establishes a conceptual basis for comprehending the adoption of OGRE technologies within Kisii County. Within this segment, we employ the Technology Acceptance Model (TAM) and the Diffusion of Innovation theory.

2.2.1 Technology Acceptance Model (TAM)

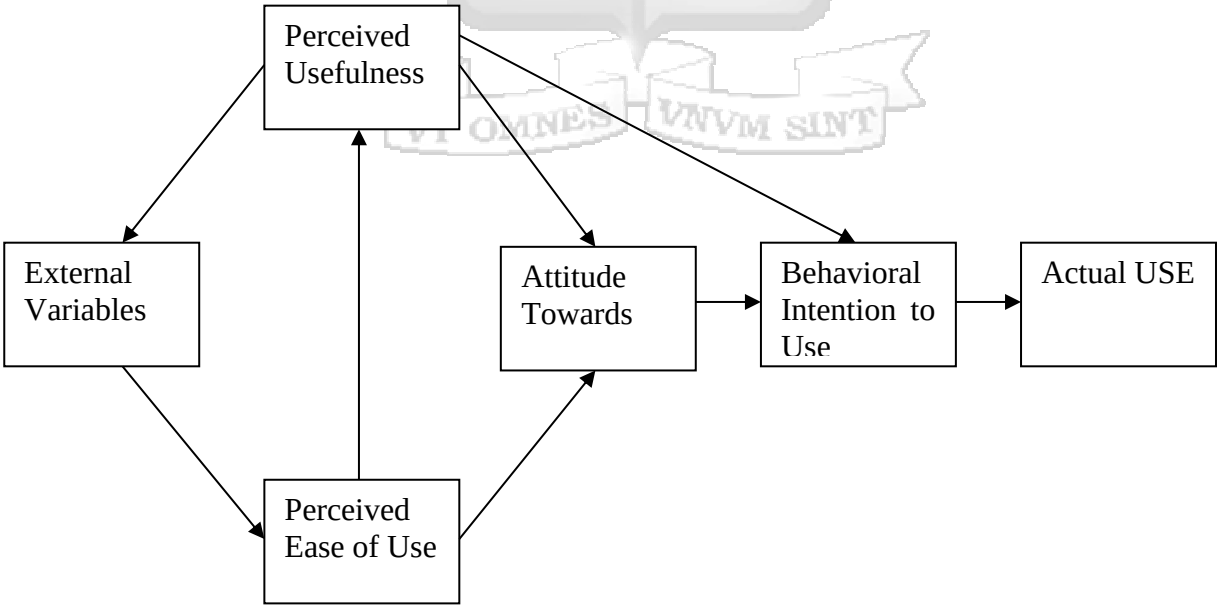
The Technology Acceptance Model (TAM) serves as a well detailed theoretical framework for the assessment of the constraints of households' adoption of OGRETs. Originating in the late 1980s, TAM, as conceived by Davis, (1989) has evolved into a resourceful tool for understanding user behavior across various technological contexts. At its core, TAM posits that adopter's behavioral intention to embrace a new technology is shaped by how they take their perceptions in terms of its Perceived Usefulness (PU) and another key factor that it notes is its Perceived Ease of Use (PEOU). These perceptions, in turn, influence users' subsequent actions, such as their intent to employ the existing technology and the real utilization of the system. PU represents the level that explains how users believe that incorporating a specific technology into their routines finally will enhance their job

performance or overall effectiveness. Factors influencing PU include considerations of job relevance, the anticipated impact on performance, and the demonstrability of positive results from using the technology.

Perceived Ease of Use (PEOU) encapsulates users' beliefs regarding the effortlessness of interacting with technology. This involves assessments of how easily users can learn and become proficient in using the technology, the overall simplicity and user-friendliness of the system, and the compatibility of the technology with existing practices.

Figure 2.1, depicting the TAM, illustrates that an individual's utilization of a technologies system is either directly or indirectly influenced by their behavioral intentions, as well as attitude, also it's influenced by Perceived Usefulness, and Perceived Ease of Use of the system. TAM further posits that external factors impact intention and actual usage by indirectly affecting perceived usefulness and perceived ease of use through mediated effects.

Figure 2.1: Technology acceptance model



Source: Davis, (1989)

The objectives of our study are intricately linked to TAM's constructs, notably the influence of technological characteristics, economic factors, environmental considerations, and psychosocial factors on the adoption of OGRETs.

Firstly, our exploration of innovation characteristics, specifically the ease of use and relative advantage of OGRETs, corresponds directly to TAM's components of PEOU and PU. Assessing economic factors, such as initial cost and financial incentives, resonates with TAM's examination of PEOU and the tangible benefits users anticipate from adopting a particular technology.

Moreover, our investigation into environmental considerations, including environmental concern and relative advantage, mirrors TAM's exploration of users' perceptions regarding the impact of the technology on the natural environment and its perceived superiority over existing alternatives. Lastly, our exploration of psychosocial factors, encompassing risk and trust, as well as awareness, closely aligns with TAM's emphasis on the influence of individual perceptions and attitudes on technology adoption.

2.2.2 Diffusion of Innovation Theory

The Diffusion of Innovation (DOI) theory elucidates the process by which a society embraces and spreads novel ideas. The theory identifies distinct groups, including innovators, early adopters, early majority, late majority, and laggards, each playing a role in the adoption of innovations. Innovators, who are early adopters, lead the way, while laggards adopt later. The DOI theory asserts that various factors, including innovation characteristics, adopter traits, and communication channels, collectively determine the pace of innovation adoption (Rogers, 2003).

The theory posits that an innovation's compatibility with prevailing values and beliefs influences its adoption; incompatible innovations face more resistance. Applying the DOI theory to Kisii County, it becomes a valuable tool for comprehending the factors shaping the adoption of OGRE systems among different societal segments. Factors like education, income, and awareness of renewable energy benefits may sway early adopters. Meanwhile, the majority groups might consider factors such as affordability, financing options, and institutional support. Laggards, on the other hand, may be influenced by issues like lack of awareness or resistance to change (Rogers, 2003).

The combination of the Technology Acceptance Model (TAM) and the Diffusion of Innovation (DOI) theory provides a comprehensive framework for understanding and predicting the adoption of Off-Grid Renewable Energy Technologies (OGRETs) in Kisii County. TAM offers insights into individual perceptions and attitudes towards technology, emphasizing factors such as perceived ease of use, usefulness, and compatibility with existing beliefs. Meanwhile, DOI theory elucidates the societal dynamics surrounding innovation adoption, highlighting the roles of different adopter groups and factors influencing their decisions. By integrating these theories, our study aims to analyze the interplay between individual and societal factors in shaping the adoption of OGRETs.

2.3 Empirical Review

This section examines empirical research that has looked into the adoption of OGRETs in a variety of settings. These studies provide an understanding regarding adoption of OGRETs, as well as the potential impacts of these systems on households, businesses, and the environment.

2.3.1 Socioeconomic factors

Subhes C. Bhattacharyya, (2014) noted that economic barriers involve challenges related to the unattainable initial costs of RE products, increased transacting costs for fuel in far to reach areas, and the absence of government subsidies. The electrification of rural zones with RE sources typically necessitates government subsidies due to the substantial capital investment required. However, government incentives in the renewable energy sector are comparatively limited when contrasted with the highly subsidized agricultural domain.

Alam Hossain Mondal et al., (2010) conducted a detailed review of RE technologies implementation in rural areas of Bangladesh, emphasizing the critical analysis of policy and institutional settings. The research aimed to discern the drivers, barriers, and strategies influencing the adoption of RETs. A notable pattern emerged as successive projects demonstrated a keen understanding of local conditions, including demand patterns, existing knowledge, and financial situations. These initiatives successfully implemented tailored financial mechanisms, training programs, and income-generating opportunities to address the specific needs of each community. However, a significant gap in the study is that the findings cannot be applicable to Kisii County due to differences in research settings and contexts.

Billanes & Enevoldsen, (2021) extensively reviewed literature to identify key factors which influence persons' decisions in considering accepting technologies by incorporating the TAM into their research framework. The study highlighted ten influential factors, including understanding, consciousness, regulations, societal impact, population characteristics, confidence in oneself, reliability, satisfaction, perceived danger, and harmony, which collectively contribute to users' choices in embracing technology. Despite the comprehensive

coverage of various technologies, including renewable energy technology, the study's use of TAM suggests a valuable framework for understanding the specific dynamics and determinants of individuals' decisions in adopting renewable energy technologies. While TAM provides a solid foundation, further exploration within the realm of renewable energy adoption could shed light on domain-specific factors that might influence users' acceptance and utilization of these technologies in Kisii County.

Takase et al., (2021) conducted a comprehensive review in 2021, examining Kenya's energy scenario and sustainable energy practices. The study highlighted a surge in energy demand, driven by rapid population growth, leading to substantial expenditures on oil imports, with oil and electricity serving as key determinants of growing the countries' economy. The energy output mix featured 52 percent from hydro, 33percent fossil sourced fuels, 13percent geothermal sourced energy, 2percent generated from biogas, and 0.4 percent wind sourced. Projections indicated a substantial increase in the existing energy demanded, reaching 2,600 to about 3600 MW by the year 2020. Notably, the review underscored a noteworthy dependence on wood related products and biomass, constituting 68 percent of the energy in usage, particularly impacting rural, urban, and informal market areas. Challenges such as limited accessibility to modern energy, biomass supply pressures, escalating energy prices, and high electricity demand compared to generation capacity were identified. The study primarily focused on broader energy issues, and the gap lies in its failure to narrow its scope to specifically address off-grid renewable energy technologies. A more targeted exploration of off-grid solutions could contribute valuable insights to address the specific challenges and opportunities in this domain.

In the existing literature, economic and institutional factors have consistently emerged as key contributors to the limited adoption of solar PV systems (Rowlands, 2007). Our study aligns with this understanding, as financial considerations, characterized by higher initial starting costs and prolonged period to realize profits, along with the crucial role of institutional support such as Community Power Groups (CPGs). (Rivera & Rogers, 2006). Palm & Tengvard (2011) exploration of household motivations for adopting residential solar PV systems also emphasizes sustainability-related factors as primary drivers. Noteworthy barriers include financial constraints, site customization leading to increased costs, solar costs exceeding commercial and utility-scale alternatives, and substantial paperwork expenses. Education emerges as a pivotal barrier, with potential customers often lacking the necessary skills to assess the cost-effectiveness of solar solutions. Overcoming these challenges may be facilitated by improved access to financing options and a more effective sales approach, as exemplified by successful solar companies like Solmentum.

Income levels and awareness were found to be major impediment to the usage of the recommended green energy products in a study carried in Shanghai by Vand et al., (2019) that examined customers' attitudes about green energy. This emphasizes how crucial it is to clarify the benefits of green energy products as a primary tactic for developing a green environment in China. Despite of the study having been done in China, there is a geographical divide in the knowledge of consumer attitudes and their acceptance of solar energy solutions. In particular, there is a paucity of study on the attitudes of consumers in Kisii County, Kenya, toward off-grid energy options.

In Shahzad et al., (2023) study aimed to identify and rank the obstacles hindering the expansion of solar power in Pakistan to inform the development of suitable energy policies.

The methodology involved utilizing a novel spherical fuzzy analytical hierarchy process to assess and prioritize the identified obstacles. The findings indicated that economic obstacles were the most significant, constituting 21.46% of the total obstacles, with budget constraints, lack of access to credit/capital, political instability, high investment risk and operation cost, and partnership issues identified as the top five critical sub-obstacles. Recommendations were provided to address these obstacles, offering policy implications for policymakers, researchers, and practitioners involved in the solar sector in Pakistan. The study contributes to understanding the barriers to solar energy deployment in the country, offering insights for the development of strategies aimed at facilitating its smooth implementation. However, further research is needed to delve deeper into the effectiveness of proposed solutions and address any remaining gaps in understanding the challenges hindering solar energy adoption in Pakistan.

Asante et al., (2020) investigated the impediments to renewable energy development, focusing on Ghana's target of integrating 10% other renewables into its energy mix by 2020. The study identified and ranked barriers across six categories, encompassing technical, economic and financial, social, political and regulatory, institutional, and geographical aspects. Employing the Multi-Objective Optimization based on Ratio Analysis (MULTIMOORA) integrated with Evaluation based on Distance from Average Solution (EDAS) method, the study ranked barriers and sub-barriers, highlighting political and regulatory barriers as the most significant. Corruption and nepotism emerged as critical hurdles within this category. The findings underscored the need for specific renewable energy standards, grid connection quotas, and streamlined certification procedures, advocating for a bottom-up approach to policy formulation for inclusiveness and

sustainability. Additionally, the study developed a framework to assess how each barrier affected renewable energy development. However, the research gap lay in further exploration of nuanced dynamics within each barrier category and their implications for effective policy implementation and sustainable renewable energy development.

Gboney, (2009) aimed to identify the external support necessary to bolster Ghana's domestic policies, thereby overcoming barriers and facilitating the wider adoption of renewable energy and energy efficiency technologies. The study acknowledged Ghana's robust regulatory environment and institutional framework but underscored the need for international cooperation to enhance domestic policies and foster an enabling environment for renewable energy transition. It advocated for leveraging international support to bolster the activities of the Energy Foundation and energy service companies (ESCOs), as well as promoting the adoption of energy efficiency technologies through demand-side management (DSM) initiatives. The findings emphasized that despite financial incentives, regulatory barriers persisted, necessitating comprehensive government strategies and stakeholder collaboration to address them effectively. The study highlighted the role of international support in capacity building, technical assistance, and finance, emphasizing the importance of domestic and international structures for program continuity and execution. However, the research identified a gap in understanding the long-term sustainability of institutional resources for program implementation, calling for further exploration in this area.

2.3.2 Environmental concerns

Zeng et al., (2022) employed a systematic research framework and utilized structural equation modeling to examine the significant factors influencing how people accept OGRETs. The results indicated that environment related concerns, levels of awareness on

green energy technologies, candidness to new experiences, and perceived benefits of GETs positively influenced consumers' inclination to adopt these technologies. Conversely, variables such as the projected costs linked with green energy technologies and the discomfort associated with its adoption had a negative impact on consumer adoption. However, it's crucial to note that the findings may not be universally applicable to all settings, especially in the middle-income country like Kenya. The unique socio-economic, unique cultural, and infrastructural aspects of Kenya may introduce variations in consumer behavior and technology adoption dynamics, warranting further exploration in the Kisii County context.

Nyarko et al., (2023) examined the catalysts and obstacles faced by OGREs initiatives in West Africa, utilizing a comprehensive framework that encompassed Political, Economic, Social, Technical, Legal, and Environmental dimensions (PESTLE challenges). Employing a blend of review and survey methodologies, the study revealed that economic hurdles posed the most significant impediments to the sustainable advancement of OGREs powered systems in West Africa. The results further unveiled intricate interconnections and patterns among these challenges, underscoring the necessity of considering the broader landscape rather than fixating solely on the most immediate issues. However, it's noteworthy that the research primarily concentrated on institutional hindrances and did not delve into the intricacies of consumer behavior, suggesting a potential gap in comprehending the factors influencing end-users in adopting off-grid renewable energy technologies.

A number of studies suggest that the importance of environmental concerns is overshadowed by economic issues. Although they may not be the main factor taken into account when evaluating economic effects, environmental views may have a significant influence on the

adoption of solar technologies. Best & Chareunsy, (2022) found that, even after controlling for the green power variable, solar-panel-owning households in an Australian green power program had almost equal economic impacts. In general, early adopters may be more concerned about environmental issues (A. Palm, 2020).

Empirical analysis faces the challenge of multiple factors contributing to solar-panel adoption. For instance, inner-city households in shaded, rented apartments are less likely to adopt solar panels Best & Chareunsy, (2022) especially if residents have lower education and wealth levels . Considering these correlated factors is crucial when isolating the impact of income.

Bamati & Raoofi, (2020) conducted a comprehensive examination of the factors influencing renewable energy (RE) production, focusing on technological, economic, and environmental variables across developed and developing countries. Employing the Generalized Least Square (GLS) panel data estimation method, the study observed that the determinants of RE sources varied based on the income level of the countries. In developed nations, high technology exports emerged as a significant determinant of RE production, contrasting with developing countries where this factor showed no statistical significance. Additionally, the study found that oil prices had minimal impact on RE production across both groups. While GDP per capita exhibited a positive influence on RE production in both sets of countries, the impact of per capita CO2 emissions differed notably between developed and developing nations. These findings underscore the nuanced dynamics driving RE production in different economic contexts, emphasizing the need for tailored policy interventions to promote sustainable energy transitions globally.

In Alam et al., (2010b) study, the objective was to identify barriers hindering the successful development of the renewable energy technology (RET) sector and improving rural livelihoods in Bangladesh, which has significant potential for harnessing renewable energy sources. Through a critical review of policy and institutional settings, as well as lessons learned from pilot demonstrations of RET projects by various organizations, the research aimed to highlight the policy implications for decision-makers in formulating renewable energy policies and plans for the country. The methodology involved a comprehensive review of existing policies and institutional frameworks, as well as an analysis of the status and lessons learned from RET projects implemented in rural areas. The findings underscored the importance of careful planning and highlighted the economic, environmental, and social benefits that renewable energy could bring to remote rural communities. While the study provided valuable insights into the barriers and potential of RET in Bangladesh, further research is needed to delve deeper into specific challenges and to assess the long-term impacts of RET projects on rural livelihoods and sustainable development in the country.

In Sen & Ganguly, (2017) study, the objective was to examine the opportunities, barriers, and related issues associated with renewable energy (RE) developments, considering its role in providing sustainable and clean energy while mitigating climate change. The study emphasized the importance of secure energy supplies at affordable rates with low environmental impacts and greenhouse gas emissions for socioeconomic development. Through an analysis of the present scenario, which included technological advancements, a broader understanding of renewable energy knowledge, and supportive government policies, the research aimed to highlight the potential of RE forms in meeting energy demands in a cleaner way. The methodology likely involved a review of existing literature, policy

documents, and possibly empirical data related to renewable energy development. The findings underscored the significance of positive support from governments and the need for favorable promoting policies to facilitate the development of RE forms. While the study provided valuable insights into the opportunities and challenges of RE development, further research could explore specific strategies for overcoming barriers and enhancing the uptake of renewable energy technologies to achieve sustainable social and economic development.

2.3.3 Psychosocial factors

Wagemann & Manetsgruber, (2016) explored risk management for the deployment of mini grids in far to reach areas. The study highlighted the importance of mini grids meeting customers' demand for high-quality service with whole day availability, relying on affordable pricing system and enough funding. One of the key challenges identified was the absence of a universally applicable risk management approach for mini grids. The risk management processes were found to face fundamental challenges, including complication, improbability, and a lack of responsiveness. The findings emphasized a diverse array of risks impacting mini-grid development, including political risks, the risk of non-payment, and variability in resource prices. However, it's essential to make a note of the study's primary focus on risk management and did not encompass other factors identified by the TAM, suggesting a gap in the understanding of broader adoption dynamics beyond risk considerations.

Wall et al., (2021) conducted a study in Thailand on the factors influencing consumers' adopting of RE. The study found that there was a significant positive association between consumers' intention to adopt off-grid energy and effectiveness. According to the study, perceptions of risk and trust had a positive influence on consumers adoption, whereas the

cost of RE had a negative but non-significant impact. The conclusion stressed the importance of considering a variety of elements when designing consumer adoption campaigns for renewable energy in Thailand, including attitudes about the benefits of renewable energy, environmental concern, perceptions of self-effectiveness, and awareness of the technology. Even though the study is being carried out in Thailand, there is a geographical difference in the knowledge of consumer attitudes and solar energy solution uptake.

A survey that was carried out in six Indian cities; Bangalore, Bhubaneswar, Chandigarh, Delhi, Gandhinagar, and Pune identified a number of obstacles that solar PV systems face. In Nigeria, despite abundant solar irradiance and low electricity access, the utilization of solar PV remains limited. Factors contributing to this include insufficient research on solar initiatives, socio-cultural awareness issues, lack of financial assistance and mechanisms, legal barriers, and political instability. These factors have deterred potential investors in renewable energy within the country (Abdullahi et al., 2017). Sub-Saharan Africa, not including South Africa, faces low electricity access, especially in rural areas where less than 10% have access, relying primarily on biomass. Despite the region's RE potential, there is a notable lack of penetration and investments. Barriers include subsidies on fossil-based generations without considering associated environmental and social costs, insufficient financial and policy support for renewable energy, and high upfront costs (Lopez et al., 2012).

In India, the development of RE initiatives has over time been significantly hindered by an inadequate institutional framework for financial management. This has instilled reluctance among investors to channel funds into RE projects. Moreover, the absence of standardized technical norms in the Indian selling places for small scale RE products is notable. Due to

this, the specifications required for renewable products in rural regions do not align with those obtainable in the marketplace. The lack of explicit directives with insufficient financial allotments from state electricity regulatory commissions further obstruct the planning and execution of renewable energy ventures. Additionally, bureaucratic procedures such as land acquisition, water, and environmental clearances entail prolonged durations, contributing to delays in the construction of renewable energy-based projects (Chauhan & Saini, 2015).

Luthra et al., (2015) aimed to address the pressing need for India to adopt renewable and sustainable energy technologies amidst escalating energy demands and environmental concerns. Through an extensive literature review, the study identified and ranked 28 barriers to adoption, categorized into seven dimensions including Economical & Financial, Market, Awareness & Information, Technical, Ecological and Geographical, Cultural & Behavioral, and Political & Government Issues. Utilizing the Analytical Hierarchy Process (AHP), expert opinions from academia and industry inform the ranking of these barriers, with sensitivity analysis employed to assess priority stability. The findings offered valuable insights for practitioners, regulators, and academics to focus their efforts on overcoming barriers to adoption, guiding policy formulation and strategy development towards widespread adoption of renewable and sustainable energy technologies in India. However, the study left room for further exploration into the dynamics of these barriers and their implications for effective adoption strategies.

(Viardot, (2013) investigated the role of cooperatives in promoting the adoption of renewable energy (RE) by addressing barriers to its uptake. The objective was to identify specific barriers to RE adoption by consumers and assess how cooperatives circumvented these obstacles to facilitate RE use. Through a survey of 9 cooperatives in countries with

government subsidies for RE, the study revealed that cooperatives effectively mitigated barriers through community-based social marketing initiatives. These initiatives included educational communication, offering competitive prices, providing local services, and cooperative distribution. The findings underscored the significant contribution of cooperatives in promoting RE uptake. The study also proposed a framework for evaluating the impact of these initiatives on reducing barriers to RE adoption. However, further research is needed to explore the long-term sustainability and scalability of these cooperative-driven initiatives, as well as their applicability in different socio-economic contexts.

Khan et al., (2020) study aimed to investigate the barriers to the growth of renewable energy technology (RET), particularly focusing on solar home systems (SHS), for rural electrification in Bangladesh. Recognizing the significance of energy in sustainable development, especially in light of increasing energy demand and environmental concerns, the research aimed to provide insights into promoting RET as an alternative to grid connectivity for non-electrified rural communities. The methodology involved the use of non-parametric tests and literature surveys, with data collected from 171 respondents in two dispersedly located villages in Noakhali and Sirajganj districts. The findings highlighted various modes of purchase for SHS, usage constraints, and both demand-side and supply-side barriers such as lack of promotional activities, economic conditions, awareness gaps, and financial constraints. The study's insights contribute to outlining a policy framework for facilitating the widespread adoption of RET in off-grid regions, addressing the identified barriers and promoting sustainable rural electrification. Despite these contributions, further research is needed to explore additional factors influencing the adoption of RET and to develop more tailored policy interventions for rural electrification in Bangladesh.

A study done Nevzorova & Kutcherov, (2019) aimed to identify and classify barriers hindering the widespread adoption of biogas as a source of energy. To achieve this, a systematic review of barriers based on the Scopus database was conducted, categorizing them into technical, economic, market, institutional, socio-cultural, and environmental barriers across developed and developing economies. The methodology involved analyzing these barriers within different contexts to identify the most frequent and crucial constraints faced by the biogas industry, along with proposing potential solutions. The findings underscored the significance of stakeholder involvement, particularly from the private sector, government, financial institutions, R&D institutions, lobby groups, media, and local communities, in addressing the identified barriers. Notably, collaboration among stakeholders was emphasized as essential for overcoming these obstacles and advancing biogas energy for sustainable development. The research highlighted the urgent need for coordinated efforts and knowledge-sharing to effectively tackle environmental protection challenges associated with biogas adoption. However, further research is needed to explore additional strategies for mitigating these barriers and fostering biogas utilization on a broader scale.

2.3.4 Technological factors

Perceived Usefulness of technology (PU) is defined as the extent to which an individual belief that the use of solar technologies for instance would lead to an improvement his or her job outputs (Davis, 1989).

In a study conducted by Yen et al., (2010) focused on examining the enablers of users' intentions to use the well covered wireless technologies within their organizations of employment. The researchers employed the Task Technology Fit (TTF) model in

conjunction with the TAM to conduct the study. Sample questionnaires were distributed to various organizations in the industry. The findings showed that both PEOU and PU considerably influenced the adoption and diffusion of wireless technology.

Mainali & Silveira, (2015) finding revealed that technological barriers included challenges such as limited energy access in far to reach areas, a lack of databases for resource valuation, a relatively low maturity level of RE sources, and the necessity for energy storage with renewable bases. The difficulty of providing energy access to rural areas was compounded by the fact that many unelectrified villages and hamlets were situated in remote hilly terrains. To ensure a continuous energy supply in these rural regions, there was a need for detailed and credible information on renewable sources. However, the Uttarakhand state had only a limited number of monitoring stations for measuring key parameters such as wind speed, solar radiation, and mean rainfall.

In Santiago, Chile, where favorable market conditions for individual's usage of photovoltaic (PV) technology exist, there is surprisingly minimal uptake. To investigate this phenomenon, a Delphi study engaged a panel of experts, identifying 26 important factors, including those related to motivation and those which could be a barring the influence PV diffusion in Santiago. Of these, 21 factors reached consensus on their relative importance. Literature suggests that PV diffusion is influenced largely by technical factors, issues related to economic challenges and those with social complexities, which were reflected in the experts' discussions on financial, environmental, and energy supply factors. Emerging barriers were attributed to financial, technical, institutional, and knowledge domains. Notably, financial motivations, such as subsidies, and barriers, such as high upfront costs, were deemed pivotal, while environmental motivations like environment systematic and clear stewardship and

technical related challenges such as concerns with roof construction were considered less significant. However, the study's focus on Santiago may limit the applicability of its findings to regions with different socio-economic and cultural contexts. A broader geographical scope could provide a better understanding of the major important factors influencing PV adoption (Walters et al., 2018).

Bhattacharyya & Palit, (2021) critically assessed the grid-off grid discourse, exploring the dynamics and interconnections among various electricity access alternatives. Even if a comprehensive critical examination, the analysis revealed that models incorporating detailed resolution, particularly accounting for inadequate power supply infrastructure, tended to favor decentralized electricity technologies. Conversely, aggregated analyses, particularly in densely populated areas and scenarios with higher energy demand, tended to endorse central grid extension as the preferred solution. Notably, the review underscored the significant impact of assumptions, data limitations, technology choices, and model flexibility on these outcomes. Key shortcomings identified included the omission of grid system generation costs, insufficient village-level information, biases towards specific technologies and scales, and a lack of consideration for social equity. In emphasizing the pursuit of universal electrification, the review underscored the importance of strong leadership, an enabling environment, a robust regulatory framework, and an inclusive approach that supports alternative options.

Chauhan & Saini, (2015) study found that In Uttarakhand state; there was a shortage of skilled manpower in the arena of RE. Experts and experienced technicians exhibited low motivation to offer services rural places unless offered remuneration which is attractive and other enhanced motivation package. The functioning and continuance of small-scale RE

projects posed challenges, particularly in remote areas where most villages were situated. Micro hydro power plants, for instance, required consistent year in year out maintenance for hydro turbines, generators, and controlling equipment. Additionally, the presence of pine trees in the state's forests meant that the compilation, management, and moving of pine needles proved challenging, especially in far to reach hilly places.

Wojuola & Alant, (2019) aimed to investigate the technical hurdles obstructing the embrace of Renewable Energy Technologies (RETs) among the Nigerian populace. Employing a convergent parallel mixed-method research design, the study gathered data through both quantitative surveys and qualitative focus group interviews. Analysis of the data revealed four primary technical barriers: accessibility, complexity, maintenance, and durability, underscoring significant challenges impeding the widespread acceptance of RETs in Nigeria. The study emphasized the critical need to address these barriers to facilitate the successful deployment of RETs. However, while the empirical literature review focused on Oyo State, Nigeria, there remains a research gap in exploring similar issues in other regions like Kisii County, Kenya, suggesting the necessity for further investigations across diverse geographical contexts to glean comprehensive insights into promoting RET adoption.

Khan et al., (2021) aimed to assess the short-term and long-term impacts of technological innovation, finance, and foreign direct investment (FDI) on renewable energy, non-renewable energy, and CO2 emissions across 69 countries participating in the Belt and Road Initiative (BRI) from 2000 to 2014. Utilizing robust standard error regression and dynamic GMM estimators, the findings indicated that technological innovations, economic growth, and FDI had a negative influence on renewable energy adoption, while financial developments positively impacted the renewable energy sector in the BRI countries.

Additionally, there was a positive association between technological innovation, FDI, and economic growth with energy use and CO2 emissions. The Granger non-causality test revealed reciprocal causal relationships among renewable energy, technological innovation, finance, and FDI. The study's practical implications highlight the importance of promoting financial markets in BRI countries to foster renewable energy development and economic growth while reducing CO2 emissions. Moreover, the findings underscore the need for increased investment in research and development (R&D) of technological innovations within these nations. Despite these insights, further research is warranted to explore additional factors influencing renewable energy adoption and to develop more targeted policy interventions in the context of the Belt and Road Initiative.

2.4 Summary and Research Gap

The literature review summary (Table 2.4) on the adoption of OGRETs highlights the multifaceted nature of factors influencing adoption across various socio-economic and environmental contexts. The review of literature on renewable energy adoption and barriers reveals several critical gaps that serve as the foundation for the current research. Firstly, geographical variability emerges as a significant factor, with many studies focusing on specific regions like India, Nigeria, or Chile, limiting the generalizability of findings to other contexts such as Kisii County, Kenya (Wojuola & Alant, 2019; Santiago et al., 2018; Khan et al., 2021). Consequently, there is a pressing need for research that encompasses other geographical settings to understand the unique challenges and opportunities in renewable energy adoption (Khan et al., 2021).

Secondly, technical barriers such as accessibility, complexity, maintenance, and durability of renewable energy technologies are recurrent themes across various studies (Wojuola &

Alant, 2019). However, there is a lack of comprehensive exploration into these technical barriers and their nuanced impacts on adoption, particularly in rural areas where these challenges may be amplified (Mainali & Silveira, 2015). This highlights the necessity for further investigation into the specific technical challenges faced by communities in regions like Kisii County, Kenya.

Policy and institutional frameworks are also highlighted as crucial factors influencing renewable energy adoption (Chauhan & Saini, 2015). Nevertheless, there is a gap in understanding the specific mechanisms through which policy interventions and institutional support facilitate or hinder adoption, especially in regions with limited government incentives like Kisii County, Kenya (Nyarko et al., 2023). Addressing this gap requires a more nuanced examination of the policy landscape and its implications for renewable energy initiatives.

Moreover, economic barriers such as high initial costs and lack of financing options are consistently identified across studies (Khan et al., 2021). However, there is a need for in-depth analyses to uncover the intricate interactions between financial constraints, economic viability, and consumer behavior, particularly in low-income communities (Nyarko et al., 2023). Understanding the economic drivers and constraints specific to regions like Kisii County is essential for designing effective interventions to promote renewable energy adoption.

Furthermore, while some studies assess short-term impacts of renewable energy adoption, there is a gap in research investigating the long-term sustainability of initiatives (Bhattacharyya & Palit, 2021). Longitudinal studies are needed to track the evolution and outcomes of renewable energy projects over time, particularly in terms of economic viability,

environmental conservation, and social equity (Bhattacharyya & Palit, 2021). By addressing these gaps, the current research aims to contribute to a more nuanced understanding of the factors influencing renewable energy adoption and to develop context-specific strategies for promoting sustainable energy transitions in regions like Kisii County, Kenya.

Table 2.4: Summary of the literature reviewed

Author	Objective	Methodology	Findings	Research Gap
Alam Hossain Mondal et al., (2010)	Identify drivers, barriers, and strategies for implementation of renewable energy technologies in rural areas in Bangladesh	A critical review of policy and institutional settings	Successive projects consider local conditions, including demand patterns, existing knowledge and skills, and financial situations. They implement specific financial mechanisms, training initiatives, and opportunities for income generation	Difference in research setting and context thus cannot be generalized for Kenya context
Billanes & Enevoldsen, (2021)	Determine factors influencing individuals' decisions of technology acceptance and adoption	Extensive literature review	Highlighted ten influential factors affecting user's decision to accept and adopt technology namely knowledge, awareness, policy, social influence, demographics, self-efficacy, trust, enjoyment, perceived risk and compatibility	The study had a general focus on technology acceptance and adoption including renewable energy technology with other technologies
Takase et al., (2021)	Comprehensive review of energy scenario and sustainable energy in Kenya	A comprehensive review	There is a significant reliance on wood for fuel and the other biomass accounting for 68% of overall energy usage. The study identified challenges in accessibility to the modern energy, high pressure on biomass supplies, rising energy prices, high demand for electricity than the available capacity	Did not narrow its focus to off-grid renewable energy technologies

Asante et al., (2020)	To investigate the impediments to renewable energy development in Ghana and provide recommendations for policy formulation.	Utilizing Multi-Objective Optimization based on Ratio Analysis (MULTIMOORA) integrated with Evaluation based on Distance from Average Solution (EDAS) method	Political and regulatory barriers were identified as the most significant obstacles, with corruption and nepotism emerging as critical hurdles. Recommendations included specific renewable energy standards, grid connection quotas, and streamlined certification procedures, advocating for a bottom-up approach to policy formulation.	Further exploration is needed to understand nuanced dynamics within each barrier category and their implications for effective policy implementation and sustainable renewable energy development
Shahzad et al., (2023)	To identify and rank obstacles hindering the expansion of solar power in Pakistan and provide recommendations for policy development.	Utilizing a spherical fuzzy analytical hierarchy process	Economic obstacles were identified as the most significant, constituting 21.46% of the total obstacles, with budget constraints, lack of access to credit/capital, political instability, high investment risk and operation cost, and partnership issues identified as the top five critical sub-obstacles. Recommendations were provided to address these obstacles, offering policy implications for	Further research is needed to delve deeper into the effectiveness of proposed solutions and address any remaining gaps in understanding the challenges hindering solar energy adoption in Pakistan
Zeng et al., (2022)	To examine the significant factors influencing people's acceptance of OGRETs	Employing structural equation modeling	Environment-related concerns, awareness on green energy technologies, candidness to new experiences, and perceived benefits of GETs positively influenced	The findings may not be universally applicable to all settings, especially in middle-income countries like Kenya, highlighting

			consumers' inclination to adopt these technologies. However, projected costs linked with green energy technologies and discomfort associated with their adoption had a negative impact on consumer adoption.	the need for further exploration in the Kisii County context
Nyarko et al., (2023)	To examine the catalysts and obstacles faced by OGREs initiatives in West Africa and provide insights for overcoming them	Utilizing a comprehensive framework encompassing Political, Economic, Social, Technical, Legal, and Environmental dimensions (PESTLE challenges)	Economic hurdles posed the most significant impediments to the sustainable advancement of OGREs powered systems in West Africa. The results further unveiled intricate interconnections and patterns among these challenges, underscoring the necessity of considering the broader landscape rather than fixating solely on the most immediate issues.	The study primarily concentrated on institutional hindrances and did not delve into the intricacies of consumer behavior, suggesting a potential gap in comprehending the factors influencing end-users in adopting off-grid renewable energy
Bamati & Raoofi, (2020)	To conduct a comprehensive examination of the factors influencing renewable energy (RE) production, focusing on technological, economic, and environmental variables	Employing Generalized Least Square (GLS) panel data estimation method	The determinants of RE sources varied based on the income level of the countries. In developed nations, high technology exports emerged as a significant determinant of RE production, contrasting with developing countries where this factor showed no statistical significance. Additionally, the study found that oil prices had minimal impact on RE production	The study highlights the nuanced dynamics driving RE production in different economic contexts, emphasizing the need for tailored policy interventions to promote sustainable energy transitions globally

			across both groups. While GDP per capita exhibited a positive influence on RE production in both sets of countries, the impact of per capita CO2 emissions differed notably between developed and developing nations	
Sen & Ganguly, (2017)	To examine the opportunities, barriers, and related issues associated with renewable energy (RE) developments, considering its role in providing sustainable and clean energy while mitigating climate change	Involved a review of existing literature, policy documents, and possibly empirical data related to renewable energy development	The study emphasized the importance of secure energy supplies at affordable rates with low environmental impacts and greenhouse gas emissions for socioeconomic development. Positive support from governments and favorable promoting policies were identified as critical factors facilitating the development of RE forms	Further research could explore specific strategies for overcoming barriers and enhancing the uptake of renewable energy technologies to achieve sustainable social and economic development in Kenya
Psychosocial factors - Wagemann & Manetsgruber, (2016)	To explore risk management for the deployment of mini grids in far to reach areas	Involved an exploration of existing literature and empirical data related to risk management in mini-grid deployment	The study highlighted the importance of mini-grids meeting customers' demand for high-quality service with whole day availability, relying on affordable pricing system, and enough funding. Key challenges included the absence of a universally applicable risk management approach for mini grids, facing fundamental challenges such as complication,	Limited focus on developing a universally applicable risk management approach for mini grids, addressing fundamental challenges such as complication, improbability, and a lack of responsiveness to facilitate their effective

			improbability, and a lack of responsiveness	deployment in far-to-reach areas
Wall et al., (2021)	To conduct a study in Thailand on the factors influencing consumers' adoption of RE	Involved surveying consumers and analyzing their responses to determine the factors influencing their adoption of renewable energy	The study found a significant positive association between consumers' intention to adopt off-grid energy and effectiveness. Perceptions of risk and trust positively influenced consumer adoption, while the cost of RE had a negative but non-significant impact. The conclusion stressed the importance of considering various elements when designing consumer adoption campaigns for renewable energy in Thailand, including attitudes about the benefits of renewable energy, environmental concern, perceptions of self-effectiveness, and awareness of the technology	Lack of the geographical differences in consumer attitudes and the uptake of solar energy solutions across different regions. Investigating the nuanced factors influencing consumer adoption of renewable energy in various geographical contexts could provide valuable insights for designing targeted adoption strategies tailored to specific regions and populations
Lopez et al., (2012)	To investigate barriers to renewable energy adoption in Sub-Saharan Africa, excluding South Africa, and analyze factors limiting the penetration and investment in renewable energy in the region.	Involved a review of existing literature, policy documents, and empirical data related to renewable energy adoption and investment in Sub-Saharan Africa.	Sub-Saharan Africa, excluding South Africa, faces low electricity access, especially in rural areas, with less than 10% having access and relying primarily on biomass. Despite the region's renewable energy potential, there is a lack of penetration and investments. Barriers include subsidies on fossil-	Inadequate focus on country specific challenges and opportunities for renewable energy adoption in Sub-Saharan Africa

			based generations without considering associated environmental and social costs, insufficient financial and policy support for renewable energy, and high upfront costs	
Chauhan & Saini, (2015)	To identify obstacles hindering the development of renewable energy (RE) initiatives in India and analyze the factors contributing to the reluctance of investors to fund RE projects	Involved a review of existing literature, policy documents, and possibly empirical data related to obstacles hindering RE initiatives in India and factors contributing to investors' reluctance to fund RE projects	In India, obstacles hindering the development of RE initiatives include an inadequate institutional framework for financial management, the absence of standardized technical norms for small-scale RE products in selling places, lack of explicit directives and insufficient financial allotments from state electricity regulatory commissions, and bureaucratic procedures such as land acquisition, water, and environmental clearances contributing to delays in the construction of RE-based projects	Lack of the specific impact of each identified obstacle on the development of RE initiatives in Kenya, providing insights for targeted interventions and policy reforms to address these challenges and promote the growth of renewable energy sector in the country
Viardot, (2013)	Investigated the role of cooperatives in promoting the adoption of renewable energy (RE) by addressing barriers to its uptake	Conducted a survey of 9 cooperatives in countries with government subsidies for RE to identify specific barriers to RE adoption by consumers and assess how cooperatives circumvented these obstacles	Cooperatives effectively mitigated barriers to RE adoption through community-based social marketing initiatives such as educational communication, competitive pricing, local services, and cooperative distribution. The study	The study does not provide the long-term sustainability and scalability of cooperative-driven initiatives in promoting RE adoption, as well as

			highlighted the significant contribution of cooperatives in promoting RE uptake and proposed a framework for evaluating the impact of these initiatives on reducing barriers to RE adoption	their applicability across different socio-economic contexts
Khan et al., (2020)	Investigated barriers to the growth of renewable energy technology (RET), focusing on solar home systems (SHS), for rural electrification in Bangladesh. Aimed to provide insights into promoting RET as an alternative to grid connectivity for non-electrified rural communities amidst increasing energy demand and environmental concerns	Utilized non-parametric tests and literature surveys, collecting data from 171 respondents in two dispersedly located villages in Noakhali and Sirajganj districts	Identified various modes of purchase for SHS, usage constraints, and demand-side and supply-side barriers such as lack of promotional activities, economic conditions, awareness gaps, and financial constraints. Insights contribute to outlining a policy framework for facilitating the widespread adoption of RET in off-grid regions, addressing identified barriers, and promoting sustainable rural electrification	The study did not provide specific socio-economic, cultural, and technological factors influencing the adoption of RET which are key in providing comprehensive insights to inform the development of effective policies and strategies for sustainable rural electrification
Nevzorova & Kutcherov, (2019)	Identify and classify barriers hindering the widespread adoption of biogas as a source of energy. Conducted a systematic review of barriers based on the Scopus database,	Analyzed these barriers within different contexts to identify the most frequent and crucial constraints faced by the biogas industry, proposing potential solutions	Highlighted the significance of stakeholder involvement, particularly from the private sector, government, financial institutions, R&D institutions, lobby groups, media, and local communities, in addressing the identified barriers. Emphasized collaboration among	Study does not provide additional strategies for mitigating these barriers and fostering biogas utilization on a broader scale

	categorizing them into technical, economic, market, institutional, socio-cultural, and environmental barriers across developed and developing economies		stakeholders as essential for overcoming obstacles and advancing biogas energy for sustainable development. Urged coordinated efforts and knowledge-sharing to effectively tackle environmental protection challenges associated with biogas adoption	
Mainali & Silveira, (2015)	Identify technological barriers hindering renewable energy (RE) adoption, particularly in far-to-reach areas, and assess the availability of resource valuation databases.	Conducted a comprehensive review to identify technological barriers and challenges in providing energy access to rural areas, examining factors such as limited energy access, the maturity level of RE sources, and the necessity for energy storage. Evaluated the availability of monitoring stations for key parameters such as wind speed, solar radiation, and rainfall in Uttarakhand state	Technological barriers included challenges such as limited energy access in far-to-reach areas, a lack of databases for resource valuation, a relatively low maturity level of RE sources, and the necessity for energy storage with renewable bases. Difficulty in providing energy access to rural areas was compounded by the remoteness of many unelectrified villages and hamlets, especially in hilly terrains	Did not explore strategies for overcoming technological barriers to RE adoption, particularly in remote and inaccessible areas in detail
Walters et al., (2018)	Investigate the minimal uptake of photovoltaic (PV) technology in Santiago, Chile, despite favorable market conditions, and	Conducted a Delphi study engaging a panel of experts to identify and assess 26 important factors related to motivation and barriers	Identified 26 factors influencing PV diffusion in Santiago, Chile, with 21 factors reaching consensus on their relative importance. Key factors included financial	The study's focus on Santiago may limit the generalizability of its findings to regions with

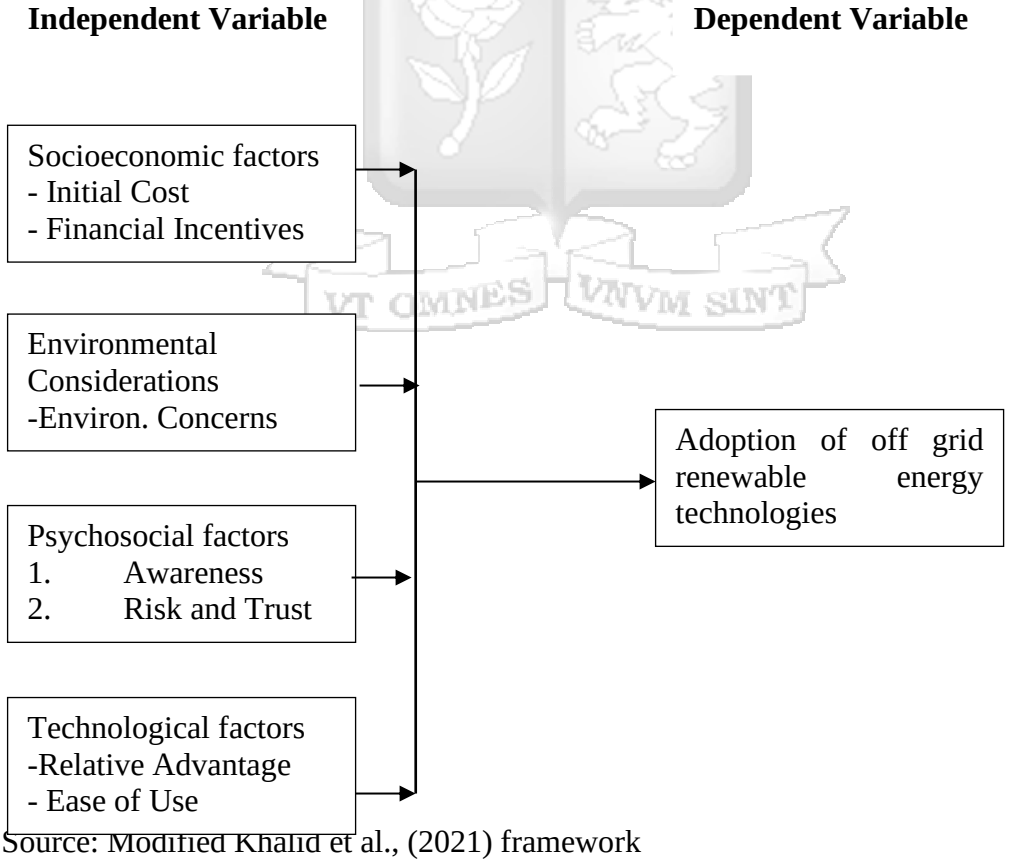
	identify the factors influencing PV diffusion in the region.	influencing PV diffusion in Santiago. Analyzed expert discussions on technical, economic, environmental, and social factors to determine their relative importance	motivations (e.g., subsidies) and barriers (e.g., high upfront costs), as well as technical, institutional, and knowledge-related challenges. Financial factors were deemed pivotal, while environmental motivations and technical challenges were considered less significant	different socio-economic and cultural contexts
Chauhan & Saini,(2015)	Identify challenges faced by small-scale renewable energy (RE) projects in Uttarakhand state, particularly in remote areas, and assess the shortage of skilled manpower in the RE sector	Conducted a qualitative study to explore challenges and shortage of skilled manpower in the RE sector, focusing on the functioning and maintenance of small-scale RE projects	Identified challenges in the functioning and maintenance of small-scale RE projects, including shortages of skilled manpower, particularly in remote areas. Maintenance of micro hydro power plants was challenging due to the need for consistent year-round maintenance, and managing pine needles in forested areas posed logistical difficulties	Inadequate strategies to address the shortage of skilled manpower in the RE sector, especially in remote areas. Additionally, inadequate investigations into innovative maintenance techniques for small-scale RE projects could enhance their sustainability in challenging terrains
Wojuola & Alant, (2019)	Investigate technical hurdles obstructing the embrace of Renewable Energy Technologies (RETs) among the Nigerian populace	Employed a convergent parallel mixed-method research design, gathering data through quantitative surveys and qualitative focus group interviews	Identified primary technical barriers: accessibility, complexity, maintenance, and durability, hindering RET adoption in Nigeria.	While focusing on Oyo State, Nigeria, a research gap persists in exploring similar issues in other regions like Kisii County, Kenya, suggesting further

				investigations across diverse geographical contexts are needed
Khan et al., (2021)	Assess the short-term and long-term impacts of technological innovation, finance, and foreign direct investment (FDI) on renewable energy, non-renewable energy, and CO2 emissions across 69 countries participating in the Belt and Road Initiative (BRI) from 2000 to 2014	Utilized robust standard error regression and dynamic GMM estimators to analyze the data	Technological innovations, economic growth, and FDI negatively influenced renewable energy adoption, while financial developments had a positive impact on the renewable energy sector in BRI countries. Additionally, a positive association was observed between technological innovation, FDI, and economic growth with energy use and CO2 emissions	Despite insights gained, further research is warranted to explore additional factors influencing renewable energy adoption and to develop more targeted policy interventions in the context of the Belt and Road Initiative

2.5. Conceptual Framework

Alongside outlining the primary components of a research investigation, as highlighted by Mugenda (2008), a succinct depiction of the phenomena being studied is presented as a conceptual framework. This framework elucidates the concepts under scrutiny and their interrelation, as emphasized by Saunders, Lewis, and Thornhill (2009). The current study was structured around a framework designed to elucidate the interaction among the dependent and independent variables. The conceptual framework derives from the research objectives and a comprehensive review of the literature. The interrelationships are as depicted in Figure 2.2.

Figure 2.2: **Conceptual framework**



Source: Modified Khalid et al., (2021) framework

Figure 2.2 shows the relationships between predicator variables and the outcome variable as they will interact in the study. The figure observes that there are four independent variables namely, socioeconomic factors, psychosocial factors, technological factors, and environmental concerns which will be analyzed against the adoption of off grid renewable energy technologies. To enable the study, achieve its objective, the study variables will be measured in a detailed manner.

Socioeconomic factors are operationalized by assessing participants' perceptions and access related to the initial cost and financial incentives associated with renewable energy adoption. Various aspects are being considered, including individuals' beliefs about the affordability of renewable energy and their access to financial resources for its purchase. Participants' perceptions of renewable energy as a wise financial decision for the future, as well as their views on its comparative cost to conventional energy sources are also being examined. Additionally, the availability of financial instruments such as loans, grants, government subsidies, feed-in tariffs, and tax relief for renewable energy adopters is being evaluated.

Environmental concerns are being operationalized by assessing participants' perceptions and anxieties related to pollution, environmental degradation, climate change, and the potential benefits of renewable energy adoption. In addition, how utilization of renewable energy can improve the environment is examined.

Psychosocial factors pertaining to awareness, risk perception, and trust in renewable energy adoption are being operationalized through assessment which encompasses individuals' levels of trust in the safety and security of renewable energy as an energy source, as well as their awareness of associated risks. Participants' sense of security and trust in renewable energy providers prioritizing their best interests are also being evaluated. Moreover, the

survey explores participants' comparative trust in renewable energy versus other energy sources. Awareness levels regarding the advantages and availability of off-grid renewable energy technologies are being explored, including exposure to educational materials, awareness campaigns, and training programs.

Technological factors relevant to the adoption of renewable energy, specifically focusing on relative advantage and ease of use are examined. Participants' perceptions are being assessed regarding the benefits of renewable energy, such as reductions in fossil fuel usage, environmental pollution, and carbon footprint, as well as potential cost savings in energy supply. Additionally, technological factors explore participants' views on the efficiency of energy generation from renewable sources compared to traditional fossil fuels. Ease of use aspects are also being examined, including the ease of installation, learning, and operation of renewable energy equipment. Participants' opinions on the clarity and accessibility of manuals for renewable energy systems are also being considered, along with their confidence in mastering the use of such equipment.

In assessing the adoption of off-grid renewable energy technologies, participants' intentions, and plans regarding the use of renewable energy technologies are being examined, including their willingness to allocate more resources to such technologies compared to other energy sources. Additionally, the survey explores the presence of positive encouragement and support for individuals to adopt renewable energy, along with participants' willingness to advocate for renewable energy adoption and recommend it to others.

Table 2.2: Operationalization of study variables.

Predicator Variable	**Outcome Variable**	**Unit of Measurement**	**Data Analysis**
Socioeconomic constraints	Adoption of off-grid renewable energy technologies	Ordinal scale	Descriptive / Regression
Environmental Considerations	Adoption of off-grid renewable energy technologies	Ordinal scale	Descriptive / Regression
Psychosocial factors	Adoption of off-grid renewable energy technologies	Ordinal scale	Descriptive / Regression
Technological factors	Adoption of off-grid renewable energy technologies	Ordinal scale	Descriptive / Regression

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This section outlines the methodology employed to examine the factors influencing the uptake and advancement of OGRETs in Kisii County, Kenya. The chapter delineates the research philosophy, design, target demographic, sampling methodology, data collection techniques, instruments utilized for data gathering, research validity, methods for data analysis, ethical protocols, and the empirical framework applied in this investigation.

3.2 Research Philosophy

This study adopted a positivist research philosophy, emphasizing quantitative methods to investigate the adoption of Off-Grid Renewable Energy Technologies (OGRETs) in Kisii County. Positivism aligns with the study's objectives, aiming to systematically assess the influence of innovation characteristics, economic factors, environmental considerations, and psychosocial factors on technology adoption. The choice of a positivist approach is justified by its emphasis on objectivity, replicability, and the systematic analysis of observable phenomena. By employing structured surveys and statistical analyses, the study sought to generate quantifiable data that can be rigorously analyzed to uncover patterns and associations in OGRET adoption.

The positivist research design facilitates the establishment of causal relationships between variables, enabling researchers to identify key drivers and barriers to OGRET adoption. Through systematic data collection and analysis, the study aimed to provide empirical evidence that can inform policy decisions and interventions aimed at promoting sustainable energy adoption in Kisii County. By adhering to a positivist philosophy and employing

quantitative methods, the study seeks to contribute valuable insights into the factors shaping technology adoption in the context of renewable energy, thereby advancing knowledge in the field and guiding efforts to address energy challenges in Kisii County and beyond (Crowther & Lancaster, 2008).

3.3 Research Design

The research design for this study was a cross-sectional survey that utilized a quantitative approach to collect and analyze the data. This design was suitable for achieving the study's objective of assessing the influence of various factors on the adoption of OGRETs in Kisii County. A structured questionnaire was developed based on the TAM and included items related to technological characteristics, socio-economic factors, environmental considerations, and psychosocial factors.

3.4 Target Population

A study population refers to a broader group encompassing all subjects, from which a sample is selected (Pernecky,2016). The target population for this study was the Kisii County households. As per the 2019 Census the total number of households in Kisii County was 308,054 (KNBS, 2019c).

3.4.1 Sampling Technique and Sample Size

A sampling technique is the method used to select a representative sample from a population. It specifies the sampling unit (e.g., individuals, households), sampling frame (list of potential participants), sampling procedures (method of selection), and sample size. The sample was stratified in a way that each population in every stratum gets an equal chance to be represented. Then random sampling technique was used to determine respondents from each stratum that were stratified. To ensure fair representation for each sub-group within each

sub-county, proportionate sampling was used. The required sample size was calculated using the formula Yemane, (1967) the formula is given as follows: -

$$n = \frac{N}{1 + N(e)^2} n = \frac{N}{1 + N(e)^2}$$

Where;

N= Population;

e = margin of error or significance level at 0.05,

n = sample size

Therefore, 308054/1+308054 (0.05^2)]

=308054/771.135

=399.48 Respondents. The sample was rounded off to the nearest whole number; hence, the study used 400 respondents.

Therefore, the calculated sample size was 400 households. The sample size provided a representative understanding of the factors influencing off-grid renewable energy technologies adoption in Kisii County while considering the desired level of precision.

The sampling strategy for this study employed a combination of stratified and cluster sampling techniques to ensure representation across various dimensions. The study area consisted of 11 sub-counties, and the total desired sample size was 400 households.

The research design employed a stratified and cluster sampling approach to ensure a comprehensive representation of the population in Kisii County. To determine the sample size per strata (sub counties), following the determination of a total of 400 respondents in the study, proportionate stratified sampling using the formula by Krejcie and Morgan (1970) was used to determine the sub-sample as shown:

$$s = XS \div P$$

Where;

s = Sub-sample size for each sub county

X = Population/ Number of households in each sub county

S = Total sample size for the study

P = Total population of all households in the county.

Substituting the values in the above formulae gave the following sub sample size to participate in the study under each sub-county as in Table 3.1.

Table 3.1: Sample size of study

Sub County	Number of households	Sample Size
Etago	18610	24
Gucha	19657	25
Gucha south	19732	26
Kenyenya	30989	40
Kisii central	44311	57
Kisii South	31696	41
Kitutu Central	41271	54
Marani	26186	34
Masaba South	29232	37
Nyamache	30712	40
Sameta	15658	22
Total	**308054**	**400**

The sampling process for this study was designed to ensure inclusive representation of the population across Kisii County. With 11 sub-counties as the primary units of analysis, the first step involved stratification based on two crucial variables: urban/rural classification and the adoption status of renewable energy (RE) technologies. This stratification facilitated the creation of four distinct strata within each sub-county, including Urban Adopters, Urban Non-adopters, Rural Adopters, and Rural Non-adopters. By stratifying the population, the

study captured the diversity of adoption statuses and geographic locations, enabling a nuanced analysis of factors influencing RE technology adoption.

After stratification, the next step involved determining the sample size for each sub-county, ensuring proportional representation based on the number of households. For instance, in Kisii Central Sub County, which boasts 44,311 households, a sample size of 57 households was selected. This proportionate allocation of sample size ensured that sub-counties with larger populations contributed more to the overall sample, maintaining statistical validity and precision in the analysis.

Cluster sampling was then employed within each stratum of every sub-county to randomly select households. Clusters were chosen to represent each stratum, ensuring that both urban and rural areas, as well as different adoption statuses, were adequately represented. Within each cluster, households were randomly selected to meet the required sample size.

For instance, for Kisii Central Sub County, we had 10 clusters representing 4 different strata, composed of Urban Adopters, Urban Non-adopters, Rural Adopters, and Rural Non-adopters. Across these clusters, we aimed to select a total of 57 households for our study. To achieve this, we allocated a proportionate number of households to each cluster based on its size. For example, if Cluster 1 comprised of 50 households, approximately 5 households were randomly selected from there. Similarly, for Cluster 2 with 60 households, around 7 households would be chosen.

Continuing this approach across all 10 clusters, we carefully adjusted the number of households selected in each cluster to ensure the total reaches our target of 57. This process of random selection minimizes bias and ensures that every household within the selected clusters has an equal chance of being included in the study. By repeating this process across

all 11 sub-counties, the study aimed to capture a diverse range of perspectives and experiences related to RE technology adoption in Kisii County.

Detailed procedure for Kisii Central Sub County was as follows. The household sampling for the study comprised of four distinct categories (Strata): Urban Adopters, Urban Non-adopters, Rural Adopters, and Rural Non-adopters. In the Urban Adopters category, two clusters were identified: Cluster 1 with 50 households, from which approximately 5 households were randomly selected, and Cluster 2 with 60 households, from which approximately 7 households were randomly selected. For Urban Non-adopters, two clusters were delineated: Cluster 3 with 40 households, from which approximately 5 households were randomly chosen, and Cluster 4 with 50 households, from which approximately 5 households were randomly selected. In the Rural Adopters category, three clusters were identified: Cluster 5 with 70 households (approximately 8 households randomly selected), Cluster 6 with 60 households (approximately 7 households randomly selected), and Cluster 7 with 50 households (approximately 5 households randomly selected). Lastly, for Rural Non-adopters, three clusters were established: Cluster 8 with 50 households (approximately 5 households randomly selected), Cluster 9 with 40 households (approximately 5 households randomly selected), and Cluster 10 with 50 households (approximately 5 households randomly selected). The total households sampled across all categories amounted to 57 households.

3.5 Data Collection Instruments

To comprehensively explore the factors influencing the adoption of OGRETs in Kisii County, a structured questionnaire was the primary data collection tool. The questionnaire was strategically designed to incorporate Likert scale items, enabling a quantitative

assessment of participants' perceptions and attitudes. This approach allowed respondents to express their opinions on various aspects related to off-grid renewable energy, including awareness, benefits, risks, and other influential factors. Moreover, the Likert scale facilitated adequate analysis by assigning numerical values to participants' responses, enabling statistical evaluation to identify existing patterns and existing trends.

In addition to the Likert scale items, the structured questionnaire included sections for collecting demographic information. This segment aimed to capture socio-economic variables such as age, income, education, and household size. Understanding these demographic factors was vital for discerning how social and economic contexts influence the adoption of OGRETs. The combination of Likert scale responses and demographic data enhanced the depth of the study, providing a holistic view of the factors shaping the adoption landscape in Kisii County.

3.6 Data Collection Procedure

The data collection strategy for this study was designed to ensure a systematic and reliable approach in gathering pertinent information from the target population. The process involved several key steps to maintain consistency and rigor throughout.

Initially, research assistants underwent training to familiarize themselves with the questionnaire, study objectives, and ethical considerations. This training emphasized the importance of unbiased data collection, confidentiality, and addressing potential challenges that may arise during the process.

Following the training, a pilot test of the questionnaire was carried out on a small subset of respondents to identify and rectify any ambiguities or difficulties in comprehension.

Adjustments were made to the questionnaire based on the results from the pilot test to enhance clarity.

Before administering the questionnaire, research assistants approached selected households to explain the study's purpose and seek informed consent. Participants were guaranteed of the confidentiality of their responses and their right to withdraw from the study at any point. During the data collection phase, the structured questionnaire, comprising Likert scale items and demographic sections, were administered through face-to-face interviews with selected household head or in their absence, any adult household member present. Supervisors conducted regular checks to ensure the quality and consistency of responses throughout the process.

Once data collection was complete, the collected information was systematically entered into a secure database and subjected to rigorous statistical analysis.

3.7 Research Quality

This research aims to uphold research quality through the application of objectivity, validity, and reliability assessments Mugenda and Mugenda, (2003). The utilization of standardized data collection tools and techniques will be instrumental in maintaining data objectivity. In summary, employing a reliable and valid data collection tool, ensuring a sample size representative of the target population, and implementing a rigorous data analysis procedure collectively contribute to ensuring research quality.

3.7.1 Validity

To ensure the validity of the research instrument, the structured questionnaire used in this study underwent a thorough validation process. Prior to deployment, the questionnaire was critically reviewed by a panel of experts with extensive knowledge in renewable energy

technologies, socio-economic factors, and survey methodology (Mugenda & Mugenda, 2003). The expert panel assessed the clarity, relevance, and appropriateness of each questionnaire item, providing valuable insights to enhance its content and ensure alignment with the research objectives. Additionally, a pilot test was carried out on a small subset of the target population to assess the questionnaire's practicality and identify any potential issues with question comprehension. Feedback from the pilot test was carefully considered, and necessary adjustments made to refine the questionnaire.

3.7.2 Reliability Tests.

To ensure the reliability of the research instrument, a pretest was conducted with a sample drawn from the population under study. The purpose of the pretest was not only to assess validity but also to gauge the consistency and stability of the questionnaire. The respondents involved in the pretest were distinct from the main study sample, contributing to the external validity of the research.

Furthermore, internal consistency reliability was evaluated using statistical measures such as Cronbach's alpha. This analysis assessed the extent to which items within the questionnaire are interrelated and measure the same underlying construct consistently. A high Cronbach's alpha value would indicate a high level of internal consistency, enhancing the confidence in the reliability of the questionnaire.

Additionally, the pretest helped identify any ambiguities or challenges in respondents' interpretation of the questions. Adjustments were made based on the feedback received during the pretest, ensuring that the final questionnaire is clear, coherent, and reliable in capturing the intended information related to OGRETs adoption. The rigorous validation and

reliability procedures will contribute to the robustness of the research instrument and the overall quality of the study.

Once the data was collected through the structured questionnaire, a systematic process of data processing and analysis was undertaken. The collected responses were entered into a statistical software package for efficient management and analysis. Data cleaning procedures were implemented to identify and rectify any inconsistencies, missing values, or outliers.

3.7.3 Reliability Analysis.

Instrument reliability pertains to its capability to yield consistent and dependable measurements. A reliable instrument will consistently assign identical scores to the same phenomena. According to Creswell (2008), reliability denotes the stability or consistency of measurements, indicating whether the same outcomes would be obtained upon repeated application of the test or measure. The most commonly used reliability coefficient is Cronbach's alpha, which assesses internal consistency by averaging the inter-item correlation. The research drew upon the findings of Haeleand Twycross (2015) and Bonett and Wright (2014), indicating that Cronbach's alpha values falling within the range of 0.6 to 0.9 suggest satisfactory internal consistency within a measurement tool. Prior to the main study, a pilot investigation involving 40 participants was conducted.

Table 4.1 gives a summary of the Cronbach’s Alpha all the study variables.

Table 3.2: Summary of Reliability Analysis

Item	**Cronbach's Alpha's coefficient**	No of Items	Comments
Initial cost	0.6000	5	Reliable
Financial incentive	0.8354	5	Reliable
Environmental concern	0.9410	5	Reliable
Risk and trust	0.8523	5	Reliable
Awareness levels	0.8751	5	Reliable
Relative advantage	0.9375	5	Reliable
Ease of use	0.8655	5	Reliable
Adoption of OGRET	0.9142	5	Reliable

Source: Field Data (2024)

The reliability of the constructs was deemed satisfactory according to the guidelines proposed by George and Mallery (2003). They suggest that a Cronbach's alpha exceeding 0.9 is excellent, 0.8 is very good, and 0.7 is considered good. In the realm of social sciences research, a reliability coefficient of 0.7 or higher is generally regarded as acceptable. All four constructs socioeconomic factors, environmental concern, psychosocial factors, and technological factors met or surpassed this threshold for acceptability in social science research (Hair et al., 2010). Consequently, the reliability of the questionnaire as a whole was affirmed and deemed adequate.

3.8 Data Processing and Analysis

Descriptive statistics were employed to provide an overview of the demographic characteristics of the respondents and key variables. Likert scale responses were transformed into numerical values for quantitative analysis.

For the main analysis, the study collapsed Likert scale items into a single continuous variable and the inferential statistical methods were applied to explore relationships and patterns within the data. Correlation coefficients and chi-square tests were used to examine

associations between different variables. Additionally, multiple regression analysis was employed to identify factors influencing the adoption of OGRETs. The empirical model for this study is:

$$Y = \beta_0 + \beta_1 x^1 + \beta_2 x^2 + \beta_3 x^3 + \beta_4 x^4 \beta_5 x^5 + \beta_6 x^6 + \beta_7 x^7 + \epsilon$$

Where:

Y = Outcome variable (adoption of OGRETs)

β0 = Intercept,

β1, β2, β3, β4, β5, β6, β7 = Coefficients of the independent variables,

X_1 = Initial Cost

X_2 = Financial Incentive

X_3 = Environmental Concern

X_4= Risk and Trust

X_5= Awareness

X_6= Relative Advantage

X_7= Ease of use

ε = Error term

3.8.1 Assumptions Check.

Before interpreting the results, a careful examination of the assumptions associated with multiple regressions was conducted. These assumptions include linearity, independence of errors, homoscedasticity, normality of residuals, and the absence of multicollinearity among predictors. Ensuring adherence to these assumptions was imperative as it contributes to the validity and reliability of the subsequent analysis.

3.9 Ethical Issues in Research.

This research upheld ethical standards by securing informed consent from participants, safeguarding anonymity, confidentiality, and ensuring participants' well-being. Respondents received information about the study, and their involvement was voluntary. All collected data was treated confidentially, with participant identities kept anonymous. To sum up, prior to interviews, informed consent was acquired, and participants were informed of their right to withdraw. The study also prioritized participant confidentiality through the use of pseudonyms and secure data storage.

CHAPTER FOUR

RESEARCH FINDINGS AND DISCUSSION

4.1 Introduction

Chapter four presents the findings and discussions derived from the research methodology outlined in the previous chapter. The results shed light on the influence of various factors, including initial cost, financial incentives, environmental concern, awareness, risk, and trust, on the adoption of Off-Grid Renewable Energy Technologies (OGRETs) in Kisii County, Kenya. Additionally, the chapter provides the extent to which these technologies are being adopted by households in the region. It encompasses a comprehensive analysis of the response rate, reliability of the research instrument, and the characteristics of the study variables. Furthermore, the chapter presents correlations and regression analyses to explore the relationships between these variables and discusses the key findings and their implications.

4.2 Response Rate

The research obtained 400 valid questionnaires from the intended sample size of 400 respondents, resulting in a response rate of 100 percent. This high return rate played a crucial role in minimizing the risk of sampling bias. According to Fincham (2008) and Saldivar (2012), achieving a minimum response rate of 70 percent is essential for mitigating sampling bias and ensuring accurate inference.

4.3 Demographic Data

To comprehensively analyze the relationships between the study variables, it was deemed essential to initially gather demographic information from respondents. This demographic data encompassed factors such as gender, age group, and place of residence, educational

attainment and the primary sources of lighting and cooking. Including demographic details is a common practice in surveys, serving to assess the representativeness of respondents within the broader population (Creswell, 2008). This step was particularly crucial as previous research has indicated that the adoption of Off-Grid Renewable Energy Technologies (OGRETs) may be influenced by such demographic characteristics. The distribution of this demographic data is presented in Tables 4.2 to 4.6.

4.3.1 Gender Distribution of Respondents

Gender representation was a significant consideration in this study, as prior research on renewable energy (RE) has indicated its direct influence on various study variables. The distribution of respondents' gender in the study reveals an equitable representation across both categories, as illustrated in Table 4.1.

Table 4.1: Gender of respondents

Gender	Frequency	Percent
Male	239	59.75
Female	161	40.00
Total	**400**	**100**

The analysis indicates that although most respondents were male (59.75%), there is a relatively balanced gender distribution. The purpose of examining gender representation was to assess its influence on the adoption of Off-Grid Renewable Energy Technologies (OGRETs). Both gender are well-represented in the study, allowing for the generalization of findings across genders. Gender intersects with the adoption of Off-Grid Renewable Energy Technologies (OGRETs) through access to resources, decision-making power, benefit distribution, training and education, economic empowerment, and community engagement.

Gender disparities in access to resources and decision-making can affect the ability of individuals, particularly women, to adopt OGRETs.

4.3.2 Respondents Age Bracket

In this study, the age distribution of household heads was investigated due to the prevailing notion that younger individuals are more receptive to adopting new technologies, like OGRETs. Among the 400 respondents, nearly a quarter (24%) were between 18 and 25 years old, followed closely by the 26-35 age group, which comprised nearly 30% of participants. The remaining individuals were distributed across the following age groups, 16% (64 individuals) between 36 and 45 years, 14% (56 individuals) between 46 and 55 years, and 16% (65 individuals) 56 years of age and older. Table 4.2 illustrates the results.

Table 4.2: Age bracket of respondents

Age bracket	Frequency	Percentage
18-25 years	96	24.0
26-35 years	119	29.8
36-45 years	64	16.0
46-55 years	56	14.0
56 years and above	65	16.3
Total	**400**	**100.0**

Age also plays a significant role in the adoption of Off-Grid Renewable Energy Technologies (OGRETs), with several key factors influencing this relationship. These include technological literacy, financial resources, decision-making autonomy, lifestyle preferences, and awareness of environmental issues. Younger generations, often more tech-savvy and environmentally conscious, may be more inclined to embrace OGRETs due to

their familiarity with technology and greater concern for sustainability. However, older individuals may face barriers such as limited access to information, fixed income, and resistance to change. Tailoring outreach efforts, providing educational resources, and offering financial incentives that cater to the needs and preferences of different age groups are crucial for promoting widespread adoption of OGRETs across generations.

4.3.3 Respondents education levels.

Table 4.3 reveals the educational background of the 400 survey respondents, offering valuable insights into potential implications for OGRET adoption. Understanding the educational backgrounds of the survey participants (40% primary school, 30% secondary school, remaining with college/university, no formal education, or vocational training) is crucial for successful OGRET adoption. While those with higher education likely have the necessary digital literacy, household heads with lower educational attainment might require targeted outreach, training programs adjusted for varying literacy levels, and additional support to bridge the digital divide and ensure successful OGRETs implementation.

Table 4.3: Education levels of the respondents

Education levels	Frequency	Percentage
College/university	58	14.5
No formal education	40	10.0
Primary school	160	40.0
Secondary school	120	30.0
Vocational/technical training	22	5.5
Total	**400**	**100.0**

Education levels significantly influence Off-Grid Renewable Energy Technologies (OGRETs) adoption by shaping individuals' awareness, understanding, and ability to use these technologies effectively. Higher education correlates with better access to information and technological literacy, facilitating OGRET adoption. Conversely, lower education levels may limit awareness and technical knowledge, posing barriers to adoption. Tailored educational programs can bridge these gaps, promoting equitable OGRET access across diverse populations.

4.3.4 Households' sources of cooking fuel.

The survey results in table 4.4 reveal a clear dominance of firewood (69.3%) as the primary cooking fuel source among the 400 households. This is followed by liquefied petroleum gas (LPG) (19.8%) and charcoal (5.5%). Biogas and solar cookers were used by a minimal portion of the population (5.0% and 0.5%, respectively).

Table 4.4: Sources of households' cooking fuel

Source of cooking fuel	Frequency	Percentage
Biogas	20	5.0
Charcoal	22	5.5
Firewood	277	69.3
Liquefied Petroleum Gas	79	19.8
Solar cooker	2	0.5
Total	**400**	**100.0**

This widespread reliance on traditional fuels like firewood highlights the need for promoting OGRETs as a sustainable and cleaner alternative. OGRETs such as biogas digesters and solar cookers can offer significant environmental benefits by reducing dependence on

deforestation and charcoal production, while also improving indoor air quality and health outcomes. However, the low adoption rates of biogas and solar cookers suggest that overcoming barriers such as affordability, awareness, and access to technical support is crucial for successful OGRET implementation.

4.3.5 Sources of lighting fuel.

Table 4.5 shows that electricity (50.8%) is the most prevalent lighting fuel source among the 400 households, followed by kerosene lamps (19.0%) and solar lanterns (30.0%). Only a negligible portion (0.3%) relies on candles.

Table 4.5: Sources of lighting fuel

Source of lighting fuel	Frequency	Percentage
Candle	1	0.3
Electricity	203	50.8
Kerosene lamp	76	19.0
Solar lantern	120	30.0
Total	**400**	**100.0**

While electricity is the dominant lighting source, a significant portion of households (49%) still depends on less sustainable options like kerosene lamps. This highlights the potential for solar lanterns as an OGRET solution to promote clean energy access and reduce reliance on fossil fuels.

4.3.6. Off-grid connectivity.

The survey findings as shown in table 4.6 unveil a significant gap in off-grid energy access among the 400 households. While solar panels are the most common off-grid technology

(29.0%), a substantial 61.7% of households lack any form of off-grid connection. This is followed by biogas (7.8%), mini hydro (1.0%), and wind turbines (0.5%).

Table 4.6: Off-grid connectivity

Off-grid connectivity	Frequency	Percentage
Biogas	31	7.8
Mini-Hydro	4	1.0
Solar Panels	116	29.0
Wind Turbines	1	0.5
None	247	61.7
Total	**400**	**100.0**

This data underscores the urgent need to bridge the gap in off-grid energy access through the promotion of OGRETs. By raising awareness, addressing affordability, and providing technical support and other barriers to adoption of OGRETs. Notably, solar panels, have the potential to empower these households with sustainable and reliable energy solutions.

4.4 Variables of the study

This study investigated the factors hindering the adoption of Off-Grid Renewable Energy Technologies (OGRETs). The study focused on four key variables: socioeconomic factors (initial cost, financial incentives), environmental concern, psychosocial factors (trust, risk and awareness), and technological factors (relative advantage, ease of use).

To understand how these factors influence households' willingness to adopt OGRETs, the study utilized the means and standard deviations. Means represent the average score for each variable, providing a clearer picture of central tendency compared to the median. Standard

deviations measure the spread of data points around the mean, indicating how much individual responses vary from the average. As per Joshi, Kale, Chandel, and Pal (2015), and Nemoto and Beglar (2014), participants were instructed to employ a 5-point Likert scale, with interpretations as follows: 4.3-5 = Strongly Agree, 3.5-4.2 = Agree, 2.5-3.4 = Undecided, 1.9-2.6 = Disagree, and 1-1.8 = Strongly Disagree. This combined analysis aimed to reveal the impact of different factors on OGRET adoption and inform strategies to overcome these barriers.

4.4.1 Socioeconomic factors

While the survey participants in Kisii County acknowledge the potential benefits of adopting Off-Grid Renewable Energy Technologies (OGRETs), financial concerns remain a significant barrier.

Table 4.7: Socioeconomic factors

Initial cost	**N**	**Mean**	**Std. Deviation**
I perceive the initial cost of owning and installing renewable energy as high	400	3.693	1.240
I believe that renewable energy should be more affordable to encourage widespread adoption	400	4.040	1.190
I have access to financial resources for the purchase of renewable energy	400	2.493	1.204
Investing in renewable energy is a wise financial decision for the future	400	3.985	1.139
I consider renewable energy to be more expensive than conventional energy sources	400	2.340	1.296
Financial incentives			
Loans are available to acquire renewable energy	400	2.542	1.143
Grants are available to acquire renewable energy	400	2.450	1.082
Government subsidies renewable energy adoption	400	2.355	1.105
Feed-in-Tariff (Fit) is available for adopters of renewable energy	400	2.733	1.090
Tax relief is available to those who acquire renewable energy	400	2.298	1.139

Table 4.7 reveals that individuals perceive the initial cost of OGRETs to be high (mean score of 3.693) and their access to financial resources for purchase is limited (mean score of 2.493). However, despite these hurdles, the survey also indicates a positive perception of OGRETs as a sound long-term investment (mean score of 3.985).

The survey results reveal an average score below 3 for all the considered financial incentives, including loans (2.542), grants (2.450), government subsidies (2.355), feed-in tariffs (2.733), and tax relief (2.298). These low scores point towards the absence of these programs in the region, not merely a lack of awareness. This unavailability of crucial financial support creates a formidable obstacle for potential adopters, hindering their ability to overcome the initial cost barrier and transition to OGRETs. Addressing this critical issue by implementing and promoting accessible financial support programs is essential to fostering wider OGRET adoption and empowering the community to embrace a more sustainable energy future.

4.4.2. Environmental concern

The survey data reveals a strong connection between environmental anxieties and potential adoption of Off-Grid Renewable Energy Technologies (OGRETs). The high average scores (above 3.8) for all statements related to environmental concerns (pollution, energy-related pollution, environmental problems, and climate change) indicate a widespread awareness and significant level of anxiety about environmental issues among the respondents.

Additionally, the highest average score (4.1) is observed for the statement "Utilization of renewable energy can improve the environment," highlighting their belief in the potential of OGRETs to address these concerns. This suggests a clear recognition of the link between traditional energy sources and environmental problems, coupled with a positive perception of OGRETs as a solution.

Table 4.8: Environmental considerations

Environmental concerns	N	Mean	Std. Deviation
I am anxious about pollution in the environment	400	3.868	1.0501
Environmental pollution caused by energy is not good	400	3.885	1.127
I am anxious about environmental problems caused by energy sources	400	3.873	1.053
I am anxious about climate change and the associated hazardous effect	400	3.995	1.095
Utilization of renewable energy can improve the environment	400	4.1	1.043

As shown in table 4.8, the high average scores (above 3.8) for all statements related to environmental concerns (pollution, energy-related pollution, environmental problems, and climate change) indicate a widespread awareness and significant level of anxiety about environmental issues among the respondents.

Additionally, the highest average score (4.1) is observed for the statement "Utilization of renewable energy can improve the environment," highlighting their belief in the potential of OGRETs to address these concerns. This suggests a clear recognition of the link between traditional energy sources and environmental problems, coupled with a positive perception of OGRETs as a solution.

Overall, the data suggests that environmental concerns can be a significant motivator for OGRET adoption in Kisii County. By emphasizing the environmental benefits of OGRETs, such as reduced pollution and contribution to a cleaner environment, stakeholders can leverage this existing environmental awareness to promote wider adoption of these sustainable energy solutions.

4.4.3 Psychosocial factors

Residents in Kisii County generally perceive renewable energy as a safe and secure option.

Table 4.9: Psychosocial factors

Awareness	**N**	**Mean**	**Std. Deviation**
I trust that renewable energy is a safe and secure energy source	400	4.005	1.057
I am aware of the risks associated with renewable energy	400	3.275	1.108
I feel secure and unexposed to risks when using renewable energy	400	3.693	1.075
I trust that renewable energy providers prioritize my best interests	400	3.700	1.033
I have more trust in renewable energy more than other energy sources	400	3.753	1.026
Risk and Trust			
I have information on the advantage of adopting off grid renewable energy technologies	400	3.395	1.167
I have been educated through mass media about the positive impacts of off grid renewable energy technologies	400	3.110	1.225
There are regular awareness campaigns, education materials and online resources educating us on off grid technologies	400	2.978	1.245
I am provided with education and training programs on off grid renewable energy technologies	400	2.740	1.221
I am aware of the off grid renewable energy technologies options available in my locality	400	3.158	1.299

Table 4.9 illustrates that while residents in Kisii County generally perceive renewable energy as a safe and secure option (average score of 4.005 for trust), their journey towards adopting Off-Grid Renewable Energy Technologies (OGRETs) is influenced by a complex interplay of psychosocial factors.

On one hand, there's a moderate awareness of potential risks associated with OGRETs (average score of 3.275), highlighting the need for comprehensive communication strategies

that address these concerns transparently. Additionally, while trusting OGRETs as a concept, individuals exhibit a moderate level of trust in the providers themselves (average score of 3.700), suggesting a potential gap in transparency and ethical practices that needs to be addressed.

Furthermore, limited access to information (average score below 4 for information access, mass media education, and awareness campaigns) and training opportunities (average score of 2.740 for education and training programs) act as significant barriers to adoption. This lack of comprehensive knowledge and understanding can lead to hesitancy and uncertainty about the technology, hindering their decision to embrace OGRETs.

Therefore, successful OGRET adoption in Kisii County hinges on addressing these psychosocial factors concurrently. By enhancing awareness and education, promoting transparency and building trust, and addressing concerns while building confidence, stakeholders can create a more favorable environment for OGRET adoption.

4.4.4 Technological factors

Residents in Kisii County see clear advantages in adopting Off-Grid Renewable Energy Technologies (OGRETs).

Table 4.10: Technological factors

Relative advantage	**N**	**Mean**	**Std. Deviation**
Using renewable energy reduces fossil fuels usage	400	3.903	1.061
Using renewable energy decreases environmental pollution	400	4.143	1.010
Using renewable energy decreases carbon footprint	400	4.005	1.033
Adopting renewable energy leads to cost savings in energy supply	400	4.063	1.045
Energy generation from renewable sources is more efficient than traditional fossil fuels.	400	3.970	1.057
Ease of use			
It is easy to install renewable energy equipment	400	2.888	1.159
Learning to use renewable energy is easy for me	400	3.450	1.121
Manuals on renewable energy are easy to understand	400	3.408	1.060
Renewable energy installations are easy to operate	400	3.435	1.104
I can master using renewable energy equipment easily	400	3.705	1.107

Table 4.10 illustrates that residents recognize the potential for cost savings (average score of 4.063 for "leads to cost savings in energy supply") and the positive environmental impact of OGRETs, including reduced reliance on fossil fuels (average score of 3.903) and a smaller carbon footprint (average score of 4.005). Additionally, they acknowledge the increased efficiency of renewable energy sources compared to traditional methods (average score of 3.970).

However, despite acknowledging these benefits, a potential hurdle exists in the perceived ease of use of OGRETs. The average scores for statements related to installation (2.888), learning to use the technology (3.450), and operating the system (3.435) all fall below 4. This suggests that concerns about complexity could be a significant barrier for wider adoption. Individuals might be hesitant to embrace OGRETs if they perceive them as difficult to install, understand, or maintain.

Therefore, fostering successful OGRET adoption in Kisii County requires addressing both sides of this equation. While highlighting the environmental and economic benefits remains crucial, it's equally important to address concerns about ease of use. Providing user-friendly resources such as installation guides, training programs, and readily available technical support can play a vital role in empowering individuals and building their confidence in using and maintaining OGRETs.

4.4.5 Adoption of off grid renewable energy technologies

Residents in Kisii County exhibit generally positive sentiments towards adoption of Off-Grid Renewable Energy Technologies (OGRETs).

Table 4.11: Adoption of off grid renewable energy technologies

Adoption of off grid renewable energy technologies	N	Mean	Std. Deviation
I have the intention to spend more on renewable energy technologies than other sources of energy	400	3.683	1.151
I am planning to use renewable energy technologies	400	3.645	1.154
Positive encouragement exists for me to adopt renewable energy	400	3.690	1.171
I am willing to be renewable energy adoption ambassador	400	3.885	1.084
I strongly recommend others to adopt renewable energy technologies	400	4.008	1.068

Table 4.11 results reveal a disconnect between intention and action. Although individuals express a moderate level of agreement with statements like spending more on renewable energy (average score of 3.683) and planning to use the technology (average score of 3.645), the average scores across the board fall below 4, suggesting a gap between positive intentions and actual adoption.

Interestingly, the data reveals a strong potential for advocacy with the highest average score (4.008) observed for "strongly recommending others to adopt renewable energy technologies." This suggests that positive word-of-mouth and community encouragement could play a significant role in influencing adoption rates.

Despite these positive inclinations, the limited translation of intention into concrete action remains a crucial challenge and strategies fostering a more actionable and sustainable energy future for Kisii County remains paramount.

4.5 Regression analysis

Before interpreting the results of our multiple regression analysis predicting OGRET adoption in Kisii County, we ensured the model's validity by evaluating several key assumptions: absence of influential outliers, normality of the residuals, lack of multicollinearity among predictors, homoscedasticity of variance and linearity between predictors and OGRET adoption. By addressing these assumptions, we can have greater confidence in the reliability and interpretability of the model, ultimately leading to more robust insights into the factors impacting OGRET adoption in this region.

4.5.1 Test absence of influential outliers

We utilized box plots, a visual tool that reveals the distribution of data. In our case, the box plots (Figure 4.1) indicated a healthy distribution with minimal data points falling outside the whisker lines. This is positive news, as it suggests our data isn't significantly skewed by extreme values.

Outliers can be problematic for regression analysis as they can disproportionately influence the results and lead to misleading interpretations. Therefore, the absence of significant outliers, as confirmed by the box plots, strengthens the validity of our model and increases our confidence in the reliability of the regression findings.

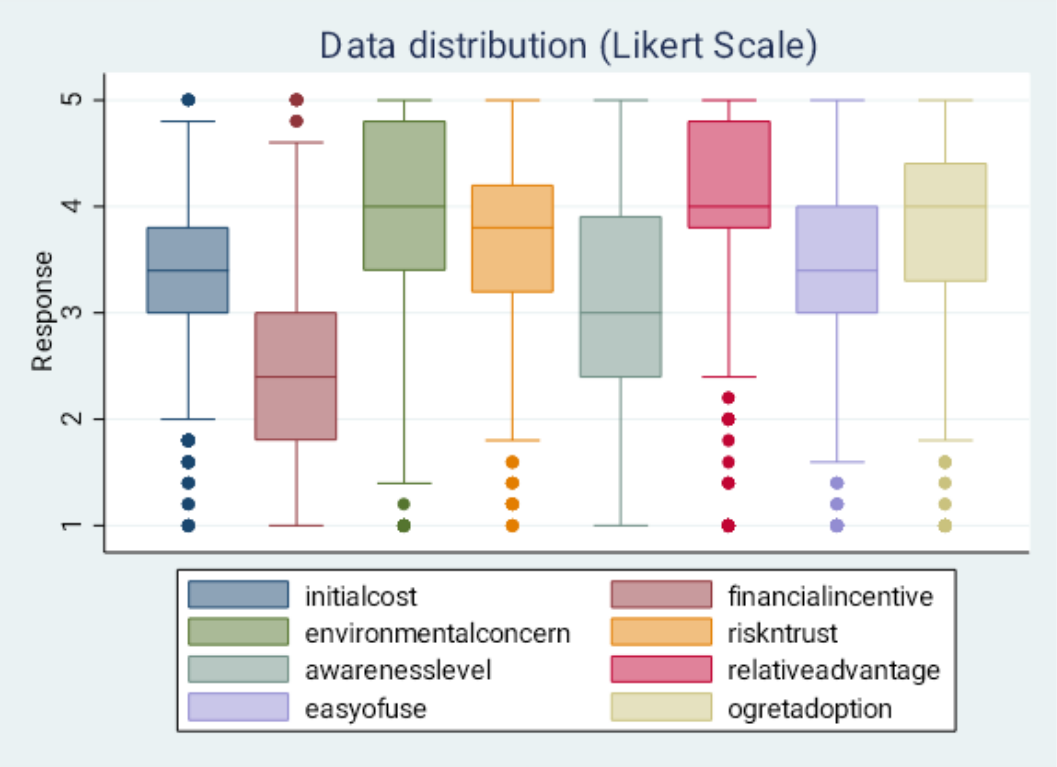


Figure 4.1: Box Plots

4.5.2 Normality test

Osborne (2013) emphasizes the importance of assessing the distribution of regression residuals to validate the predictive model. The normality of residuals plays a crucial role in

minimizing bias in regression coefficients. Therefore, it is imperative that regression residuals adhere to a normal Gaussian distribution, characterized by skewness and kurtosis values within acceptable ranges. In this study, normality of regression residuals was evaluated in the histogram of standardized residuals (Figure 4.2).

The histograms of standardized residuals exhibit a roughly symmetric, bell-shaped curve resembling a normal distribution; it suggests that the residuals approximately follow normality.

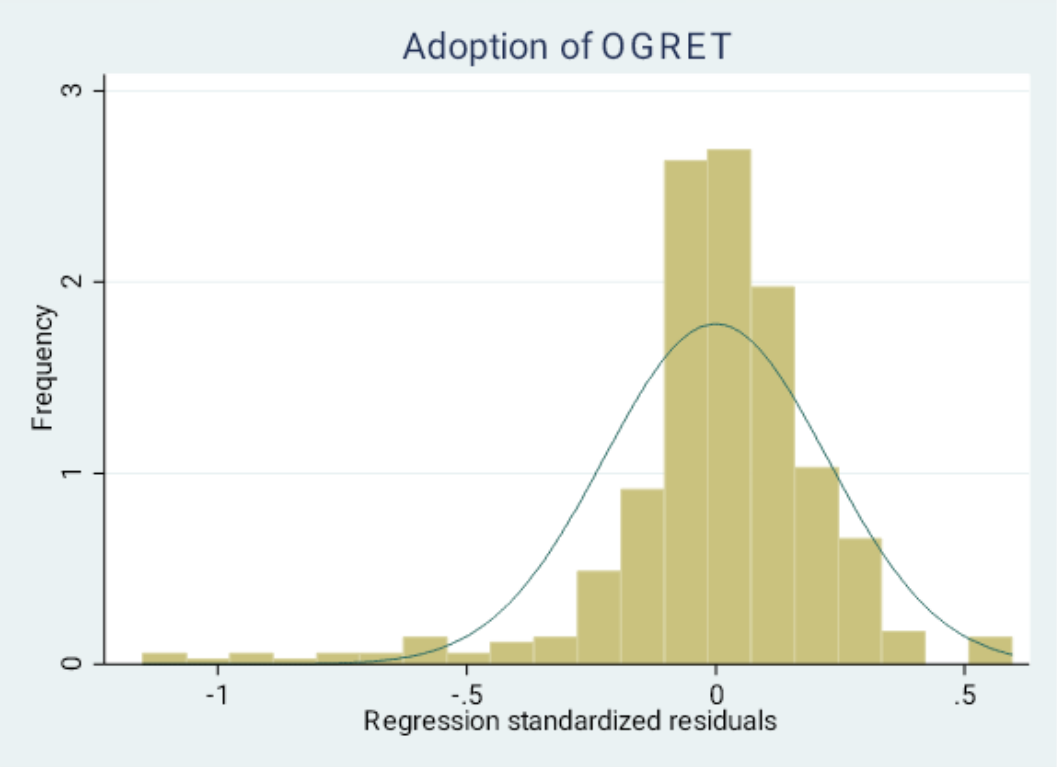


Figure 4.2: Normality test

4.5.3 Multicollinearity

The analysis of Variance Inflation Factors (VIFs) (Table 4.12) indicates that multicollinearity is unlikely to be a major concern in your regression model. All VIF values are below 5, and the mean VIF is also well below commonly used thresholds. According to

Ombaka (2014), a VIF of less than five signifies absence of multicollinearity amongst the predictor variables. This suggests that the independent variables in the model are not highly correlated with each other, and their variances are not excessively inflated due to collinearity.

Table 4.12: Variance Inflation Factors

Variable	**VIF**	**1/VIF**
Relative advantage	2.92	0.342779
Risk and trust	2.45	0.407545
Environmental concern	2.05	0.488304
Ease of use	1.71	0.584728
Awareness levels	1.59	0.63044
Initial cost	1.44	0.695238
Financial incentive	1.35	0.739505
Mean VIF	1.93	-

4.5.4 Homogeneity of Variance

The Breusch-Pagan / Cook-Weisberg test for heteroskedasticity (Table 4.13) was conducted to assess whether there is a constant variance in the fitted values of adoption rates. The null hypothesis (Ho) states that there is constant variance, while the alternative hypothesis suggests otherwise. The test yielded a chi-square statistic of 5.19 with a p-value of 0.023, indicating that there is significant evidence to reject the null hypothesis. Therefore, it can be concluded that there is heteroskedasticity present in the model, meaning that the variance of the error term is not constant across all levels of the independent variable. To address heteroskedasticity in the model, the study employed the robust standard errors.

Table 4.13: Breusch-Pagan (BP)

Inferential Statistical Test	**Chi-square statistic**	**P- Value**
Breusch-Pagan / Cook Weisberg test	5.19	0.023

4.6 Regression coefficients for predictors of adoption of OGRET

The regression analysis explored the following factors: Initial cost, financial incentives, environmental concerns, risk and trust, awareness levels, relative advantage, and ease of use. These specific factors were regarded as independent variables influencing the adoption of OGRETs, and the analysis was guided by the TAM theoretical framework.

Table 4.14: Model summary for predicting the study variables.

Model	R Square	Root MSE
Regression	0.567	0.657

Based on the provided regression results, the model's R-squared value is 0.567, indicating that approximately 56.7% of the variance in the dependent variable is explained by the independent variables included in the regression model.

Additionally, the root mean squared error (RMSE) is 0.657, which represents the average deviation of the observed values from the predicted values by the regression model. Lower RMSE values indicate better model fit, suggesting that the model's predictions are relatively close to the actual observed values.

To determine whether there existed a linear relationship among the variables in the regression, the analysis of variance (ANOVA) output was examined.

Table 4.15: Analysis of variance

Model	Sum of squares	DF	Mean square	F	Sig
Regression	221.581	7	31.654	73.31	0.00
Residual	169.250	392	0.431		
Total					

The provided ANOVA table summarizes the results of a regression analysis. In the "Regression" row, the table indicates that the regression model explains a significant portion of the variance in the dependent variable, with a sum of squares of 221.581 and 7 degrees of freedom. The mean square for the regression, calculated as the sum of squares divided by the degrees of freedom, is 31.654. The F-statistic, computed by dividing the mean square for the regression by the mean square for the residuals (error), is 73.31, indicating that the regression model is statistically significant. The associated p-value (Sig) of 0.00 confirms this significance, suggesting that at least one of the independent variables has a significant effect on the dependent variable. In contrast, the "Residual" row shows the sum of squares, degrees of freedom, and mean square for the residuals, which represents unexplained variance in the dependent variable after accounting for the regression model. Overall, the ANOVA table indicates that the regression model is a good fit for the data, with a significant relationship between the independent and dependent variables.

Table 4.16: Regression model

Variable	Regression coefficient	P-value
Initial cost	-0.039 (0.76)	0.448
Financial incentive	0.053	0.180
Environmental concern	0.147	0.009
Risk and trust	0.221	0.000
Awareness levels	0.206	0.000
Relative advantage	0.273	0.000
Ease of use	0.195	0.000

Table 4.16 provides regression analysis examining the adoption of OGRET (Off-Grid Renewable Energy Technology) as the dependent variable and initial cost, financial incentives, environmental concerns, risk and trust, awareness levels, relative advantage, and ease of use were considered as the independent variables. Initial cost and financial incentives displayed minimal impact, with initial cost yielding a non-significant coefficient of -0.039 ($p = 0.448$) and financial incentives showing a weak positive association (coefficient = 0.053, $p = 0.180$). Conversely, environmental concerns significantly influenced OGRET adoption, indicated by a positive coefficient of 0.147 ($p = 0.009$). Additionally, variables such as risk and trust, awareness levels, relative advantage, and ease of use exhibited statistically significant positive associations with OGRET adoption. These findings suggest that while socioeconomic factors may not strongly affect adoption decisions, considerations regarding environmental impact, perceived risk, awareness, and usability significantly shape the propensity to adopt OGRET.

The results show that initial cost is not associated with lower adoption rates. The coefficient is negative but not statistically significant, meaning there is no clear evidence that higher

initial costs are associated with lower adoption rates of OGRET. Households might be willing to pay an initial cost if they perceive the value of OGRET outweighs the cost.

For financial incentive, there is a possible association with increased adoption rates. The coefficient is positive but with a marginally non-significant p-value, suggesting a possible, but weak, association between financial incentives and increased adoption rates. Financial incentives might encourage people to try OGRET, but the effect might be weak.

The findings reveal that higher environmental concern level is associated with increased adoption rates. The positive and statistically significant coefficient indicates that people with higher environmental concerns are more likely to adopt OGRET. This suggests that people who care about the environment are more receptive to adopting OGRET, potentially because they perceive it as an environmentally friendly technology.

From the results, higher level of risks and trust is associated with increased adoption rates. The positive and statistically significant coefficient suggests that people who have higher trust in OGRET and are less risk-averse are more likely to adopt it. This implies that people are more likely to adopt OGRET if they believe it is a reliable and safe technology.

In terms of awareness levels, higher level of awareness is associated with increased OGRET adoption rates. The positive and statistically significant coefficient indicates that people who are more aware of OGRET are more likely to adopt it. This suggests that increasing awareness about OGRET could be an effective strategy to promote its adoption.

Higher level of relative advantage is associated with increased adoption rates. The positive and statistically significant coefficient suggests that people who perceive OGRET to have a relative advantage over other options are more likely to adopt it. This highlights the

importance of emphasizing the unique benefits and advantages of OGRET compared to other alternatives.

Ease of use of OGRET has a positive and statistically significant coefficient thus indicating that people who find OGRET easy to use are more likely to adopt it. This suggests that designing a user-friendly OGRET system is crucial for promoting its adoption.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter provides a comprehensive overview of our study, aligning with the research objectives and hypotheses formulated earlier. We analyzed primary data collected from respondents, as discussed in Chapter 4, to derive the findings presented here. Furthermore, we drew upon theoretical and empirical literature from Chapter 2 to contextualize and compare our study findings. By synthesizing these elements, we aim to offer insights into the implications of our research findings.

Overall, this chapter serves as a culmination of our study, synthesizing the findings, conclusions, and recommendations derived from our research. Through this synthesis, we seek to inform stakeholders, policymakers, and practitioners about the implications of our study findings and provide actionable insights to support efforts towards a more sustainable energy future.

5.2 Summary of the Findings

The analysis of factors influencing the adoption of off-grid renewable energy technologies (OGRET) reveals several noteworthy insights. Firstly, while concerns about initial costs and financial incentives are present, their influence on adoption decisions appears limited. Respondents expressed apprehension about the affordability of renewable energy, yet there is a notable absence of significant financial resources or incentives available to support adoption efforts. This indicates that while cost considerations remain relevant, they may not be the primary drivers of adoption, suggesting a need to explore other factors that may exert greater influence.

Secondly, environmental concerns emerge as a prominent motivator for OGRET adoption. Respondents exhibit moderate to high levels of anxiety about pollution, environmental degradation due to energy sources, and the dire consequences of climate change. Moreover, there is a prevailing belief that embracing renewable energy can serve as a solution to mitigate these pressing environmental challenges. This underscores a growing awareness of the imperative to transition towards sustainable energy sources to address environmental degradation effectively.

Thirdly, trust and risk perception play crucial roles in shaping attitudes towards renewable energy adoption. While respondents generally exhibit high levels of trust in renewable energy as a safe and secure energy source, there appears to be less awareness of the risks associated with its use. This suggests a need for greater education and awareness regarding potential risks and benefits to enhance informed decision-making among adopters.

Fourthly, relative advantage and ease of use are important factors influencing OGRET adoption this concurs with Khalid et al., (2021) findings. Respondents perceive several advantages of using renewable energy, including reductions in fossil fuel usage, environmental pollution, and cost savings in energy supply. However, there are some challenges associated with the ease of installing and learning to use renewable energy equipment, indicating areas for improvement in user-friendliness and educational materials.

Fifthly, intentions and attitudes towards renewable energy adoption are predominantly positive among respondents. There is a clear intention to allocate more resources towards renewable energy technologies and a willingness to advocate for their adoption. This signals a growing commitment towards transitioning to sustainable energy sources and promoting renewable energy adoption within Kisii County.

5.3 Conclusions

In conclusion, the analysis underscores the multifaceted nature of factors influencing the adoption of off-grid renewable energy technologies (OGRET). While concerns about initial costs and financial incentives are present, they appear to be outweighed by broader environmental concerns, trust in renewable energy, perceived advantages, and positive intentions towards adoption. The findings highlight the need for a holistic approach to promoting OGRET adoption, one that addresses not only economic considerations but also environmental awareness, trust-building, and the facilitation of user-friendly adoption processes.

Moving forward, policymakers and stakeholders should prioritize initiatives that enhance environmental education and awareness, fostering a deeper understanding of the environmental benefits of renewable energy adoption. This includes efforts to raise awareness about the risks and benefits associated with renewable energy, thereby empowering households and communities to make informed decisions about energy consumption and adoption.

Furthermore, efforts to build trust in renewable energy sources and technologies are paramount. This entails providing transparent information about the safety, reliability, and long-term viability of renewable energy solutions. By instilling confidence in renewable energy, stakeholders can overcome barriers to adoption and cultivate a culture of sustainability that prioritizes the transition towards clean, renewable energy sources.

Lastly, enhancing the ease of adoption through user-friendly technologies and accessible resources is essential for driving widespread OGRET adoption. This includes simplifying installation processes, providing comprehensive training and support programs, and ensuring

that information and resources are readily available to all segments of society. By addressing these key factors and fostering an enabling environment for OGRET adoption, we can accelerate the transition towards a more sustainable and resilient energy future for all.

5.4 Implications of Study and Recommendations

5.4.1 Implications

The implications of the findings on OGRET adoption are far-reaching, with significant implications for both policymakers and stakeholders in the energy sector. Firstly, the prominence of environmental concerns underscores the urgent need for concerted action to mitigate climate change and environmental degradation. Policymakers must prioritize the development and implementation of policies that incentivize renewable energy adoption, such as subsidies, tax incentives, and regulatory frameworks that promote the transition away from fossil fuels towards cleaner, renewable energy sources.

Secondly, building trust and addressing risk perceptions are crucial for fostering widespread OGRET adoption. Stakeholders in the energy sector, including governments, businesses, and advocacy groups, must prioritize transparent communication and education initiatives to enhance public understanding of the safety, reliability, and benefits of renewable energy technologies. By addressing misconceptions and building trust, stakeholders can create an enabling environment that encourages individuals and businesses to embrace renewable energy solutions with confidence. Collaboration between public and private sectors, along with clear regulatory frameworks, is crucial for navigating uncertainties and ensuring the long-term success of renewable energy initiatives.

Lastly, the findings underscore the importance of enhancing ease of use by promoting the accessibility and usability of renewable energy technologies. Policymakers and industry

stakeholders must invest in research and development to innovate user-friendly technologies and streamline adoption processes. Additionally, efforts to expand access to renewable energy resources, particularly in underserved communities, are essential for ensuring equitable and inclusive energy transitions. By prioritizing accessibility and usability, stakeholders can lower barriers to OGRET adoption and accelerate the transition towards a more sustainable energy future.

5.4.2 Policy recommendation

Drawing upon the insights gleaned from the analysis, tailored policy recommendations can be crafted to effectively promote the adoption of off-grid renewable energy technologies (OGRET) and foster a transition towards sustainable energy practices.

Firstly, addressing initial costs involves strategies aimed specifically at reducing the upfront expenses associated with adopting renewable energy technologies. These strategies may include subsidies, grants, tax credits, or other direct financial assistance provided by governments or organizations to offset the initial investment required adoption of OGRETs.

Secondly, there is need to enhance the financial incentives. Effective financial incentives measures encourage investment in renewable energy by offering financial benefits or rewards. This may include provision of feed-in tariffs, net metering programs, renewable energy certificates, or favorable loan terms, which aim to stimulate market demand, promote investment, and drive the adoption of OGRETs.

Thirdly, there is need to prioritize initiatives that encourage the widespread adoption of OGRETs, such as solar panels, micro hydro Systems, biomass energy systems and wind turbines which produce clean energy and reduce greenhouse gas emissions. Implementing

regulations to support the development and deployment of OGRETs, along with incentives like tax credits or subsidies for renewable energy projects, can accelerate their uptake.

Forth, it is imperative for governments to develop and enact energy policies that prioritize the integration and mainstreaming of OGRET into national energy strategies. These policies should encompass ambitious renewable energy targets, accompanied by robust regulatory frameworks that facilitate the deployment of OGRETs. Additionally, investments in research and development should be encouraged to spur innovation in OGRETs.

Furthermore, policy efforts should be directed towards enhancing public awareness and understanding of the benefits of OGRET adoption. Government-led education campaigns should be launched to disseminate information regarding the environmental, economic, and social advantages associated with renewable energy technologies. These initiatives should highlight the environmental harms caused by traditional energy sources, emphasize the potential cost savings afforded by renewable energy, and underscore the opportunities for local economic development through the promotion of renewable energy projects. Moreover, investments in renewable energy training programs are essential to build the capacity of individuals and communities to effectively install, operate, and maintain off-grid renewable energy systems.

Lastly, policymakers should prioritize policies that promote equity and inclusivity in renewable energy adoption. Efforts should be made to ensure that marginalized communities, including low-income households and rural populations, have equitable access to OGRET solutions. To this end, targeted programs should be implemented to provide financial assistance and technical support to underserved communities, thereby addressing energy poverty and environmental justice concerns.

5.5 Areas for Further Research

More research is needed to promote the adoption of off-grid renewable energy technologies (OGRET), especially in examining how different financial incentives can help overcome initial cost barriers. Comparative studies can offer valuable insights into how subsidy programs, tax incentives, and financing schemes influence the adoption of renewable energy technologies in various socio-economic contexts. Through thorough analysis, studies can evaluate the effectiveness of different incentive structures and determine the most successful strategies for encouraging OGRET adoption. Moreover, longitudinal studies that track the long-term effects of financial incentive programs can provide valuable insights into their sustainability and effectiveness over time.

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APPENDICES

Appendix I: Introduction Letter.

Strathmore University
P.O. Box 59857-00200
Nairobi, Kenya

Dear Respondent.

RE: Assessing the factors influencing the adoption of off-grid renewable energy technologies in Kenya. A case for Kisii County.

As a postgraduate student, I would like to conduct research on the subject indicated above. Information for this study will be gathered using the questionnaire that is attached. Please fill out the questionnaire completely honestly and sincerely, as all information provided will be handled in the strictest confidence. No one will need to know your name or any other form of identification when filling out the questionnaire, so don't write it down. We respectfully ask that you complete the form completely and honestly.

Your enthusiastic reply will be much valued. I appreciate your cooperation in advance.

Regards,

Alex Nyamweya Nyangaresi

Reg. No 135799.

MPPM-Strathmore University.

Appendix II: Questionnaire

We appreciate your involvement in this survey. Your knowledge will advance our comprehension of the variables affecting the adoption of off-grid renewable energy technologies. To the best of your knowledge and honesty, please respond to the following questions.

Section 1: Demographic Information

1.1. Household Head Phone Number:_____

1.2. **Sub-County:**

1.3. **Location:**[ ] Urban [ ] Rural

1.4. Number of Household Members: [Please specify]

1.5. **Main Source of Income:** [Specify, e.g., Employment, Farming, Business]

1.6. **What is your gender:** Male [ ] Female [ ] Other [ ]

1.7. **In which age bracket do you belong**? Below 18 years [ ] Between 19-30 Years [ ] 31-42 Years [ ] 43-54 Years [ ] above 55 Years [ ]

1.8. **What is your education level?** Unschooled [ ] Primary School Level [ ] Diploma [ ] B. Ed [ ] Masters [ ] PhD [ ]

Section 2: Energy Consumption

2.1. **Primary Cooking Fuel:**[ ] Electricity [ ] Firewood [ ] Gas [ ] Other (Specify)

2.2. **Main Lighting Source:**[ ] Electricity [ ] Solar [ ] Kerosene [ ] Other (Specify)

2.3. **Energy Expenses:** On average, how much do you spend on energy-related expenses per month? [Specify in Ksh. currency]

Section 3: Renewable Energy Adoption

3.1. **Awareness of Renewable Energy Technologies:**[ ] Yes [ ] No

3.2. **Current Use of Renewable Energy:**[ ] Solar Panels [ ] Wind Turbines [ ] Mini-Hydro [ ] Main Grid [ ] None [ ]

3.3. Interest in Future Adoption: [ ] Yes [ ] No [ ] Unsure

3.4. Preferred Renewable Energy Source**:**[ ] Solar Panels [ ] Wind Turbines [ ] Mini-Hydro [ ] Biogas [ ] Main Grid [ ]Other (Specify

3.5 Rate the following statements regarding your constraints to adoption of off-grid renewable energy technologies. Use the scale 1-5 where 1 implies Strongly Disagree, 2 Disagree, 3 Neutral, 4 Agree and 5 strongly Agree.

Socioeconomic factors					
Initial Cost	5	4	3	2	1
I perceive the initial cost of owning and installing renewable energy as high					
I believe that renewable energy should be more affordable to encourage widespread adoption					
I have access to financial resources for the purchase of renewable energy					
Investing in renewable energy is a wise financial decision for the future					
I consider renewable energy to be more expensive than conventional energy sources					
Financial Incentives					
Statement	5	4	3	2	1
Loans are available to acquire renewable energy					
Grants are available to acquire renewable energy					
Government subsidies renewable energy adoption					
Feed-in-Tariff (Fit) is available for adopters of renewable energy					
Tax relief is available to those who acquire renewable energy					

3.6 Rate the following statements regarding your constraints to adoption of off-grid renewable energy technologies. Use the scale 1-5 where 1 implies Strongly Disagree, 2 Disagree, 3 Neutral, 4 Agree and 5 strongly Agree.

Environmental Concerns					
Statement	5	4	3	2	1
I am anxious about pollution in the environment					
Environmental pollution caused by energy is not good					
I am anxious about environmental problems caused by energy sources					
I am anxious about climate change and the associated hazardous effect					
Utilization of renewable energy can improve the environment					

3.7 Rate the following statements regarding your constraints to adoption of off-grid renewable energy technologies. Use the scale 1-5 where 1 implies Strongly Disagree, 2 Disagree, 3 Neutral, 4 Agree and 5 strongly Agree.

Psychosocial factors					
Risk and Trust	5	4	3	2	1
I trust that renewable energy is a safe and secure energy source					
I am aware of the risks associated with renewable energy					
I feel secure and unexposed to risks when using renewable energy					
I trust that renewable energy providers prioritize my best interests					
I have more trust in renewable energy more than other energy sources					
Awareness					
Statement	5	4	3	2	1
I have information on the advantage of adopting off grid renewable energy technologies					
I have been educated through mass media about the positive impacts of off grid renewable energy technologies					
There are regular awareness campaigns, education materials and online resources educating us on off grid technologies					
I am provided with education and training programs on off grid renewable energy technologies					
I am aware of the off grid renewable energy technologies options available in my locality					

3.8 Rate the following statements regarding your constraints to adoption of off-grid renewable energy technologies. Use the scale 1-5 where 1 implies Strongly Disagree, 2 Disagree, 3 Neutral, 4 Agree and 5 strongly Agree.

Technological factors					
Relative Advantage	5	4	3	2	1
Using renewable energy reduces fossil fuels usage					
Using renewable energy decreases environmental pollution					
Using renewable energy decreases carbon footprint					
Adopting renewable energy leads to cost savings in energy supply					
Energy generation from renewable sources is more efficient than traditional fossil fuels.					
Ease of Use					
Statement	5	4	3	2	1
It is easy to install renewable energy equipment					
Learning to use renewable energy is easy for me					
Manuals on renewable energy are easy to understand					
Renewable energy installations are easy to operate					
I can master using renewable energy equipment easily					

3.9 Rate the following statements regarding your constraints to adoption of off-grid renewable energy technologies. Use the scale 1-5 where 1 implies Strongly Disagree, 2 Disagree, 3 Neutral, 4 Agree and 5 strongly Agree.

Adoption of off grid renewable energy technologies					
Statement	5	4	3	2	1
I have the intention to spend more on renewable energy technologies than other sources of energy					
I am planning to use renewable energy technologies					
Positive encouragement exists for me to adopt renewable energy					
I am willing to be renewable energy adoption ambassador					
I strongly recommend others to adopt renewable energy technologies					

Appendix III: Introduction Letter

Ole Sangale Rd, Madaraka Estate,
P.O Box 59857 00200, Nairobi, Kenya.
Cell: +254 703 414/6/7, Twitter: @SBSKenya
Email: info@sbs.ac.ke or visit **www.sbs.strathmore.edu**

Strathmore UNIVERSITY
BUSINESS SCHOOL

Tuesday, 19 March 2024

To Whom It May Concern,

RE: FACILITATION OF RESEARCH – ALEX NYANGARESI

This is to introduce Alex Nyangaresi who is a Master's in Public Policy and Management (MPPM) student at Strathmore University Business School, admission number MPPM/135799/21. As part of our MPPM Program, Nyangaresi is expected to do applied research and undertake a project. This is in partial fulfillment of the requirements of the MPPM course. To this effect, he would like to request for appropriate data from your organization.

Nyangaresi is undertaking a research paper on **"Accessing the constraints to adoption of off-grid renewable energy technologies in Kenya. Case Kisii County".**

The information obtained from your organization shall be treated confidentially and shall be used for academic purposes only.

Our MPPM Program seeks to establish links with industry, and one of these ways is by directing our research to areas that would be of direct use to industry. We would be glad to share our findings with you after the research, and we trust that you will find them of great interest and of practical value to your organization.

We appreciate your support and shall be willing to provide any further information if required.

Yours Faithfully,

Alois Njenga,
Manager – Graduate Programs,
Strathmore University Business School.

Strathmore Business School is a Proud member of:

Association of African Business Schools AABS EFMD AACSB

Appendix IV: Ethics Approval

Strathmore UNIVERSITY

15th March 2024

Mr Nyangaresi Alex,
alex.nyangaresi@strathmore.edu

Dear Mr Nyangaresi,

RE: Assessing the Constraints to Adoption of Off Grid Renewable Energy Technologies in Kenya. A Case for Kisii County

This is to inform you that SU-ISERC has reviewed and **approved** your above **SU-masters** research proposal. Your application reference number is **SU-ISERC2022/24.** The approval period is from **15th March 2024 to 14th March 2025.**

This approval is subject to compliance with the following requirements:

i. Only approved documents including (informed consents, study instruments, MTA) will be used.
ii. All changes including (amendments, deviations, and violations) are submitted for review and approval by SU-ISERC.
iii. Death and life-threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to SU-ISERC within 72 hours of notification.
iv. Any changes anticipated or otherwise that may increase the risks or affected safety or welfare of study participants and others or affect the integrity of the research must be reported to SU-ISERC within 72 hours.
v. Clearance for the export of biological specimens must be obtained from relevant institutions.
vi. Submission of a request for renewal of approval at least 60 days prior to the expiry of the approval period. Attach a comprehensive progress report to support the renewal.
vii. Submission of an executive summary report within 90 days of completion of the study to SU-ISERC.

Before commencing your study, you will be expected to obtain a research license from National Commission for Science, Technology, and Innovation (NACOSTI) https://research-portal.nacosti.go.ke/ and obtain other clearances needed.

Yours sincerely,

Mr Ambrose Rachier,
Chairperson; SU-ISERC

STRATHMORE UNIVERSITY INSTITUTIONAL SCIENTIFIC AND ETHICAL REVIEW COMMITTEE
(SU-ISERC)
15-Mar-2024
Email:ethicsreview@strathmore.edu
P.O BOX 59857-00200
NAIROBI-KENYA

Ole Sangale Rd, Madaraka Estate. PO Box 59857-00200, Nairobi, Kenya. Tel +254 (0)703 034000
Email admissions@strathmore.edu www.strathmore.edu

Appendix V: NACOSTI License

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **224519**

Date of Issue: **03/April/2024**

RESEARCH LICENSE

This is to Certify that Mr.. ALEX NYAMWEYA NYANGARESI of Strathmore University, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Kisii on the topic: Assessing the constraints to adoption of off-grid renewable energy technologies in Kenya. A Case of Kisii County for the period ending : 03/April/2025.

License No: **NACOSTI/P/24/34185**

224519

Applicant Identification Number

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